

11-13 November 2024 Arroma Grand Bangkok, Thailand



Proceedings  
of  
The 2<sup>nd</sup> Southeast Asia  
Public Health Nutrition Conference  
(2<sup>nd</sup> SEA-PHN)

Organised by :



Nutrition Association of Thailand Under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn

Co-organised by :



Food and Nutrition Society of Indonesia



Nutrition Society of Malaysia



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# **Proceedings of The 2nd Southeast Asia Public Health Nutrition Conference (2nd SEA-PHN)**

**11-13 November 2024**

# Preface

The 2nd Southeast Asia Public Health Nutrition Conference (2nd SEA-PHN) was held from November 11-13, 2024. According to the theme of this conference "Nutrition in Fostering Health and Well-Being"; Nutrition plays a critical role in fostering health and well-being, serving as a foundational element for preventing diseases and promoting longevity. Public health nutrition addresses the nutritional needs of populations, emphasizing the importance of equitable access to healthy foods and nutritional education. It contributes significantly to research on dietary patterns, lifestyle diseases, and health outcomes, thus informing policies and interventions aimed at improving community health. Achieving the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-Being), relies on effective public health nutrition strategies that ensure sustainable food systems, enhanced maternal and child nutrition, and overall health equity, ultimately promoting a healthier society.

This conference highlights the importance of ongoing research within this field, which is essential for identifying effective interventions and understanding the dietary impacts on various populations. The research and review articles presented are published in the proceedings of the Journal of Nutrition Association of Thailand, Volume 59, Special Issue, ISSN 3056-9192 (Online). This publication includes abstracts from oral, free oral, and poster presentations, as well as notable full papers. The organization and presentation of the content within this publication are the responsibility of the corresponding author and the co-authors. The scientific committee and editorial team wish to express their sincere appreciation to all authors for their valuable contributions to this publication. Furthermore, we would like to extend our gratitude to all reviewers for their constructive feedback on the submitted papers.

Associate Professor Dr. Jintana Sirivarasai

Editor

Associate Professor Dr. Kunchit Judprasong

Editor-in-Chief

Journal of Nutrition Association of Thailand

# Welcome Message

Dear Colleagues,

Nutrition Association of Thailand (NAT) is proud and delighted to host the 2<sup>nd</sup> Southeast Asia Public Health Nutrition Conference (2<sup>nd</sup> SEA-PHN) which is the official scientific meeting of the Southeast Asia Public Health Nutrition (SEA-PHN) Network Council. Particularly, this year we will celebrate the 10<sup>th</sup> anniversary of the accomplished Network Council. Topics in the meeting include the following: Emphasizing the nutrition issues in mother, infant, and young child (MIYC); Achieving nutrition, health and well-being for the elderly in SEA; Tackling NCDs with the implementation of real goals; Updating global trends and scientific knowledge in nutrition; and Discussion in harmonization of nutrient reference intake in SEA. In addition, we will broaden the research paper presentations in the areas of nutrition and community interventions in various groups, dietary intake, dietary patterns and diseases, nutrient and innovative food technologies, human nutrition and nutrition epidemiology, as well as food and nutrition policy in SEA.



The 2<sup>nd</sup> SEA-PHN will be held in Bangkok, Thailand on November 11-13, 2024 at Grand Arnona Hotel. Apart from the strong scientific content, it is being held in this culturally rich city with lots of opportunities for exploration and the venue is located in the heart of Bangkok with easy access to various attractions. The meeting is expected to be attended by about 300 delegates and exhibitors. The 3-day conference will comprise of Keynote Lectures, Plenary Lectures, Symposia, Oral and Poster Presentation of research papers.

On behalf of the Organizing Committee, I would like to extend my warm welcome to the 2<sup>nd</sup> SEA-PHN, under the theme “Nutrition in Fostering Health and Well-Being”

**Associate Professor Dr. Rewadee Chongsuwat**

President, Nutrition Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn

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# **Conference Program**

The 2nd Southeast Asia Public Health Nutrition Conference  
“Nutrition in Fostering Health and Well-Being”

11-13 November 2024

Organized by  
Nutrition Association of Thailand (NAT)

## Day 1: 11 November 2024

Time	Room A (Arroma 1&2)	Room B (Arroma 3)
07.00-08.45	<b>Registration</b>	
08.45-09.30 (45 min)	Opening Ceremony and 10 <sup>th</sup> Anniversary of SEA-PHN Network Tee E Siong, Ph.D. (Malaysia) Assoc. Prof. Rewadee Chongsuwat, Ph.D. (Thailand) Prof. Emeritus Kraisid Tontisirin, MD (Thailand)	
09.30-10.15 (45 min)	<b>Keynote Lecture</b> Nutrition Landscapes in SEA; Challenges to End All Forms of Malnutrition Warren T K Lee, Ph.D. (FAO) Moderator: Assoc. Prof. Rewadee Chongsuwat, Ph.D. (Thailand)	
10.15-11.00 (45 min)	<b>Plenary Lecture 1</b> Harmonization of Nutrient Reference Intakes in SEA Assoc. Prof. Emorn Udomkesmalee, Ph.D. (Thailand) Moderator: Tee E Siong, Ph.D. (Malaysia)	
11.00-11.30 (30 min)	Poster Presentation and Committee Evaluation/Trade Exhibition <b>(Coffee Break)</b>	
11.30-12.15 (45 min)	<b>Plenary Lecture 2</b> The Impact of Globalization on Dietary Patterns in SEA Prof. Emeritus Wichai Aekplakorn, MD (Thailand) Moderator: Clinical Prof. Emeritus Nalinee Chongviriyaphan, MD, Ph.D. (Thailand)	
12.15 -13.00 (45 min)	<b>Lunch Symposium 1</b> Muscle Matters Nutrition Strategies to Prevent Muscle Loss for Optimal Health and Functional Outcomes Asst. Prof. Sanit Wichansawakun, MD (Thailand) <b>(Abbott Laboratories Limited)</b>	
13.00-13.45 (45 min)	<b>Lunch Symposium 2</b> Dairy: High Quality Protein for Everyone Assoc. Prof. Wantanee Kriengsinyos, Ph.D. (Thailand) <b>(U.S. Dairy Export Council)</b>	
13.45-14.00 (15 min)	<b>Short Break for Setting the Room</b>	
14.00-15.00 (60 min)	<b>Symposium 1</b> Sustainable Management to Promote Healthy Longevity 1. Prof. Weerasak Muangpaisan, MD (Thailand) Perspectives on Healthy Ageing: Physical Activity and Fitness 2. Assoc. Prof. Mahenderan Appukutty, Ph.D. (Malaysia) Moderator: Assoc. Prof. Korapat Mayurasakorn, MD (Thailand)	<b>Symposium 2</b> Multiple Burdens in Maternal and Child Health 1. Assoc. Prof. Charintip Somprasit, MD (Thailand) Bridging Data and Policy: Enhancing Maternal and Child Nutrition Through the National Surveys and Routine Surveillance in Vietnam 2. Nguyen Son, Ph.D. (Vietnam) Rethinking Maternal and Child Nutrition in Thailand's Evolving Landscape 3. Thanit Vinitchagoon, Ph.D. (Thailand) Moderator: Assoc. Prof. Charintip Somprasit, MD (Thailand)
15.00-16.20 (80 min)	<b>Oral Presentation (Room A)</b> (10 minutes presentation and 2 minutes Q&A) Chairperson: Assoc. Prof. Jintana Sirivarasai, Ph.D. (Thailand) Co-chairperson: Asst. Prof. Sanit Wichansawakun, MD (Thailand) and Visaratana Therakomen, MD, FRCPT (Thailand)  <b>Presentation 1.</b> Analysis the Determinants of Stunting among 6-23 Months Children in Papua: Structural Equation Modeling Approach: <i>Dewi Hapsari Ratna M, Siti Helmyati, Shinta Prawitasari</i>	

	<p><b>Presentation 2.</b> The Potency of Postprocessed Fish Bone as Biomaterial for Hydroxyapatite Synthesis: <i>Masagus Muhammad Prima Putra, Dian Isyabillah Anggraini, Yolanda Lativa, Retno Ardhani</i></p> <p><b>Presentation 3.</b> The Effects of Policy Announcements Abolishing Temporary Street Food Selling Areas in Public Places on Vendors' Performance: A Comparative Analysis of Knowledge, Attitudes, and Practices: <i>Kulratida Rakglud, Rewadee Chongsuwat, Chanchira Phosat</i></p> <p><b>Presentation 4.</b> Assessing Anemia Risk in Young Children Using Non-Invasive Screening and Nutritional Correlates in Northeast Thailand: <i>Suchaorn Saengnipanthkul, Prapassara Sirikarn, Sasupang Musikaboonlert, et al.</i></p> <p><b>Presentation 5.</b> FTO rs9939609 Gene Polymorphism Related to High Sugar Intake in Obese Adults: <i>Sakawrut Poosri, Usa Boonyuen, Pattaneya Prangtip</i></p> <p><b>Presentation 6.</b> Factors Associated with Stunting among Under-Five Child in Thailand: <i>Ameen Mhamad, Nurin Dureh, Apiradee Lim</i></p>
	<p><b>Oral Presentation (Room B)</b> (10 minutes presentation and 2 minutes Q&amp;A)</p> <p>Chairperson: Clinical Prof. Emeritus Nalinee Chongviriyaphan, MD, Ph.D. (Thailand)</p> <p>Co-chairperson: Assoc. Prof. Suwimol Sapwarabol, Dr.P.H. (Thailand) and Asst. Prof. Tippawan Pongcharoen, Ph.D.</p> <p><b>Presentation 1.</b> Effect of <i>Wolffia globosa</i> Incorporation on the Physical, Phytochemical and Antioxidant Properties of Breadsticks: <i>May Phy Wai, Sathaporn Ngamukote, Tanyawan Suantawee, et al.</i></p> <p><b>Presentation 2.</b> The Potential Use of Banana Blossom as a Functional Ingredient in Kombucha Beverage for the Prevention of Type 2 Diabetes Risk: <i>Thitirat Poolsawat, Bandhita Wanikorn, Wilawan Sinthuprapa</i></p> <p><b>Presentation 3.</b> Effectiveness of Local Supplementary Feeding on Under-fives' Nutritional Status in Magelang Utara, Indonesia: <i>Nara Citarani, Retno Wulan Sari</i></p> <p><b>Presentation 4.</b> Local Food as a Supplementary Feeding Program for Pregnant Women with Chronic Energy Deficiency: Evaluation in Yogyakarta, 2024: <i>Aulia Rahmadini Saputri, Asma Rizkiyani, Khairani Fauziah</i></p> <p><b>Presentation 5.</b> Empowerment-Based Nutrition Communication Training Improves Nutrition Advocacy and Diet Quality in Nutrition Undergraduates: <i>Ang Zheng Feng, Chin Yit Siew, Nurzalinda Zalbahar, et al.</i></p> <p><b>Presentation 6.</b> Empowering Mothers and Their Children Through Nutrition and Urban Farming: The Impact of the PUTRA Community Nutrition Ambassador Program (PUTRACNAP) in Urban Poor Settings: <i>Yit Siew Chin, Nur Amalin Juhari, Juju Nakasha Jaafar, et al.</i></p>
	<p><b>Trade Exhibition and Scientific Talk "Moving to the Next Era with Better Nutrition Care"</b></p> <p><b>(Room: Thip-Ubol)</b></p> <p>(15.00-15.30) Empowering Thai Well-being with i-LiveWell Mr. Benjaphon Limphonyan <b>(Ajinomoto Co., Thailand Ltd.)</b></p> <p>(15.30-16.00) Management to Improve Nutritional Value and Safety of Street Food in Thailand Chanchira Phosat, Ph.D.</p> <p><b>(Thai Health Promotion Foundation)</b></p>
	<p>Poster Tour <b>(Coffee Break)</b></p>
	<b>End of Day 1 Meeting Program</b>
18.00-22.00	<p><b>Welcome Dinner and Cultural Activity</b></p> <p>Pre-registration and additional fees will be applied Number of participants: 100 (45 USD/person)</p>
	<b>End of day 1</b>

## Day 2 : 12 November 2024

Time	Room A (Arnoma 1&2)	Room B (Arnoma 3)
08.00-08.30	<b>Registration</b>	
08.30-09.15 (45 min)	<p style="text-align: center;"><b>Plenary Lecture 3</b></p> <p style="text-align: center;">Success in Anemia Reduction from an Exemplar Country</p> <p style="text-align: center;">Drivers in Anemia Reduction among Women of Reproductive Age: The Philippines Case Study</p> <p style="text-align: center;">1. Prof. Eva Goyena, Ph.D. (Philippines)</p> <p style="text-align: center;">Moderator: Assoc. Prof. Emorn Udomkesmalee, Ph.D. (Thailand)</p>	
09.15-10.15 (60 min)	<p style="text-align: center;"><b>Plenary Lecture 4</b></p> <p style="text-align: center;">Emerging Trends in Nutrition Innovation</p> <p style="text-align: center;">Personalized Nutrition: A Paradigm Shift in Public Health Strategies</p> <p style="text-align: center;">1. Asst Prof. Pornpoj Pramyothin, MD (Thailand)</p> <p style="text-align: center;">2. Taweeporn Gedaram, M.Sc. (Thailand)</p> <p style="text-align: center;">Moderator: Asst. Prof. Sanit Wichansawakun, MD (Thailand)</p>	
10.15-10.45 (30 min)	<p><b>Free Oral (Room: Thip-Ubol)</b></p> <p>Chairpersons: Assoc. Prof. Wantanee Kriengsinyos, Ph.D. and Chanchira Phosat, Ph.D.</p> <p>10.15: Improving PUFA Incorporation in Brain and Cell Membrane: <i>Theo van Kempen, Nan Ma, Lotte Smolders, et al.</i></p> <p>10.25: Calf Circumstances Identified Malnutrition in Head and Neck Cancer Patients: <i>Tran Chau Quyen, Nguyen Thi Loan, Do Tat Cuong, et al.</i></p> <p>10.35: Mapping the Diet-Obesity-Cardiometabolic Nexus Through Multidimensional Profiling and Modeling of Food Consumptions in Malaysians Adult Population: <i>Jun-Hao Lim, Ayesha Sualeheen, Ban-Hock Khor, et al.</i></p> <p><b>Free Oral (Room: Pathummas)</b></p> <p>Chairpersons: Assoc. Prof. Pattaneeya Prangtip, Ph.D. and Visaratana Therakomen, MD, FRCPT</p> <p>10.15: Parental Feeding Style and Paternal Involvement with Dietary Diversity among Young Children Aged 6 -24 Months in Malaysia: <i>Nurzalinda Zalbahar, Nurul Balquis Azlan, Nur Amalina Amirullah, Norhasmah Sulaiman</i></p> <p>10.25: Factors Influencing Ultra-Processed Food Consumption Within Vulnerable Populations: A Scoping Review: <i>Rina Chomawati, Digna Niken Purwaningrum</i></p> <p>10.35: Nutritional Challenges among Adolescents: Examining the Effects of Ultra-Processed Foods and Sugar-Sweetened Beverages: <i>Rahayu Indriasari, Rebecca Naya, Resky Ayu Glori, et al.</i></p> <p style="text-align: center;">Poster Presentation and Committee Evaluation /Trade exhibition (Coffee break)</p>	
10.45-11.45 (60 min)	<p><b>Symposium 3</b></p> <p>Health and Nutrition Literacy for Older Persons; How Can the Community Encourage and Facilitate Healthy Nutrition Behavior</p> <p>1. Prof. Vipan Prachuabmoh, Ph.D. (Thailand) 2. Terence Ng, M.Sc. (Singapore)</p> <p>Moderator: Assoc. Prof. Suwimol Sapwarabol, Dr.P.H. (Thailand)</p>	<p><b>Symposium 4</b></p> <p>Remaining Challenges on Micronutrients Malnutrition in Women and Children</p> <p>Strengthening Maternal and Child Health: Indonesia's Shift from Iron Folic Acid to Multiple Micronutrient Supplements</p> <p>1. Endang L. Achadi, Ph. D. (Indonesia)</p> <p>Iron Deficiency in the Etiology of Anemia in Southeast Asia and Global Health Context</p> <p>2. Assoc. Prof. Pattanee Winichagoon, Ph. D. (Thailand)</p> <p>Moderator: Assoc. Prof. Pattanee Winichagoon, Ph.D. (Thailand)</p>
11.45-12.00 (15 min)	<b>Short Break for Setting the Room</b>	
12.00-12.45 (45 min)	<p style="text-align: center;"><b>Lunch Symposium 3</b></p> <p style="text-align: center;">Development of Codex Nutrient Reference Values-Requirements (NRVs-R) for Older Infants and Young Children</p>	

Time	Room A (Arnoma 1&2)	Room B (Arnoma 3)
	Assoc. Prof. Umaporn Suthutvoravut, MD (Thailand) Moderator: Prof. Emeritus Kraisid Tontisirin, MD (Thailand) <b>(Pediatric Nutrition Manufacturer Association)</b>	
12.45-13.30 (45 min)	<b>Lunch Symposium 4</b> How to Tackle Obesity with Meal Replacement Panida Borisut, M.Sc.(Thailand) <b>(GIFFARINE Skyline Unity Co., Ltd.)</b>	
13.30-13.45	<b>Short Break for Setting the Room</b>	
13.45-14.45 (60 min)	<b>Symposium 5</b> Implementation of a Nutrient Profiling Scoring System from Food Group Associated Risk of NCDs/Obesity Nutrient Profiles: Facilitating Healthier Food Choices 1. Assoc. Prof. Wantanee Kriengsinyos, Ph.D. (Thailand)  Nutrient Profiling System (NPS) Based on Dishes and Meals: Pilot Implementation in Thailand 2. Pakpadsorn Sarachantapong, M.Sc.(Thailand)  Dietary Characteristics of Japanese: Meal-Based Approach 3. Murakami Kentaro, Ph.D. Japan Moderator: Assoc. Prof. Wantanee Kriengsinyos, Ph.D. (Thailand)	<b>Symposium 6</b> The Obesity Pandemic: From Preschool Child to Adolescents: The Challenges of Implementing Nutrition Program  MySNPP - Integrating 'Good Nutrition Key to Healthy Children' Module into the School Meal Programme for Obesity Prevention in Malaysia 1. Choon Huey Teo, M.Sc. (Malaysia)  Revolutionizing Child-Centric Care with Integrated Model and Digital Technologies for Improved Support and Scalable Impact 2. Chong Si Jack, MD (Singapore) Moderator: Assoc. Prof. Patcharapa Thaweekul, MD (Thailand)
14.45-15.15 (30 min)	<b>Free Oral (Room: Thip-Ubol)</b> Chairpersons: Assoc. Prof. Pattaneeya Prangthip, Ph.D and Assoc. Prof. Jintana Sirivarasai, Ph.D.  14.45: Online Food Delivery Habits and Body Image Are Associated with Percent Body Fat but Not BMI among Nutrition Students in Indonesia: <i>Nurzakiah, Safrullah Amir, Marini Amaliah Mansur, et al.</i> 14.55: Examining the Pervasiveness and Characteristics of Unhealthy Food Ads on Indian Television Targeting Children: <i>Naveen Kumar, Naresh Kumar Sharma, Vijay Pal Singh, et al.</i> 15.05: Food Environment Transformations and Policy Landscape in Zambia: A Qualitative Inquiry of the Ongoing Nutrition Transition: <i>Peter Yiga, Pui Yee Tan, Stephen Whitfield, et al.</i>	
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	<b>Free Oral (Room: A)</b> Chairpersons: Assoc. Prof. Parisut Chalermchaiwat, Ph.D. and Jitraporn Panpatch, Pham D, Ph.D  14.45: Evaluation of Physicochemical Properties and Children's Consumers Preference of Fish Galantine Added with <i>Arthrosphaira Platensis</i> for School Supplementary Feeding Program: <i>Mohammad Khosidil Haq, Indun Dewi Puspita, Latif Sahubawa, et al.</i> 14.55: Addition of Pandan Leaf Powder Increases Antioxidant Activity and Consumer Acceptance of <i>Sargassum Cristaefolium</i> Seaweed Tea: <i>Sekar Ayuning Tyas, Amir Husni</i> 15.05: Perception, Knowledge, Attitudes and Practices on Body Weight Management and Its Relationship with Physical Activity among University Students: <i>Siti Nuraisyah Mohd Rosli, Norlida Mat Daud</i>	
	<b>Free Oral (Room: B)</b> Chairpersons: Asst. Prof. Sanit Wichansawakun, and Chanchira Phosat, Ph.D.  14.45: Red Palm Oil Intervention Improves Nutritional Status of Vitamin A-Deficient Rural Schoolchildren: <i>Tan Pei Yee, Radhika Loganathan, Yvonne Lim Ai-Lian, et al.</i>	

Time	Room A (Arnoma 1&2)	Room B (Arnoma 3)
	14.55: The Evaluation of Training Programs for Community Health Worker in Monitoring Toddler Growth and Development in Yogyakarta, Indonesia: <i>Dini Triwahyuni, Ayudiva Rizky Anugraheni</i> 15.05: GEMILANG: Best Practices in Health Worker-Community Collaboration to Reduce Anemia in Stunted Toddlers in Sleman, Indonesia: <i>Khalisa Khairani, Azmia Naufala Zahra</i>	Trade exhibition / Poster tour <b>(Coffee break)</b>
15.15-16.15 (60 min)	<b>Symposium 7</b> Program to Reduce Fat, Sugar, and Salt Consumption: Positioning in SEA Assoc. Prof. Petch Rawdaree, MD (Thailand) Moderator: Prof. Jongjit Angkatavanich, Ph.D., RPh, RD, (Thailand)	<b>Symposium 8</b> Current Insights and Future Directions of Gut Microbiota on Public Health Nutrition 1. Wanilada Runggrassamee, Ph.D. (Thailand) 2. Assoc. Prof. Supapon Cheevadhanarak, Ph.D. (Thailand) Moderator: Asst. Prof. Pornpoj Pramyothin, MD (Thailand)
		<b>End of day 2</b>

### Day 3: 13 November 2024

Time	Room A (Arnoma 1&2)	Room B (Arnoma 3)	
08.30-09.00		<b>Registration</b>	08.30-11.00
09.00-10.15 (1 hr 15 min)		<b>Meet the Experts: Panel Discussion</b> Food-Based Dietary Guidelines (FBDGs) in Southeast Asian Countries: Status and Impact 1. Tee E Siong, Ph.D. (Malaysia) 2. Prof. Hardinsyah, Ph.D. (Indonesia) 3. Assoc. Prof. Mahenderan Appukutty, Ph.D. (Malaysia) 4. Assoc. Prof. Truong Tuyet Mai, MD, Ph.D. (Vietnam) Moderator: Visaratana Therakomen, MD, FRCPT (Thailand)	<b>Integrated Site Visits</b> <b>Site 1: Elderly Care Unit</b> <b>Site 2: School Visits</b>
10.15-10.45 (30 min)	<b>Free Oral (Room: Thip-Ubol)</b> Chairpersons: Asst. Prof. Sanit Wichansawakun and Assoc. Prof. Jintana Sirivarasai, Ph.D. 10.15: Unveiling the Effectiveness of the 'Care-Nutri' Programme among Caregiver-Child Dyads of the Urban Poor in Malaysia: <i>Chek Lok Poh, Gan Wan Ying, Norhasmah Sulaiman, et al.</i> 10.25: Factors Influencing Compliance with Weekly Iron-Folic Acid Supplementation among Adolescent Girls in Medan Deli, North Sumatra: <i>Asma Rizkiyani, Aulia Rahmadini Saputri, Khairani Fauziah</i> 10.35: The Relationship between Family Support and Subjective Well-Being of Diabetes Mellitus Patients at the Sangkrah Health Center: <i>Anisa Catur Wijayanti, Widya Galih Puspita, Nur Riqqah Maulita</i>	<b>Free Oral (Room: Pathummas)</b> Chairpersons: Assoc. Prof. Suwimol Sapwarabol, Dr.P.H. and Jitraporn Panpetch, Pham D, Ph.D 10.15: Assessing the Impact of the Integrated Child Health Check-up (ICH) Program on Early Detection of Nutritional and Developmental Issues in Yogyakarta: <i>Dean Salsabila Rihadatulaisi Falahudin</i> 10.25: Evaluating the Effectiveness of a Nutrition Program in Reducing Anemia Among Adolescent Girls in Yogyakarta, Indonesia: <i>Khairani Fauziah, Asma Rizkiyani, Aulia Rahmadini Saputri</i> 10.35: Factors Associated with Stress During Pregnancy in the First Trimester of Pregnancy: A Preliminary Finding of the MYBIOTA Cohort Study: <i>Shiang Yen Eow, Ling Jun Lee, Wan Ying Gan, et al.</i>	Pre-registration and additional fees will be applied USD 45 / site
	<b>Trade exhibition and poster tour</b> <b>(Coffee break)</b>		

Time	Room A (Arnoma 1&2)	Room B (Arnoma 3)	
10.45-11.45 (60 min)	<p><b>Symposium 9</b> Challenges in Alleviating Stunting in SEA Leveling up Child Health and Development Through Alleviating Stunting</p> <p>1. Assoc. Prof. Truong Tuyet Mai, MD, Ph.D. (Vietnam) Challenges in Reducing Stunting: The Unaddressed Causes 2. Asst. Prof. Tippawan Pongcharoen, Ph.D. (Thailand) Moderator: Prof. Emeritus Ladda Mo-suwan, MD (Thailand)</p>	<p><b>Symposium 10</b> Local Culinary Approach to Support a Healthy Balanced Diet and Prevent NCDs</p> <p>1. Prof. Hardinsyah, Ph.D. (Indonesia) 2. Colonel Korrakot Weratean, Ph.D. (Thailand) 3. Maria Veritas Luna, Ph.D. (Philippines) Moderator: Assoc. Prof. Pattaneeya Prangthip, Ph.D. (Thailand)</p>	
11.45-12.00 (15 min)	<b>Short Break for Setting the Room</b>		
12.00-12.45 (45 min)	<p><b>Lunch Symposium 5</b> Astaxanthin: The Antioxidant Powerhouse for Skin and Eye Sarah Cheng (Singapore)</p> <p><b>(Suntory Beverage &amp; Food (Thailand) Co., Ltd.)</b></p>		
12.45-13.00 (15 min)	<b>Short Break for Setting the Room</b>		
13.00-14.00 (60 min)	<p><b>Symposium 11</b> Nutrition Labeling to Raise Public Awareness of NCDs How the Food Industry Responds to Front-of-Package Nutrition Labeling: A Case Study of Thailand's Healthier Choice Logo</p> <p>1. Hung Nguyen-Ngoc, M.Sc. (Vietnam) Evaluation of the Impact of Singapore's Nutri-Grade Front-of-Pack Beverage Label on Food and Beverage Purchases 2. Prof. Soye Shin, Ph.D. (Singapore) Moderator: Assoc. Prof. Wantanee Kriengsinyos, Ph.D. (Thailand)</p>	<p><b>Symposium 12</b> Using AI Innovation to Improve Nutrition Management Artificial Intelligence for Carb Counting from Thai Food Image</p> <p>1. Phawinpon Chotwanvirat, Ph.D. (Thailand)</p> <p>Harnessing Artificial Intelligence: Enhancing Dietary Intake Assessment with Digital Food Images</p> <p>2. Assoc. Prof. Wong Jyh Eiin, Ph.D. (Malaysia)</p> <p>Moderator: Assoc. Prof. Tantawan Pirak, Ph.D. (Thailand)</p>	
14.00-14.30 (30 min)	<p>Trade exhibition <b>(Coffee break)</b></p>		
14.30-15.30 (60 min)	<p><b>Plenary lecture 5</b> Ecosystem in Food and Nutrition: Promoting a Healthy Diet for All Warren T K Lee, Ph.D. (FAO)</p> <p>Moderator: Prof. Emeritus Kraisid Tontisirin, MD (Thailand)</p>		
15.30-16.30 (60 min)	<p><b>Awards and Closing ceremony</b> Tee E Siong, Ph.D. (Malaysia) Assoc. Prof. Rewadee Chongsuwat, Ph.D. (Thailand) Prof. Emeritus Kraisid Tontisirin, MD (Thailand)</p>		
	<b>Adjourn</b>		

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# **Full Paper (FF)**

**The 2nd Southeast Asia Public  
Health Nutrition Conference  
(2nd SEA-PHN)**

## Research Article (FF02)

# The Effects of Policy Announcements Abolishing Temporary Street Food Selling Areas in Public Places on Vendors' Performance: A Comparative Analysis of Knowledge, Attitudes, and Practices

Kulratida Rakglud <sup>1</sup>, Rewadee Chongsuwat <sup>1</sup>, Chanchira Phosat <sup>1,\*</sup>

<sup>1</sup> Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand

## ABSTRACT

Street food vendors potentially impact consumer health outcomes, thereby influencing the broader public health landscape. This study aimed to evaluate the knowledge, attitudes, and practices of street food vendors-factors that can affect the availability of healthy food options. A descriptive cross-sectional study was conducted using a questionnaire. Data comparison was performed between two distinct phases: during the announcement of the abolition of temporarily permitted selling areas (Phase 1) and after the announcement (Phase 2). The study included 218 and 227 participants in Phase 1 and 2, respectively. Notable differences were observed between the phases: Phase 2 had a higher proportion of younger vendors (46.3% aged 18-39 years compared to 28.4% in Phase 1;  $p=0.000$ ) and a greater number of vendors with a bachelor's degree (53.7% compared to 14.0%;  $p=0.000$ ). Despite similar overall health conditions across the phases, Phase 2 showed fewer annual health check-ups (30.0% compared to 77.1%;  $p=0.000$ ) and less necessary training (27.3% compared to 65.1%;  $p=0.000$ ). Vendors in Phase 1 exhibited higher levels of knowledge ( $11.7\pm1.3$  compared to  $9.9\pm2.3$ ;  $p=0.000$ ) and better practices (99.5% compared to 73.1%;  $p=0.000$ ). These findings indicate a decline in vendor performance following the announcement, possibly due to reduced enforcement by authorities. This underscores the need for targeted strategies to effectively regulate and enhance street food vendor practices on a sustainable basis.

**Key words:** street food, street food policy, street food vendor, KAP

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\* Correspondence: chanchira.pho@mahidol.ac.th

## INTRODUCTION

Street foods are ready-to-eat items prepared and/or sold by vendors or hawkers, predominantly in street environments and similar settings. These foods constitute a substantial component of urban food consumption for millions of low- and middle-income individuals on a daily basis. As a result, street food vendors are integral to urban food systems, providing accessible and affordable meal options to a wide segment of the population<sup>1</sup>. In numerous cities, street food not only serves as a crucial source of daily nutrition for consumers but also represents an essential livelihood for vendors<sup>2-3</sup>. Recent years have seen significant regulatory changes in urban areas across Thailand, particularly concerning street food selling practices<sup>4-5</sup>. The informal nature of street food vending presents notable challenges for public health authorities, particularly regarding food safety and hygiene standards. Consequently, the regulation of street food vendors has become a key focus for policymakers seeking to balance economic opportunities with public health considerations<sup>6</sup>. One such regulatory intervention is the announcement of policies aimed at abolishing temporary street food selling areas in public places<sup>7</sup>. This policy shift has incited considerable debate about its potential impacts on both vendors and urban food environments<sup>4</sup>. Temporary selling areas have traditionally provided vendors with access to high-traffic locations, thereby ensuring the broad accessibility of their products. The elimination of these areas introduces several concerns, including increased operational challenges for vendors, such as diminished access to prime selling locations and potential reductions in customer base<sup>8</sup>. Such regulatory changes may also affect vendors' knowledge, attitudes, and practices (KAP) regarding their business operations, which could, in turn, influence their performance and overall livelihood<sup>9</sup>. Understanding the impact of these regulatory changes is essential, as vendors' KAP are directly linked to the quality and safety of the food they provide, impacting consumer health outcomes. According to KAP theory, effective behavioral change in health is achieved through the acquisition of knowledge, the formation of attitudes, and the adoption of practices. Vendors with enhanced knowledge and practices are more likely to adhere to food safety standards, thereby reducing the risk of foodborne illnesses<sup>10-11</sup>. Conversely, a decline in vendor performance could lead to poorer food quality and increased public health risks. This study aims to conduct a comparative analysis of the effects of policy announcements abolishing temporary street food selling areas on vendors' performance in Thailand. By investigating changes in vendors' knowledge, attitudes, and practices, this research seeks to provide a comprehensive understanding of how such regulatory changes impact the street food sector. The findings will offer valuable insights into the broader implications of urban food policy and contribute to ongoing discussions on effectively regulating street food vending while supporting vendors' livelihoods and ensuring public health safety.

## MATERIALS AND METHODS

### Study design and participants

A cross-sectional study was conducted involving 445 Thai street food vendors aged 18 years and older, who communicated in Thai, sold street food in Bangkok, Thailand, and voluntarily agreed to participate. Participants who were unable to complete the self-administered questionnaire were excluded from the study. The study protocol was approved by the Ethics Committee of the Faculty of Public Health, Mahidol University (Certificate of Approval No. MUPH 2021-068). Written consent was obtained from all participants prior to the study.

### Data collection

The data utilized in the current study were sourced from two distinct periods. First, secondary data were obtained from the project "Development of a Street Food Management Model to Promote Health" conducted by the Nutrition Association of Thailand <sup>12</sup>. This data was collected between 2018 and 2019, prior to the official enforcement of the cancellation of street food concession points. Second, data collected during 2021-2022 were incorporated, representing the period after the official enforcement of the cancellation. Data were gathered using a self-administered questionnaire, which was evaluated by three food and nutrition experts before its implementation. The questionnaire comprises four sections: general information, knowledge of food safety and nutrition (15 yes-or-no questions), attitudes toward food safety and nutrition (12 questions with a 5-point scale: strongly agree, agree, neutral, disagree, strongly disagree), and practices related to food safety and nutrition (12 questions with a 5-point frequency scale: always, usually, sometimes, rarely, never). For the knowledge questions, the total possible score is 15, with 1 point awarded for each correct answer. Knowledge levels were categorized based on Bloom's cut-off points <sup>13</sup>. In the attitude and practice sections, each has a maximum score of 60. The most appropriate responses receive 5 points, while the least appropriate responses receive 1 point. Attitudes and practices toward food safety and nutrition were categorized according to Best's principle <sup>14</sup>.

### Statistical analysis

All data analysis was conducted using the statistical package for the social sciences (SPSS) version 18. Data were summarized using percentages, means, and standard deviations (SD). Comparisons between data from the two phases were performed using chi-square tests and independent t-tests. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

### Participants' characteristics

The characteristics of the street food vendor participants across the two phases of the study, during the announcement of the abolition of temporarily permitted selling areas (Phase 1) and after the announcement (Phase 2), revealed notable differences (**Table 1**). In terms of age distribution, Phase 2 exhibited a notably higher proportion of younger vendors, with 46.3% aged 18-39 years compared to 28.4% in Phase 1 ( $p=0.000$ ). Conversely, Phase 1 had a greater percentage of vendors aged 40-59 years (61.5%) compared to Phase 2 (50.7%). Educational attainment also varied significantly between the phases. In Phase 2, a considerably larger proportion of vendors held a bachelor's degree (53.7%) compared to Phase 1 (14.0%), accompanied by a corresponding decrease in vendors with only high school education or less (26.0% in Phase 2 vs. 74.8% in Phase 1) ( $p=0.000$ ). Health status was largely similar across the phases, with approximately 79.8% of participants in Phase 1 and 79.7% in Phase 2 reporting no underlying health conditions. However, there was a significant difference in the incidence of infectious diseases in the six months prior to the study, with Phase 2 showing a higher proportion of vendors reporting no infectious diseases (85.0% vs. 79.4% in Phase 1,  $p=0.012$ ). The frequency of annual health check-ups decreased markedly from Phase 1 to Phase 2, with 77.1% of vendors in Phase 1 undergoing annual check-ups compared to only 30.0% in Phase 2 ( $p=0.000$ ). Similarly, the proportion of vendors who had received food/nutrition training dropped significantly in Phase 2 (27.3%) compared to Phase 1 (65.1%) ( $p=0.000$ ).

### Comparison between levels of knowledge, attitude, and practices at before and after Abolishing Temporary Street Food Selling Areas

The study findings revealed significant differences in the knowledge, attitudes, and practices (KAP) of street food vendors between Phase 1 and Phase 2. The total scores of knowledge, attitudes, and practices are presented in **Table 2**. The total knowledge score was significantly higher in Phase 1 ( $11.7 \pm 1.3$ ) compared to Phase 2 ( $9.9 \pm 2.3$ ) ( $p=0.000$ ). In contrast, no significant difference was observed in the total attitude scores between the two phases, with Phase 1 scoring  $45.2 \pm 5.8$  and Phase 2 scoring  $44.1 \pm 5.5$  ( $p=0.053$ ). A marked decline in practice scores was noted, with Phase 1 scoring  $46.2 \pm 5.8$ , significantly higher than Phase 2's score of  $30.6 \pm 3.4$  ( $p=0.000$ ). Additionally, the comparison of participant proportions across different KAP levels is illustrated in **Figure 1**. While attitudes remained relatively stable between the two phases ( $p=0.474$ ), both knowledge and practices declined significantly in Phase 2. A greater proportion of participants in Phase 1 exhibited good knowledge (57.3%) compared to those in Phase 2 (24.7%), with this difference being statistically significant ( $p=0.000$ ). In terms of practices, 99.5% of vendors in Phase 1 demonstrated good practices compared to 73.1% in Phase 2 ( $p=0.000$ ).

**Table 1.** Street food vendor participants' characteristics (n=445)

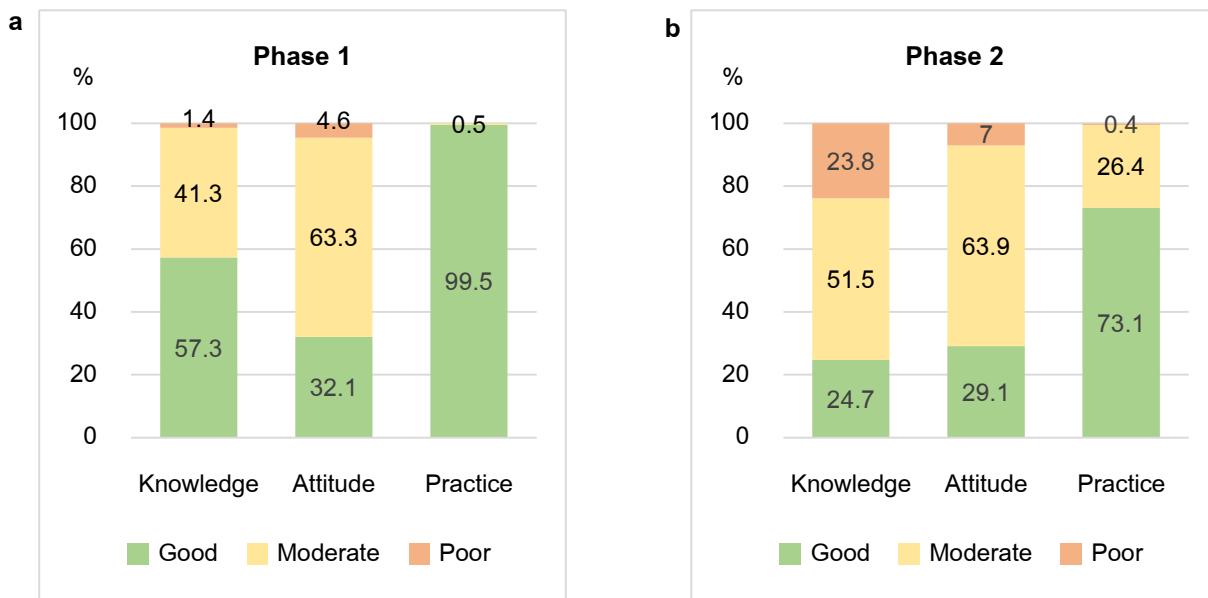
Parameters	Phase 1 (n=218)	Phase 2 (n=227)	p-value
Age			0.000*
18-39 years	62 (28.4%)	105 (46.3%)	
40-59 years	134 (61.5%)	115 (50.7%)	
> 60 years	22 (10.1%)	7 (3.1%)	
Educational level			0.000*
High school or less	160 (74.8%)	59 (26.0%)	
Diploma/high-vocational certificate	21 (9.8%)	34 (15.0%)	
Bachelor's degree	30 (14.0%)	122 (53.7%)	
Postgraduate	3 (1.4%)	12 (5.3%)	
Underlying health			0.983
No	174 (79.8%)	181 (79.7%)	
Yes	44 (20.2%)	46 (20.3%)	
Having Infectious disease during 6 months prior to the study			0.012*
No	173 (79.4%)	193 (85.0%)	
Flu	37 (17.0%)	21 (9.3%)	
Diarrhea	3 (1.4%)	4 (1.8%)	
Covid-19	2 (0.9%)	9 (4.0%)	
Others	3 (1.4%)	0 (0.0%)	
Having annual health check-up			0.000*
No	50 (22.9%)	159 (70.0%)	
Yes	168 (77.1%)	68 (30.0%)	
Participating in any food/nutrition training			0.000*
No	76 (34.9%)	165 (72.7%)	
Yes	142 (65.1%)	62 (27.3%)	

Data are presented as n (%). Significant differences were analyzed using the Chi-square test. \*p-value < 0.05 was considered statistically significant.

**Table 2.** Comparison of the average scores for knowledge, attitudes, and practices among street food vendor participants

Parameters	Phase 1 (n=218)	Phase 2 (n=227)	P-value
Knowledge (Total score = 15)	11.7±1.3	9.9±2.3	0.000*
Attitude (Total score = 60)	45.2±5.8	44.1±5.5	0.053
Practice (Total score = 60)	46.2±5.8	30.6±3.4	0.000*

Data are presented as mean ± standard deviation (SD). Significant differences were analyzed using an independent t-test. \*p-value < 0.001 was considered statistically significant.



**Figure 1.** Comparison of the levels of knowledge, attitudes, and practices (KAP) among street food vendor participants in Phase 1 and Phase 2. Figure 1a and 1b present the percentage of participants at different levels of KAP in Phase 1 and 2, respectively.

## DISCUSSION

The analysis of street food vendor characteristics across two study periods revealed notable shifts in demographic, educational, and health-related factors, providing valuable insights into the effects of policy changes and other influences on the street food vending sector. A significant change in the age distribution of vendors followed the policy amendment concerning temporary street food selling areas. The increase in younger vendors (aged 18-39 years) suggests that street food vending has become more appealing to this age group, potentially driven by economic shifts or new employment opportunities in urban areas during the COVID-19 pandemic. In contrast, the reduction in older vendors (aged 40-59 years) following the policy change might reflect retirement trends or a shift toward alternative sources of income among this age group. This demographic transition is significant for the sustainability of the street food sector, as younger vendors may introduce innovative business strategies, technological advancements, and greater adaptability to regulatory changes<sup>15</sup>. Educational attainment among vendors also demonstrated significant changes. The proportion of vendors with a bachelor's degree increased substantially after the policy change (53.7%) compared to before (14.0%). This rise indicates a trend toward greater formalization and professionalization within the street food sector. More educated individuals may be better equipped to handle the challenges posed by policy changes, health regulations, and business management. This trend could reflect a response to economic pressures or an increased perception of street food vending as a viable business opportunity for those with higher educational backgrounds<sup>16</sup>. Health status data showed consistency across both periods, with the majority of vendors reporting no underlying health conditions. However, a significant decline in the frequency of annual health check-ups was observed after the policy change, with only 30.0% of vendors undergoing regular check-

ups, compared to 77.1% before the change. This marked decrease raises concerns about the long-term health and well-being of vendors, as regular health check-ups are critical for early detection of illnesses and preventive health care. The decline may be attributed to reduced access to healthcare services, changing vendor priorities, or economic constraints limiting their ability to maintain routine health monitoring. Another concerning trend is the significant reduction in food and nutrition training among vendors after the policy change, with only 27.3% receiving training compared to 65.1% before the policy change. Given the importance of food safety and nutrition in the street food industry, this decline is alarming and suggests a potential gap in vendors' knowledge and adherence to food safety standards, posing risks to public health. This decline may be linked to a reduction in government-sponsored training programs following the policy change. Addressing this gap is essential to ensuring that street food continues to meet acceptable health and safety standards <sup>17</sup>.

An analysis of changes in vendors' knowledge, attitudes, and practices (KAP), critical elements for the appropriate performance of street food vendors, revealed significant changes following the policy intervention. The total knowledge score was notably higher in the earlier period, indicating a decline in vendors' overall understanding of food safety, and nutrition practices post-policy change. This decrease could be due to reduced access to training and educational resources or changes in the operational environment that affected vendors' ability to stay informed <sup>18-19</sup>. In contrast, attitude scores remained relatively stable between the two periods, suggesting that while vendors' knowledge and practices were affected, their general attitudes toward street food vending remained unchanged. This stability implies that vendors' perceptions and beliefs about their work's importance persisted despite shifts in knowledge and practices. A significant decline was observed in practice scores, with a substantial deterioration in the implementation of food safety and nutrition practices following the policy change. This decline may reflect operational challenges or reduced opportunities for vendors to maintain effective practices due to changes in their selling environments or regulations. A comparison of vendor proportions across different KAP levels further underscores these changes. While attitudes remained stable, significant declines in both knowledge and practices were evident, with the earlier period showing a higher proportion of vendors exhibiting good knowledge and practices compared to the later period. These differences highlight the considerable negative impact of policy changes on vendors' adherence to best practices and their understanding of food safety, raising critical public health concerns. Overall, the study suggests that the policy changes, particularly the abolition of temporary street food selling areas, may have negatively impacted vendors' ability to maintain high standards of food safety and nutrition. The observed decline in knowledge and practices highlights the need for targeted interventions to support vendors in adapting to regulatory changes while ensuring compliance with essential food safety standards and nutrition recommendation. Such interventions should focus on enhancing access to training and healthcare resources to mitigate the negative impacts of policy changes and promote the overall well-being of the street food vending community <sup>20-22</sup>. However, this study has limitations. First, it

relies on self-reported data from vendors, which may introduce reporting bias. Second, data collection was confined to two specific time periods, which may not fully capture long-term trends or fluctuations in street food vending practices. Lastly, the absence of longitudinal follow-up limits the study's ability to assess the long-term impacts of policy changes on vendor behavior and public health outcomes.

## CONCLUSION

In conclusion, the study highlights significant demographic, educational, and health-related shifts among street food vendors following policy changes, particularly the abolition of temporary selling areas. The increased participation of younger vendors indicates that street food vending has become more appealing to this demographic, while the decline in essential training raises concerns about the sector's long-term sustainability. The findings emphasize the negative impact of policy changes on vendors' knowledge and practices, particularly in relation to food safety and nutrition. Despite stable attitudes, the decline in the practical implementation of safety measures underscores the need for targeted interventions. This highlights the importance of developing comprehensive and sustainable strategies to ensure consistent adherence to safety and nutrition standards among street food vendors. Addressing these issues is critical for enhancing the availability of healthy food options and improving public health outcomes within the community.

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## CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest concerning the publication.

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## Research Article (FF03)

### Factors Associated with Stunting in Children Under Five in Thailand

Ameen Mhamad <sup>1,2\*</sup>, Nurin Dureh<sup>1</sup>, Apiradee Lim<sup>1</sup>

<sup>1</sup>Department of Mathematics Computer Science, Faculty of Science Technology,

Prince of Songkla University, Pattani Campus, Pattani, Thailand

<sup>2</sup>Regional Health Promotion Center 12, Yala, Thailand

#### ABSTRACT

Stunting among children affects their wellbeing and growth, especially in children under five years of age, which is the golden period of brain development. This study aims to examine the prevalence and factors influencing stunting among children under five. Thailand Multiple Indicator Cluster Survey (MICS) 2022 data were used in this study, with 9,263 children under-five year olds. The study analyzed the 14 independent variables comprised of child (age, gender, and health insurance), maternal (age, education, marital status, and insurance), and household (region, area, wealth index, language, and household's head age, gender and education) characteristics. The Chi-squared and multiple logistic regression (MLR) were used for data analysis. The results showed that 14.9 percent of children under-five were stunted. Child's gender and age, mother's age and education, household head's age and education, regions, wealth index, and language were significant factors related to stunting. MLR analysis revealed that children under 12 months old were 2.36 times more likely to be stunted compared to those aged 48-59 months (95% CI [1.96,2.85]). Children who lived with mothers had lower secondary education were 1.35 times more likely to be stunted compared with higher education (95% CI [1.13,1.62]). Compared to the central region, children in the southern region were 1.40 times more likely to be stunted (95% CI [1.1,1.71]). Parent education were significantly associated with under-five stunting. Effective maternal and child health policies must focus on the southern region, particularly improved parent's nutrition literacy to reduce under-five child stunting in Thailand.

**Key words:** stunting, children under five, multiple indicator cluster survey, Thailand

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\* Correspondence: 6520330006@email.psu.ac.th

## INTRODUCTION

Addressing stunting is a global priority. Despite the establishment of target through the sustainable development Goals (SDGs) to eliminated hunger and all form of malnutrition in 2030<sup>1</sup>. This policy driving effort to eliminate stunting across countries remains a major challenge, due to impacts of COVID-19<sup>2</sup> and climate change which effect to the food security, household incomes, and healthcare system<sup>3-4</sup>, which are all contributing factors to stunting in children in child age under five. Globally, 148.1 million children under age of five year suffer from stunting with estimated 22.3 percent, which mostly occurred in Asia and Africa, especially in low- and middle-income countries (LMIC)<sup>5</sup>.

Stunting is a consequence of long-term deficiency of energy and nutrients which effect to child length/height which too short for their age<sup>6</sup>. Stunting effected to child development and increases the risk of morbidity, and chronic disease<sup>7</sup>. Stunting in the early period of life especially in the first 5 years effects to cognitive impairments in later adulthood and another generation. The stunting in children not only effect to public health sector but also in economic outcome in those countries<sup>8</sup>. Factor associated with stunting can be classified in to three main factors. Firstly, child factor such as gender<sup>9</sup>, child age<sup>10</sup> and child health insurance covering. Maternal factor such as age and educational levels<sup>10-11</sup>, marital status and health insurance. Household factors including area<sup>12</sup>, geographical regions and household wealth (10) (household type, ownership of consumer goods, energy use, water sanitation). Moreover, household head characteristic comprised with gender, age, education, and language<sup>13</sup> using in household were the determinants of stunting. Thailand has implemented maternal and child health care framework to reduce stunting<sup>14</sup>. Supporting the nutritional needs of pregnant women and promoted child nutrition and increase food accessibility, stunting rates have been decreasing from over 22 percent in 1987<sup>15</sup> to 13.3 percent in 2019<sup>16</sup>.

Thailand has successful reduced the stunting among under-five children, but achieving the ministry of public health's target less than 10 percent and eliminated stunting in Thailand remain challenging. Therefore, it is importantly to understand the situations and factors which are continuously changing to find precision solutions. The main objective of this study is examining the prevalence and factors influence on stunting in children under five in Thailand.

## MATERIALS AND METHODS

### Data source

This study uses the data from the Thailand Multiple Indicator Cluster Survey (MICS) 2022. The Thailand MICS 2022 collected data through a trained interviewer team and a translator or non-Thai household interview, using computer-assisted personal interviewing. As per the norm of MICS procedures, before conducting the survey, consent was gathered from all potential respondents. Multi-stage random sampling of provinces in four regions (Central, North, Northeast, and South) was

conducted in this study. The number of census areas was determined using probability proportional to size within each stratum. In accordance with UNICEF data collection guidelines, written informed consent was obtained from all mothers or caregivers during the primary data collection process. Although the MICS dataset is freely accessible, consent for secondary data analyses was also obtained via mail as part of the protocol.

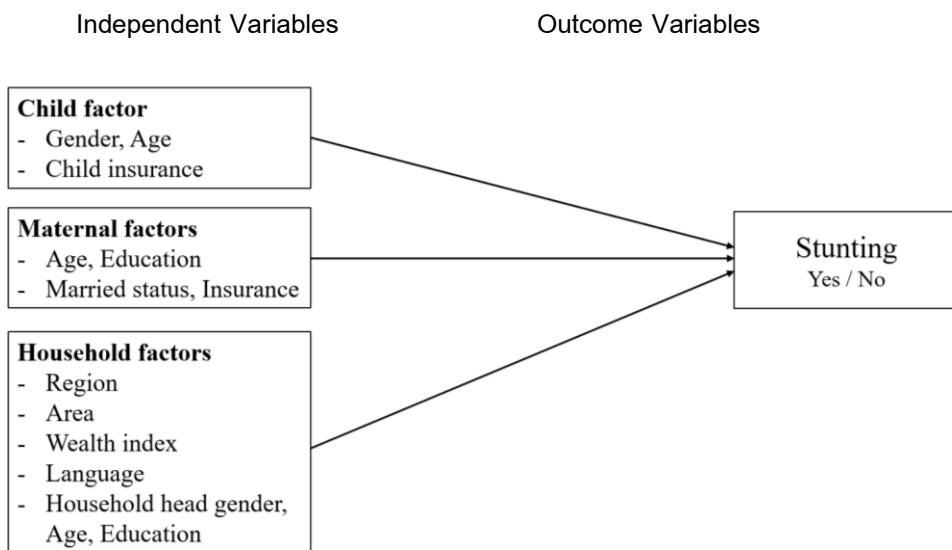
## Variables

### Outcome variables

For the outcome variables, WHO child growth standard<sup>17</sup> was used to classify the under 5 child nutritional status. Weight, age and gender of children were used as indicator to calculate z-score value by using library z-score in R program. The children who had low height for their age which are height-for-age (HAZ) z-score below-2 SD classified as stunting.

### Independent variables

Variables on potential determinants included in the analysis were: child sex (male or female), child age (0-11, 12-23, 24-35, 36-47 and 48-59 months), child health insurance (with and without insurance), mother's age (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49 year old), mother's education (pre-primary or non, primary, lower secondary, upper secondary, higher), marital status (With registration, without registration, and not in union), mother wealth insurance (with and without insurance), regions (Central, North, Northeast, and South), area of residence (rural and urban), language of household head (Thai and non-Thai), household head gender(male and female), household head age(<30,30-44,45-59,>60 years old), household head education (pre-primary or non, primary, lower secondary, upper secondary, higher), wealth index (poorest, second, middle, forth, and richest) (Figure 1).

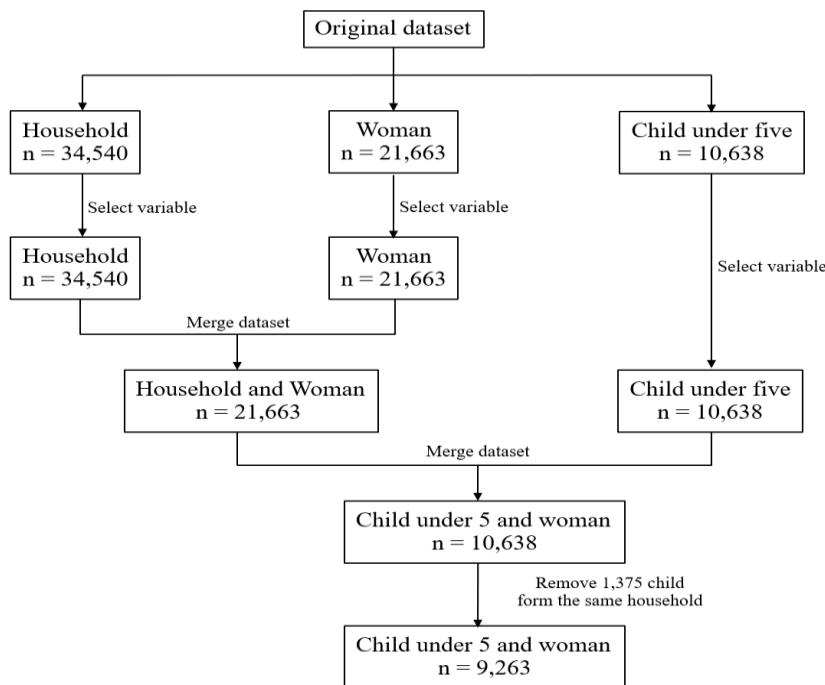


**Figure 1.** Relationship between independent variables and outcome.

### Data management

Data management of this study using various steps. Each original dataset was collected using different standard questionnaires comprised with household, women, and children questionnaire. For household questionnaire, there were 34,540 observations. For individual woman, there were 21,663 observations collected from woman aged 15-59 years. This dataset includes woman's background such as age, education, and occupation, which are represent the mother of the under five children. The last questionnaire is the under 5 child questionnaires, there were 10,638 observations of the children under five questionnaires consist of under five children' background, birth registration and anthropometry as shown in **Figure 2**.

The variables of interest were selected from the household data, women's dataset, and under-five child datasets. These three datasets were then merged using unique identifiers cluster number, household number, and line number, resulting in 10,638 observations. Duplicate children from the same household were removed, leaving 9,263 observations for analysis. The data management process is illustrated in **Figure 2**.



**Figure 2.** Data Management Diagram

### Statistical analysis

All analyses were performed with various factors for under five children using the R program. The Chi-square test was used to examine the association of stunting and factors (child, maternal, and household factors), which hypothesized that those variables were likely related to stunting, as supported by literature review in the previous section. All significant variables from the univariate analysis were included in the multiple logistic regression analysis, with the final variable selection determined using the backward selection method. Likelihood Ratio (P-LR test) showed the overall fit of the model by comparing the likelihoods. Wald's test (P-Wald Test) was used for testing the relationship between each variable and outcome. The adjusted odds ratios (OR) were reported with 95% confidence intervals, and a P-value of less than 0.05 was considered statistically significant.

### Ethical approval

The protocol of this study was approved by the human research committee, Prince of Songkla University, Pattani campus (COA number: psu.pn.1-003/67).

## RESULTS

### Descriptive statistics

This study included a total of 9,263 children under the age of five. The distribution of child characteristics showed that gender was almost evenly split, with 51.5 percent being male. More than 95.8 percent of the children were covered by health insurance. The age distribution was roughly 20 percent for each age group, except for children aged 12-23 months, who made up 11.3 percent of the

sample. The majority of mothers in the study were aged between 30 to 34 years, representing 20 percent of the group. Approximately 28.2 percent of the mothers had attained higher education. Regarding health insurance, only 3.1 percent of the mothers were not covered by any form of health insurance. In terms of marital status, 52.4 percent of mothers were married but without official registration. For household characteristics, 32.8 percent of the children resided in the southern region, and 55 percent lived in rural areas. Regarding household wealth, only 14.5 percent were in the 5th quintile, indicating the wealthiest households. Over 86.6 percent of households primarily spoke Thai. Most household heads were male, making up 59 percent, with 34.3 percent aged between 45-59 years. Additionally, 52.7 percent of household heads had primary education, while only 5.6 percent had pre-primary or no formal education.

### Univariate analysis

The results of the univariate analysis are presented in **Table 1**, showing the association between child factors, maternal factors, household factors, and stunting status using the Chi-square test. The study found that both gender and age group were significantly associated with stunting in children under the age of five. Among maternal factors, only mother's education level was significantly associated to child stunting. In terms of household factors, region, wealth index, language spoken in the household, as well as the age and education level of the household head were all significantly associated with stunting ( $p$ -value  $< 0.05$ ). These significant variables were then included in the full model for further analysis.

**Table 1.** Univariate analysis of factor associated with under-5 child stunting

Predictors	Stunting		Test stat.	P value
	No	Yes		
Total	7259	1274		
Gender			Chisq. (1 df) = 6.8	0.009
Female	3575(49.2)	577(45.3)		
Male	3684(50.8)	697(54.7)		
Age group			Chisq. (4 df) = 130.41	< 0.001
0-11 month	1244(17.1)	355(27.9)		
12-23 month	744 (10.2)	178 (14)		
24-35 month	1674(23.1)	296(23.2)		
36-47 month	1812 (25)	237(18.6)		
48-59 month	1785(24.6)	208(16.3)		
Child insurance			Chisq. (1 df) = 1.22	0.27
Yes	7059(97.3)	1232(96.7)		

Predictors	Stunting		Test stat.	P value
	No	Yes		
No	199 (2.7)	42 (3.3)		
Maternal age (years)			Chisq. (6 df) = 16.46	0.012
15-19	147 (2.5)	34 (3.1)		
20-24	652 (11.2)	148 (13.6)		
25-29	1247(21.5)	267 (24.5)		
30-34	1490(25.7)	263 (24.2)		
35-39	1243(21.4)	194 (17.8)		
40-44	730 (12.6)	129 (11.9)		
45-49	294 (5.1)	53 (4.9)		
Marital status			Chisq. (2 df) = 0.51	0.777
With registration	2275(39.2)	420 (38.6)		
Without registration	3043(52.4)	582 (53.5)		
Not in union	485 (8.4)	86 (7.9)		
Mother education			Chisq. (4 df) = 18.63	< 0.001
Pre-primary or none	238 (3.3)	48 (3.8)		
Primary	1926(26.6)	329 (25.8)		
Lower secondary	1359(18.7)	282 (22.2)		
Upper Secondary	1701(23.5)	321 (25.2)		
Higher	2027 (28)	293 (23)		
Mother insurance			Chisq. (1 df) = 2.24	0.134
Yes	5576(96.1)	1056(97.1)		
No	225 (3.9)	32 (2.9)		
HH head gender			Chisq. (1 df) = 0.08	0.774
Female	2994(41.2)	520 (40.8)		
Male	4265(58.8)	754 (59.2)		
HH head age group			Chisq. (3 df) = 31.74	< 0.001
<30	590 (8.1)	161 (12.6)		
30-44	2084(28.7)	366 (28.7)		
45-59	2531(34.9)	439 (34.5)		
>60	2054(28.3)	308 (24.2)		

Predictors	Stunting		Test stat.	P value
	No	Yes		
HH education level			Chisq. (4 df) = 13.9	0.008
Pre-primary or none	367(5.1)	95(7.5)		
Primary	3905(53.9)	659 (51.7)		
Lower Secondary	871 (12)	163 (12.8)		
Upper Secondary	1061(14.6)	188 (14.8)		
Higher	1043(14.4)	169 (13.3)		
Area			Chisq. (1 df) = 0	0.99
Rural	4081(56.2)	716(56.2)		
Urban	3178(43.8)	558 (43.8)		
Region			Chisq. (3 df) = 38.33	< 0.001
Central	1191(16.4)	171 (13.4)		
North	1366(18.8)	198 (15.5)		
Northeast	2417(33.3)	395 (31)		
South	2285(31.5)	510 (40)		
Wealth index			Chisq. (4 df) = 9.68	0.046
Poorest	1547(21.3)	291 (22.8)		
Second	1593(21.9)	304 (23.9)		
Middle	1645(22.7)	274 (21.5)		
Fourth	1436(19.8)	258 (20.3)		
Richest	1038(14.3)	147 (11.5)		
Language			Chisq. (1 df) = 42.31	< 0.001
Non-Thai	892 (12.3)	242 (19)		
Thai	6367(87.7)	1032 (81)		

### Multivariate analysis

**Table 2** reveals the association between factors and stunting using multiple logistic regression. Both child gender and age were significantly associated with stunting. Male children under the age of 5 were 1.16 times more likely to be stunted. Children younger than 12 months were 2.36 times more likely to experience stunting compared to those aged 48-59 months. Regarding maternal factors, only the mother's education level had a significant impact on stunting. Children whose mothers had a lower secondary education were 1.35 times more likely to be stunted, using higher education as the reference.

Additionally, children living in households where the head was younger than 30 years were 1.49 times more likely to be stunted compared to those where the household head was older than 60 years. Children from households that did not speak Thai as the primary language were 1.42 times more likely to be stunted. In terms of regional differences, children in the southern region were 1.44 times more likely to be stunted compared to those in the northern region.

Other variable such as child insurance, maternal age, maternal married status, mother health insurance, household head gender, household head education, area of living, and household wealth index does not appear to significant effect on stunting with statistical model.

## DISCUSSION

This study estimated the prevalence of under 5 child stunting by using data form Thailand MICS 2022 data. The prevalence among under-5 child stunting in this study was 14.9 percent. The prevalence of stunting in Thailand is seen to be lower rate when compare with the region (26.4) and global (22.3) estimated<sup>5</sup>. Moreover, when compared with countries in south and southeast Asia, Thailand prevalence of stunting still lower than Pakistan (40.0), Afghanistan (33.1), India (31.7), Philippines (28.8), Lao People's Democratic Republic (27.7), Nepal (26.7), Myanmar (24.1), Cambodia (22.3), Malaysia (21.9), Viet Nam (19.3) and Sri-Laka (15.9)<sup>5, 18</sup>. However, Brunei Darussalam (3.4) and Singapore (3.0) shows the lower prevalence of stunting than Thailand<sup>5</sup>. The prevalence of stunting varies by country, indicating the efficiency of public health interventions. Thailand's reduced prevalence relative to regional and worldwide averages signals progress, although there is still potential for improvement when compared to countries with substantially lower rates such as Singapore and Brunei.

In term of risk factors of stunting amongst under-5 children in Thailand. The household factors were the strongest influence on stunting. Children in southern regions of Thailand were about more likely to experience stunting. This study showed similar results to the study of childhood stunting in Thailand<sup>19</sup> found that children who lived with southern of Thailand more likely to face with stunting than another region<sup>11, 20</sup>. The study of food insecurity in household by using MICS survey 2019 also found that, household food insecurity in southern region significantly higher than other regions which may increase the risk of stunting among children. Moreover, language using in household was significantly associated with under five child stunting after adjusting the confounding factor. Ethnic, culture and language are a major influence on health and nutrition<sup>21</sup>. Especially, language mostly indicated the barrier of communication between the under-five child parent and health care provider, which restrict the access quality child health knowledge<sup>22</sup>. Non-Thai speaker household might have difficulties in assessing information. Even though, Thailand performed well in maintaining mother and health child service(23), an overarching ethical language health information should be considered for improved caregiver health literacy to reduce prevalence of stunting in Thailand.

**Table 2.** The association between factors and stunting using multiple logistic regression

Predictors	OR <sub>adj</sub> (95 % CI)	P-Walds test	P-LR test
Gender			
Age group			< 0.001
48-59 month (ref.)	1		
0-11 month	2.36 (1.96,2.85)	< 0.001	
12-23 month	1.91 (1.53,2.38)	< 0.001	
24-35 month	1.47 (1.22,1.78)	< 0.001	
36-47 month	1.1 (0.91,1.35)	0.327	
Mother education			0.017
Higher (ref.)	1		
Pre-primary or none	1.27 (0.9,1.8)	0.18	
Primary	1.21 (1.01,1.44)	0.034	
Lower Secondary	1.35 (1.13,1.62)	0.001	
Upper Secondary	1.24 (1.05,1.48)	0.014	
HH head age			0.006
> 60 yr (ref.)	1		
< 30 yr	1.49 (1.2,1.85)	< 0.001	
30 – 44 yr	1.09 (0.92,1.29)	0.323	
45- 59 yr	1.1 (0.94,1.29)	0.24	
Language			< 0.001
Thai (ref.)	1		
Non-Thai	1.42 (1.19,1.68)	< 0.001	
Region			< 0.001
North (ref.)	1		
Central	1.03 (0.82,1.29)	0.816	
Northeast	1.18 (0.97,1.42)	0.094	
South	1.44 (1.2,1.73)	< 0.001	

There are few limitations of this study, this study was the cross-sectional study which cannot explain the causality of the risk factors and under-5 child stunting. Secondly, other child characteristics such as exclusive breastfeeding, diet history pattern and young child feeding practice were excluding

form this study, due to data were available only for a subset of children, which not cover all children age under five. In spite of the study limitations, the appropriate protocol and research methodology of the MICS data produce the huge dataset of nationally representative of under 5 child nutritional status.

## CONCLUSION

This study assessed the prevalence and factors associated with stunting in children under five in Thailand. The findings revealed that stunting prevalence in Thailand is relatively low compared to other South and Southeast Asian countries, which are predominantly low- to middle-income. Household factors were confirmed to play a significant role in child stunting, with children in the southern region and non-Thai-speaking households being more affected. The study suggests that targeted nutritional policies, along with integrated medical and social interventions, are essential for addressing and ultimately eliminating stunting in Thailand, especially in high-risk regions.

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## Research Article (FF04)

### Effect of *Wolffia globosa* Incorporation on the Physical, Phytochemical and Antioxidant Properties of Breadsticks

May Phy Wai<sup>1</sup>, Sathaporn Ngamukote<sup>1</sup>, Sirichai Adisakwattana<sup>1</sup>, Tanyawan Suantawee<sup>1\*</sup>

<sup>1</sup>Phytochemical and Functional Food Research Unit for Clinical Nutrition, Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand.

#### ABSTRACT

Unhealthy diets high in fats, sugars, carbohydrates, and low in fiber are linked to an increased risk of non-communicable diseases (NCDs) such as obesity, hypertension, diabetes, and heart disease. This has driven people towards healthier lifestyles and foods enriched with fiber and phytochemicals. *Wolffia globosa*, or duckweed, is a nutrient-dense plant rich in protein, fiber, phytochemicals, and antioxidants, offering health benefits including lowering blood glucose levels. This study aims to develop nutrients enriched breadsticks by utilizing duckweed. Nutritionally enhanced breadsticks were developed by using 5%, 10% and 15% of *Wolffia globosa* powder (WP). The effect of WP on breadsticks' hardness, fracturability, color, total phenolic compounds (TPC), total flavonoid contents (TFC), antioxidant power (DPPH radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP)) and consumer acceptability by 9-point hedonic scale were then evaluated. Results showed that adding 5-15% WP significantly increased the breadsticks' hardness and fracturability while reducing lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ ) of the breadsticks ( $p < 0.05$ ). TPC, TFC, and antioxidant power increased significantly with 10% and 15% WP ( $p < 0.05$ ). In terms of acceptability, consumer acceptance was not negatively impacted by 5% and 10% WP, while 15% WP received neutral ratings. Our findings indicate that incorporating high phytochemical and antioxidant rich WP into breadsticks enhances their bioactive compounds and antioxidant activity while also being well-received by consumers. These results suggest that WP could be a valuable addition for creating healthier, antioxidant-enriched food products, offering more nutritious options for consumers.

**Key words:** *Wolffia globosa*, phytochemicals, breadsticks, antioxidant, consumer acceptability

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\*Correspondence: Tanyawan.S@chula.ac.th

## INTRODUCTION

Busy lifestyles have led a lot of people to opt for ready-to-eat foods (RTE) that require no further preparation to save time and energy. However, these RTE often contain high levels of fat, sugar, and refined carbohydrates, contributing to their unhealthiness<sup>1</sup>. It has been reported that unhealthy behaviors such as eating diets rich in fats and sugars, and lack of physical activity contribute to the incidence of non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes and obesity. These unhealthy factors also contribute to over half of the global mortality<sup>2</sup>. Due to this knowledge, individuals are becoming more conscious of RTE products such as cookies and doughnuts, associated with health problems and are actively searching for the foods with healthier ingredients, focusing on those with reduced fats, sugars and refined carbohydrates<sup>3</sup>. Therefore, many researchers are trying to enhance the nutritional content of the food products mostly starch based items such as cookies, noodles, and breadsticks by incorporating with high phytochemicals plant compounds that also have antioxidant properties. In other study, researchers incorporated different percentages of lotus rhizome powder (LRP), a good source of dietary fiber and phytochemicals into the refined wheat flour ranging from 0% to 20% and found that it can enhance the nutritional composition of the products significantly<sup>4</sup>. Another study investigated the phytochemicals, antioxidants, texture, and consumer preference of breadsticks by substituting wheat flour with red grape pomace at varying concentrations (0%, 5% and 10%). The results showed that the breadsticks enriched with red grape pomace increased in phenolic compounds and antioxidant properties, received positive feedback from the consumers<sup>5</sup>. These researchers try to provide consumers with healthier food choice options.

*Wolffia globosa*, a species of water lentil, is an aquatic plant with green fronds that float or sink<sup>6</sup>. *Wolffia globosa* belongs to *Lemnoidae* (duckweed) family and *Araceae* subfamily, also known as duckweed or watermeal. Historically, *Wolffia arrhiza* which also belongs to the same family with *Wolffia globosa* and has been consumed as a vegetable by Burmese, Laotian, and northern Thai communities for generations. It has been reported that freeze-dried *Wolffia globosa* contains 52.59% carbohydrates, 5.18% fat, 31.50% protein, and 36.52% dietary fiber<sup>7</sup>. Appenroth K. *et al.* reported that the amino acid contents (isoleucine, leucine, cysteine, methionine, threonine, and valine) of *Wolffia* exceeds the WHO's reference for preschool children, and On-Nom N. *et al.* found out that freeze-dried *Wolffia globosa* contains all 9 essential amino acids<sup>6, 7</sup>. Additionally, freeze-dried *Wolffia* is rich in total phenolic compounds, total flavonoids contents, and total tannins contents, with higher phenolic content than many therapeutic plants and grains, with powerful antioxidant properties and offering potential benefits against Alzheimer's, cancer, aging, and metabolic disorders<sup>8, 9</sup>. In addition to this, *Wolffia globosa* is known to provide several health benefits, including boosting the production of phenolic metabolites and short-chain fatty acids by the gut microbiota, significantly reducing abdominal fat, and positively affecting glucose levels<sup>10-12</sup>. Because of its numerous health benefits, some studies have aimed to develop food products incorporating *Wolffia* to boost their nutritional value such as *Wolffia* cookie and *Wolffia* pork ball<sup>7, 13</sup>. However, no study has attempted to develop breadsticks using vacuum heat-dried *Wolffia globosa*.

powder (WP) nor to investigate their bioactive phytochemical compounds, antioxidant properties and consumers acceptability. Therefore, this study aimed to develop breadsticks enriched with bioactive compounds through the incorporation of WP and to evaluate their physical properties (hardness, fracturability, and color) along with their total phenolic compounds (TPC) and total flavonoid contents (TFC). Additionally, the antioxidant capacity of the breadsticks was assessed using DPPH radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP) assays. Consumer acceptability was evaluated using a 9-point hedonic scale.

## MATERIALS AND METHODS

### 1. Materials

Vacuum heat-dried *Wolffia globosa* powder (WP) was obtained from Advanced Greenfarm Co., Ltd, Bangkok, Thailand. The ingredients used in the breadstick development were purchased from supermarkets in Bangkok, Thailand. Chemicals for WP extraction and determination of phytochemical and antioxidant properties of WP extract and breadsticks were supplied by Merck (Darmstadt, Germany), QRëC™ - Qchemical (New Zealand), Sigma-Aldrich Co. (St. Louis, MO, USA), and Ajax Finechem (Taren Point, Australia).

### 2. Preparation of the breadsticks using different concentrations of *Wolffia globosa* powder (WP)

The breadsticks were made with all-purpose flour and different concentrations of WP at 0%, 5%, 10% and 15% according to the recipe with minor modifications<sup>14</sup>. The table below outlines the ingredients utilized in making the breadsticks.

**Table 1.** Breadsticks recipe incorporated with different percentage of WP

	All-purpose flour (g)	Sugar (g)	Salt (g)	Butter (g)	Water (ml)	Yeast (g)	<i>Wolffia globosa</i> powder (WP) (g)
Control	100	6.5	2.1	11	66	1.8	0
5% WP	100	6.5	2.1	11	66	1.8	5
10% WP	100	6.5	2.1	11	66	1.8	10
15% WP	100	6.5	2.1	11	66	1.8	15

Control = 0% *Wolffia globosa* powder, 5% WP = 5% *Wolffia globosa* powder, 10% WP = 10% *Wolffia globosa* powder, 15% WP = 15% *Wolffia globosa* powder

Combined the ingredients in a steel bowl and mix thoroughly to form a dough. The dough was kneaded for 5 minutes, then let it rest for 1 hour and 20 minutes at 35°C, covered with plastic wrap.

Then rolled out the dough to a 5 mm thickness and cut into rod shaped pieces. After that, rod shaped breadsticks dough was rested for further 40 minutes at room temperature and then baked at 170°C for 18-25 minutes.

### **3. Determination of the physical properties of the breadsticks**

#### **3.1. Texture Analysis**

The hardness and fracturability of the breadsticks was assessed using TA.XTplusC texture analyzer and Exponent connect software. Briefly, the hardness and fracturability were determined by using HDP/ 3 BP probe along with the test speed of 1 mm/sec and distance 10mm under the category of "Measurement of the hardness and fracturability of pretzel sticks". The hardness was expressed in g and the fracturability was expressed in mm.

#### **3.2. Color measurement**

The breadsticks were powdered using a grinder, and their color was evaluated using a Hunter Lab colorimeter, presenting results in L\*, a\*, and b\* values.

### **4. Determination of the phytochemical compounds and antioxidant properties**

#### **4.1. Sample extraction**

Samples (WP and breadsticks) were extracted with minor modifications (8). Initially, 5 g of samples were mixed with 50 ml of 80% ethanol and shaken at 50 °C for 2 hours. After centrifugation and filtration, the supernatant was evaporated and stored at -20 °C for further analysis.

#### **4.2. Total phenolic compounds (TPC)**

The extracted samples were dissolved in 80% ethanol (10 mg/ml). Total phenolic compounds were determined according to previous study with minor modifications<sup>8</sup>. Briefly, samples were mixed with 10-fold dilution of Folin-Ciocalteu reagent and 10% Na<sub>2</sub>CO<sub>3</sub>. After incubating for 90 minutes at room temperature, the absorbance was measured at 760 nm. Gallic acid was used for the standard curve. Results were reported as mg Gallic acid equivalents (GAE) /100 g sample.

#### **4.3. Total flavonoid contents (TFC)**

Total flavonoid contents were determined according to previous study with minor modifications<sup>8</sup>. The method involves mixing the samples with 5% NaNO<sub>2</sub> and 10% AlCl<sub>3</sub> solutions, followed by incubation. The reaction was stopped by adding NaOH, and the mixture was adjusted with an 80% ethanol solution. Catechin was used for the standard curve. Absorbance was measured at 510 nm wavelength to determine flavonoid content, reported as mg catechin (CE) /100g sample.

#### **4.4. 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay**

The antioxidant activity of the samples was evaluated using the DPPH assay, with slight modifications<sup>8</sup>. Initially, samples (10 mg/ml) were mixed with an equal volume of 0.2 mM DPPH reagent and incubated for 30 minutes at room temperature in the dark. Absorbance of the mixture was measured

at 515 nm wavelength using a spectrophotometer. Antioxidant activity was determined using a vitamin C equivalent to the standard curve, and results were reported as mg ascorbic acid /100 g sample.

#### **4.5. Ferric reducing antioxidant power (FRAP) assay**

The antioxidant capacity of the samples was assessed using the FRAP assay with minor adjustments<sup>8</sup>. Briefly, samples (10 mg/ml) were mixed with the FRAP reagent and incubated for 30 minutes at room temperature in darkness. Iron II sulphate ( $\text{FeSO}_4$ ) was used as a standard. The absorbance of the samples was measured at 595 nm wavelength using a spectrophotometer. Results were reported as mmol  $\text{FeSO}_4$  /100g sample.

### **5. Sensory Analysis**

The sensory evaluation involved 50 volunteers aged 18-50 who enjoy snacks and have no gluten or dairy allergies, sensory impairments, color blindness, nor flu symptoms. The study was approved by Chulalongkorn University's Research Ethics Committee (COA No. 174/67, project No. 67099), with participants providing written informed consent. The evaluation took place in the Sensory Analysis room at Chulalongkorn University's Nutrition and Dietetics Department. Participants were briefed on the process and potential minor allergy risks after eating the breadsticks, then instructed to rinse their mouths before and between samples. They rated 7 attributes: appearance, color, odor, taste, aftertaste, texture, and overall liking, using a 9-point hedonic scale, where 9 is the highest preference and 1 is the least preference rating.

### **6. Statistical analysis**

Experiments were done in triplicates and data are expressed as mean  $\pm$  SEM,  $n = 3$ . Data was analyzed using one-way ANOVA and followed by the Duncan post hoc test by using SPSS version 28. Statistical significance was considered at  $p < 0.05$ .

## **RESULTS**

### **1. Preparation of the breadsticks using different concentrations of *Wolffia globosa* powder (WP)**

The addition of WP had a significant impact on the dough and the physical properties of the breadsticks. The addition of WP altered the viscoelastic behavior of the dough, making the dough harder and difficult to handle compared with the control dough (0% WP). The hardness of the dough increased with the higher concentrations of the WP. The expansion of the dough containing WP is also found to be reduced compared with the control under the same incubation period and temperature. The thickness of the breadsticks with WP was also affected by the incorporation of WP resulting in thinner breadsticks as presented in **Figure 1**.



**Figure 1.** Photos of control breadstick and breadsticks containing *Wolffia* powder at 5%, 10% and 15% (w/w) front view (A) and side view (B)

## 2. Physical properties of the breadsticks

### 2.1 Texture of the breadsticks

Table 2 presents the textural properties of breadsticks with varying WP concentrations. Hardness increased significantly with higher WP levels ( $p < 0.05$ ). At 5% WP, hardness rose by 1.30-fold and continued to increase with greater WP concentrations, showing a 1.79-fold increase at 10% WP and reaching a 2.20-fold increase at 15% WP, all significantly different from the control ( $p < 0.05$ ). Fracturability also increased significantly by about 1-fold in all *Wolffia* breadsticks compared to the control ( $p < 0.05$ ), though the differences among WP incorporated breadsticks were not statistically significant.

### 2.2. Color analysis of the breadsticks

The addition of WP significantly reduced the lightness ( $L^*$ ) of all breadstick formulas compared to the control ( $p < 0.05$ ).  $L^*$  decreased by approximately 26% at 5% WP and continued to decline with higher concentrations of *Wolffia*, dropping by 35% at 10% WP and 37% at 15% WP. The  $a^*$  values also showed significant reductions of 72%, 82%, and 90% with 5%, 10%, and 15% WP additions, respectively comparing with the control ( $p < 0.05$ ). In terms of yellowness ( $b^*$ ), the WP incorporated breadsticks experienced significant decreases compared to the control ( $p < 0.05$ ), with an 11% reduction at 5% WP and around 21% decreases at both 10% and 15% WP, as detailed in Table 2.

**Table 2.** Textural properties and color analysis of the breadsticks.

Textural properties				
	Control	5% WP	10% WP	15% WP
Hardness (g)	1,314.41 ± 32.52 <sup>a</sup>	1,683.61 ± 26.24 <sup>b</sup>	2,351.07 ± 71.83 <sup>c</sup>	2,897.01 ± 77.31 <sup>d</sup>
Fracturability (mm)	38.97 ± 0.51 <sup>a</sup>	39.99 ± 0.34 <sup>b</sup>	40.05 ± 0.28 <sup>b</sup>	40.78 ± 0.10 <sup>b</sup>
	Control	5% WP	10% WP	15% WP
L*	59.58 ± 0.93 <sup>a</sup>	44.14 ± 0.59 <sup>b</sup>	39 ± 0.57 <sup>c</sup>	37.68 ± 0.43 <sup>c</sup>
a*	10.15 ± 0.29 <sup>a</sup>	2.85 ± 0.62 <sup>b</sup>	1.86 ± 0.67 <sup>b</sup>	0.97 ± 0.58 <sup>b</sup>
b*	28.89 ± 0.68 <sup>a</sup>	25.58 ± 0.24 <sup>b</sup>	22.74 ± 0.25 <sup>c</sup>	22.54 ± 1.22 <sup>c</sup>

These values represent the mean ± SEM of 3 independent experiments. Statistical analysis involved ANOVA with a post hoc Duncan test at  $p < 0.05$ . Significant differences between means are indicated by different superscript letters in each line.

### 3. Total phenolic compounds (TPC) and total flavonoid contents (TFC) of the *Wolffia globosa* powder (WP) extract and breadsticks

The TPC and TFC of the WP extract were  $478.04 \pm 9.8$  mg GAE/100g and  $385.6 \pm 13.3$  mg CE/100g, respectively (Table 3). These values were calculated as percentages by dividing the measured amounts by the total sample weight (100 g), yielding approximately 0.48% and 0.39% for TPC and TFC, respectively. Adding WP to the breadsticks significantly increased TPC and TFC in a dose-dependent manner compared to the control ( $p < 0.05$ ). TPC rose 1.35-fold in 5% WP, 1.57-fold in 10% WP, and 1.77-fold in 15% WP, measuring  $157.2 \pm 2.3$  mg GAE /100g sample,  $183.9 \pm 3.3$  mg GAE /100g sample, and  $206.6 \pm 3.3$  mg GAE /100g sample, respectively. Similarly, TFC increased 1.91-fold in 5% WP, 2.75-fold in 10% WP, and 3.56-fold in 15% WP, with values of  $37.05 \pm 1.19$ ,  $53.40 \pm 0.84$ , and  $69.12 \pm 2.87$  mg CE /100g samples, respectively ( $p < 0.05$ ).

### 4. Antioxidant properties of the *Wolffia globosa* powder (WP) extract and the breadsticks

The DPPH radical scavenging activity and ferric reducing antioxidant power were used to assess the antioxidant properties of WP extract and breadsticks (Table 3). The WP extract had DPPH and FRAP values of  $433.9 \pm 23$  mg ascorbic acid equivalents /100 g sample and  $51.18 \pm 1.56$  mmol  $\text{FeSO}_4$  /100 g sample, respectively. Adding 5% WP led to a non-significant increase in DPPH (1.15-fold) and FRAP (1.29-fold) compared to the control. However, adding 10% and 15% WP significantly increased both DPPH and FRAP of the breadsticks ( $p < 0.05$ ). DPPH increased 1.6-fold in 10% WP and 1.9-fold in 15%

WP, with values of  $77.52 \pm 4.73$  and  $95.07 \pm 3.84$  mg ascorbic acid equivalents/100 g samples, respectively. FRAP increased 1.48-fold in 10% WP and 1.7-fold in 15% WP, with values of  $24.77 \pm 2.21$  and  $28.47 \pm 2.43$  mmol FeSO<sub>4</sub> /100 g samples, respectively.

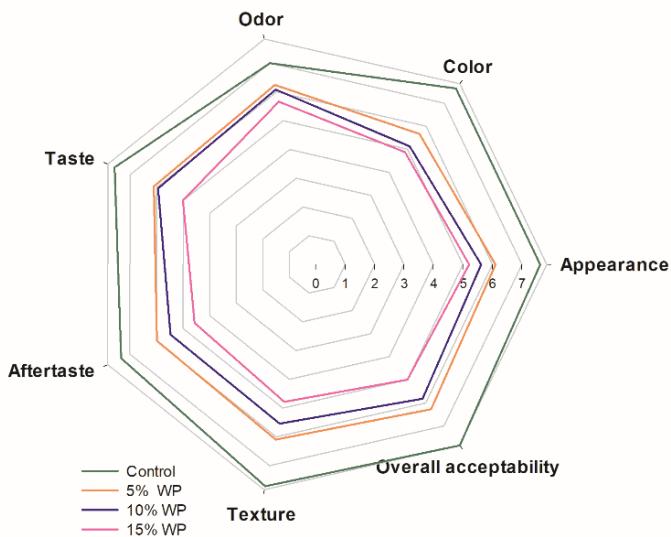
**Table 3.** Phytochemical compounds and antioxidant properties of the WP extract and the breadsticks

Phytochemical and antioxidant properties					
	Control	5% WP	10% WP	15% WP	WP extract
TPC (mg GAE /100g sample)	$116.7 \pm 4.3^a$	$157.2 \pm 2.3^b$	$183.9 \pm 3.3^c$	$206.6 \pm 3.3^d$	$478.04 \pm 9.8^e$
TFC (mg CE /100g sample)	$19.39 \pm 1.82^a$	$37.05 \pm 1.19^b$	$53.40 \pm 0.84^c$	$69.12 \pm 2.87^d$	$385.6 \pm 13.3^e$
DPPH (mg ascorbic acid /100 g sample)	$50.02 \pm 1.33^a$	$57.33 \pm 1.56^a$	$77.52 \pm 4.73^b$	$95.07 \pm 3.84^c$	$433.9 \pm 23^d$
FRAP (mmol FeSO <sub>4</sub> /100 g sample)	$16.72 \pm 1.72^a$	$21.57 \pm 0.43^{ab}$	$24.77 \pm 2.21^{bc}$	$28.47 \pm 2.43^{cd}$	$51.18 \pm 1.56^d$

These values represent the mean  $\pm$  SEM of 3 independent experiments. Statistical analysis involved ANOVA with a post hoc Duncan test at  $p < 0.05$ . Significant differences between means are indicated by different superscript letters in each line.

## 5. Sensory Analysis

The sensory evaluation involved 50 untrained panelists, and the results showed that the *Wolffia*-enriched breadsticks differed significantly in appearance, color, odor, taste, aftertaste, texture, and overall acceptability compared to the control ( $p < 0.05$ ) (Figure 5). However, the 5% WP breadsticks received satisfactory ratings in appearance, odor, taste, texture, and overall acceptability, scoring above 6 (slightly liked). Consumers also gave favorable scores for odor to the control, 5% WP, and 10% WP breadsticks, with ratings of  $7.00 \pm 0.23$ ,  $6.24 \pm 0.24$ , and  $6.08 \pm 0.23$ , respectively. The control breadsticks scored above 7 (moderately liked) for taste and texture, while the 5% WP breadsticks scored slightly above 6 for these attributes. All *Wolffia* breadsticks received neutral ratings of around 5 (neither like nor dislike) for color, and panelists were less satisfied with the aftertaste, giving similar neutral ratings. For overall acceptability, the control breadsticks were most preferred ( $7.84 \pm 0.14$ ), followed by 5% WP ( $6.29 \pm 0.22$ ) and 10% WP ( $5.82 \pm 0.20$ ). The least preferred was the 15% WP breadsticks, with a neutral score of  $5.00 \pm 0.24$ .



**Figure 5.** Sensory evaluation of 4 different breadsticks

## DISCUSSION

Our investigation revealed that *Wolffia globosa* powder (WP) extract is rich in phytochemicals (TPC and TFC) and has strong antioxidant properties assessed by DPPH and FRAP assays. Incorporating WP into the flour altered the viscoelasticity of the dough, resulting in thinner breadsticks compared to the control, with this effect becoming more pronounced at higher WP concentrations. Additionally, WP reduced the lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ ) of the breadsticks while also decreasing consumer acceptability as WP levels increased. Notably, the addition of WP significantly enhanced the phytochemical content and antioxidant capacity of the breadsticks, with these values increasing proportionally with higher WP percentages.

Adding WP affects the viscoelastic properties of the dough and the physical characteristics of the breadsticks. WP makes the dough harder to handle than the control (0% WP), reduces its expansion, and results in thinner breadsticks. A similar effect is seen when using 10%, 15% and 20% of LRP, which is also high in phytochemicals in the development of the breadsticks. LRP is found to alter the viscoelasticity of the dough by increasing resistance to deformation due to interactions between wheat proteins and LRP fiber <sup>3</sup>. WP significantly increases the hardness and fracturability of the breadsticks, especially at 15% WP, consistent with studies showing that plant compounds high in phytochemicals and fiber increase snack hardness <sup>4, 7, 15</sup>. As WP concentration increases, the breadsticks become greener and darker, with lower lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ ) compared to the control. The drop in  $a^*$  values reflect reduced redness and increased greenness with higher WP levels. However, the Maillard reaction during baking, which causes browning limits the visibility of the green color of WP, preventing negative  $a^*$  values which represent the green color <sup>16</sup>. However, breadsticks with more WP

appear greener and darker overall. This trend is consistent with previous studies showing that the chlorophyll in WP imparts a green color in foods such as pork balls and cookies<sup>7, 13</sup>.

In this study, the phytochemical contents of vacuum heat-dried WP extract were found to be around 0.48% for total phenolic compounds and 0.39% for total flavonoid contents. These values differ from those reported by Somdee T. *et al.* who found TPC at 1.24% and TFC at 0.25%, and by On-Nom N. *et al.* who reported TPC and TFC of freeze-dried WP at 1.16% and 1.25%, respectively<sup>7, 17</sup>. Differences in plant variety, growing conditions, and processing methods likely explain these variations (8). Incorporating high polyphenol ingredients such as LRP ranging from 10% to 20% and moringa leaves 2.5% to 5 % into breadsticks and cookies has been shown to boost TPC and TFC of the final food products<sup>4, 18</sup>. Their results are concomitant with our study, where WP addition significantly increased these values in the WP incorporated breadsticks, especially at higher concentrations of WP (Table 3). Monthakantirat O. *et al.* identified key phytochemicals in *Wolffia globosa* such as ferulic acid, luteolin 7-O- $\beta$ -D-glucoside, and kaempferol which are known for their antioxidant, antidiabetic, and anti-inflammatory benefits<sup>7, 19</sup>. Polyphenols, mainly found in plant roots and leaves, are secondary metabolites that scavenge harmful reactive oxygen species (ROS), helping to mitigate health issues such as cancer and inflammation<sup>20</sup>. The strong antioxidant properties of high polyphenol WP extract, assessed by DPPH radical scavenging and FRAP assays, support this mechanism. Both WP extract and WP incorporated breadsticks showed increased antioxidant activity as WP concentration rose, consistent with studies that show incorporating polyphenol rich plants such as unripe papaya and moringa leaves enhances antioxidant properties in final food products<sup>18, 21</sup>.

The results showed significant differences in consumer acceptability of WP incorporated breadsticks compared to the control across all sensory attributes: appearance, color, odor, taste, aftertaste, texture, and overall acceptability ( $p < 0.05$ ). This could be attributed to the unfamiliarity of consumers with the bitter taste of WP and the firmer texture caused by the fiber content of WP, especially at higher concentrations. However, breadsticks with 5% and 10% WP were generally accepted, receiving scores around 6 (slightly liked) for appearance, odor, taste, texture, and overall acceptability. Interestingly, the odor of WP did not negatively affect consumer acceptance, while the color and aftertaste of WP enriched breadsticks were less favored. Similarly, On-Nom N. *et al.* found that while the distinct odor of freeze-dried WP did not decrease consumer acceptability in cookies while overall acceptance declined as WP levels increased<sup>7</sup>. A similar trend has been observed in breadsticks with added functional ingredients, such as olive cake powder and buckwheat flour, where higher concentrations led to reduced consumer perception<sup>16, 22</sup>. According to our study, using higher concentrations of WP increases the antioxidant activity of the breadsticks but decreases the consumer's acceptability. Therefore, we recommend further research to explore ways to improve the palatability of WP incorporated breadsticks by adding flavors such as garlic, barbecue, and chocolate to mask the bitterness and odor of WP.

## CONCLUSION

*Wolffia globosa* powder (WP) extract is rich in phytochemicals and antioxidants, which enhance the functional properties of breadsticks. Incorporating WP not only improves the bioactive compounds including total phenolic compounds and total flavonoid contents but also boosts antioxidant levels, even at a 5% addition, with the highest benefits seen at 15% WP. Although WP increases the hardness of the breadsticks compared to the control, consumers favor the 5% WP and accept the 10% WP according to sensory analysis by 9-point hedonic scale showing that WP could be a valuable ingredient for developing health-focused food products in the future, providing diverse healthier food choices for the consumers.

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## Research Article (FF05)

# The Potential Use of Banana Blossom as a Functional Ingredient in Kombucha Beverage for the Prevention of Type 2 Diabetes Risk

Thitirat Poolsawat<sup>1,2</sup>, Bandhita Wanikorn<sup>1,2</sup>, Wilawan Sinthuprap<sup>1,3\*</sup>

<sup>1</sup>Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand.

<sup>2</sup>Specialized Research Unit: Functional Food and Human Health Laboratory, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand. <sup>3</sup>Specialized Research Unit: Probiotic and Prebiotics for Health, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand.

## ABSTRACT

The risk of acquiring type 2 diabetes is reduced by reducing glucose absorption into the bloodstream via antioxidants in body cells. Banana blossom (BB) has antioxidant and anti-inflammatory properties and inhibits the activity of carbohydrate-digesting enzymes *in vivo*. These properties make it suitable for creating functional food and beverage products as kombucha which fermented tea drinks contain of functional benefits from raw materials and products from microbial growth. This study focuses on developing functional beverages like banana blossom kombucha. The dried banana blossoms (DBB) to water ratios of 0.75% and 2.25% were investigated and fermented for 21 days. Chemical properties (total acid as acetic acid) and functional properties (total phenolic content, antioxidant activity by the DPPH method, and  $\alpha$ -glucosidase inhibition) were examined. DBB had 38.66 mg GAE/g of total phenolic compounds, 4.69 mg TE/g of DPPH antioxidant activity, and 94.12%  $\alpha$ -glucosidase inhibition. BB kombucha with a ratio of 2.25% showed total acid as acetic acid increased during fermentation and had significantly the highest total acid at 1.24% ( $p < 0.05$ ) at day 21, with the highest phenolic content, the antioxidant activity of DPPH and inhibition of  $\alpha$ -glucosidase compared with 0.75%. BB can be used as a functional ingredient in commercial functional foods and beverages like kombucha drinks to promote health and reduce risk factors for type 2 diabetes by using a ratio of 2.25% BB in water.

**Key words:** risk of type 2 diabetes, banana blossom, kombucha, functional properties

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\* Correspondence: fagiwlw@ku.ac.th

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a prevalent disease that is projected to affect over 1.32 billion people by 2050<sup>1</sup>. It can affect individuals of any age and gender. The primary cause of T2DM is related to lifestyle and dietary habits, which result in reduced glucose uptake by body cells due to Insulin resistance<sup>2</sup>. High blood glucose levels increase hyperglycemia disorder and accumulate in the kidney, cord cells in the eye, and nerve systems, leading to oxidative stress and inflammation in various microvascular and macrovascular complications<sup>3</sup>. The blood glucose level in the body is related to postprandial hyperglycemia (PPHG), which depends on glucose digestion and absorption in the digestive system. When consuming a carbohydrate food containing starch and sugar, enzyme  $\alpha$ -amylase and  $\alpha$ -glucosidase enzyme digest carbohydrate and produce monosaccharide glucose in the small intestine<sup>4</sup>. Glucose is absorbed from the small intestine into the bloodstream through the utilization of carriers for transporting glucose. To control glucose digestion and absorption activity in people who consume carbohydrate-rich food and keep the PPHG under control<sup>4</sup>. The carbohydrate hydrolyzing enzyme Inhibitors used in the clinical treatment of T2DM can be synthetic or chemical, but there are side effects such as flatulence, diarrhea, and liver disorder. Besides, inhibitors contain sugar moieties, and their synthesis involves tedious multistep procedures<sup>5</sup>. There is a need for inhibitors from non-sugar sources with lesser side effects and high perfect binding in the active site of enzymes related to decreased blood glucose levels in PPHG to prevent T2DM.

The alternate approach makes use of plant-bioactive substances, particularly polyphenols, which have the advantages of reduced enzyme activity and antioxidants<sup>6-7</sup>. The identified polyphenols in 26 plants that have the potential to inhibit carbohydrate digesting enzymes found caffeic acid, curcumin, cyanidin, daidzein, epicatechin, ferulic acid, hesperetin, naringenin, pinoresinol, quercetin, resveratrol, and syringic acid significantly inhibited  $\alpha$ -glucosidase. Catechin, hesperetin, kaempferol, silibinin, and pelargonidin have significantly inhibited  $\alpha$ -amylase<sup>8</sup>. Agricultural products, particularly banana blossom (BB) from *Musa sapientum* L. (ABB) banana trees have a significant potential for soluble phytochemical components to act as antioxidants both *in vitro* and *in vivo*. According to the animal study show BB with high dietary fiber, low glycemic index value, and high antioxidant activity (FRAP and DPPH) used to treat diabetes symptoms in diabetes rats by control body weight, reducing sugar in the urine, fructosamine and advanced glycation end products (AGEs) in serum, liver, and kidney<sup>9</sup>.

Functional beverages have higher nutritional value or health benefits compared to regular beverages because they contain additional functional ingredients. The criteria for functional beverages include promoting health and beauty, replenishing lost energy, and offering medical benefits. The market for fortified or enriched functional beverages has been growing, and many entrepreneurs are investing in research and development of new functional beverage products with health benefits for consumers. However, commercial functional beverages need to offer more noticeable health benefits for consumer<sup>10</sup>.

Kombucha is a fermented tea beverage made by a symbiotic community of acetic acid bacteria (ABB) and osmophilic yeast. The typical procedure proceeds as follows: tea or other substrates are brewed for at least 5 minutes, supplemented with sucrose (5-10% w/v), cooled to room temperature (20°C), and inoculated with kombucha liquid from the previous batch (10-20% v/v and 2.5% biofilm w/v) and allowed to ferment for 10-14 day<sup>11</sup>. Kombucha has a sour taste from organic acids and a sweet taste from sweeteners. It contains amino acids, polyphenols, hydrolytic enzymes, micronutrients, and minerals, which contribute to its health benefits. These include detoxifying the pancreas and kidneys, lowering blood glucose levels, and boosting the immune system<sup>12-14</sup>.

However, there is still a need for comprehensive research and development of products derived from BB that may help reduce the risk factors of T2DM. It's important to promote the use of BB in creating functional beverages that share similarities with kombucha.

This study aims to enhance the value of BB by producing functional kombucha and examining the ratio of BB and water. The chemical and functional properties are being analyzed during the fermentation of kombucha in order to finalize a formula for BB kombucha with high functional properties to reduce the risk factors for T2DM.

## MATERIALS AND METHODS

### 1. Raw material preparation

#### 1.1 Fresh banana blossom (FBB)

Fresh banana blossom (FBB) from the banana tree (*Musa* ABB group (triploid) cv. 'Nam Wa') from the coffee plantation in Nam-now city, Phetchabun province, Thailand, harvested when the last banana fruit grows in a banana bunch, then weighing the total of FBB and directly to dried banana blossom preparation.

#### 1.2 Dried banana blossom (DBB) preparation

FBB had peel one to two of the outer bracts, cut off the BB tip and stem, then wash in the water, chop and blend it into small pieces at medium speed for 5-7 seconds. BB was dried for 11 hours at 70°C using a hot air tray dryer until a moisture content of less than 10% is adequate for preserving DBB at room temperature without spoilage and molds<sup>15</sup>. Lastly, dried banana blossom (DBB) was collected in an aluminum foil vacuum bag and stored at room temperature.

### 2. Chemical properties analysis in DBB

Moisture content analysis of FBB and DBB were conducted, with slight modifications to the method of<sup>16</sup>. 3 g of FBB and DBB were dried at 105°C for 3 hours or until the weight difference did not exceed 0.001 g.

DBB was analyzed the chemical composition using the AOAC method including carbohydrate, starch, sugar, protein, crude fat, vitamin (A, B1, B2 and  $\beta$ -carotene), mineral (sodium, potassium,

magnesium, calcium, iron, copper, and phosphorous), soluble dietary fiber, insoluble dietary fiber, cellulose and hemicellulose.

### 3. Functional properties analysis

Briefly, 10 mL of deionized (DI) water and 0.1 g of DBB were mixed, and the mixture was extracted using a shaking incubator at 250 rpm for 15 minutes. Centrifuge at 3879 g for 10 minutes, then collect the supernatant for analysis of total phenolic content, antioxidant activity, and  $\alpha$ -glucosidase inhibition.

#### 3.1 Total phenolic content

According to the Folin-Ciocalteu method of In-house method WI-TMC-138 based on ISO 22855 (2008). In brief, standardize with gallic acid at 0 - 0.05 mg/mL and dilute DBB extract at 0.02 - 0.04 mg/mL. 20  $\mu$ L of sample was mixed with 100  $\mu$ L of 10% (w/v) Folin-Ciocalteu reagent. After 8 min, 80  $\mu$ L of sodium carbonate (7.5%) was added to the mixture and incubated in the dark for 30 min. The absorbance was measured at 765 nm using a UV spectrophotometer against a blank without extract. Report as mg of gallic acid equivalents of g DBB (mg GAE/g).

#### 3.2 Antioxidant activity

The antioxidant activity using DPPH (1,1-diphenyl-2-picrlhyzyl) radical scavenging assay using a slightly modified<sup>17</sup>, Trolox (0-42.86  $\mu$ g/mL) was used as a standard. The DBB extract had a concentration of 0.02 to 0.04 mg/mL. 100  $\mu$ L of 0.4 mM DPPH radical solution in methanol mix with 100  $\mu$ L of sample. Then, incubate in the dark for 30 min. The absorbance was measured at 517 nm using a UV spectrophotometer against a blank without extract. Report as mg of Trolox equivalents of g DBB (mg TE/g).

#### 3.3 $\alpha$ -glucosidase inhibition assay

The  $\alpha$ -glucosidase inhibition assay was investigated, followed by<sup>17-18</sup> with slight modification. 200  $\mu$ L of 0.1 mM phosphate buffer pH 6.8 mixed with 40  $\mu$ L of  $\alpha$ -Glucosidase 1 U/mL. Incubate at 37 °C for 15 min. Add 80  $\mu$ L of 5 mM pNPG mix and incubate at 37 °C for 20 min, then stop the reaction with 200  $\mu$ L of 0.1 M Sodium carbonate. The color reaction should be yellow to light yellow. Acarbose (0 – 6 mg/mL) was used as a positive control. The absorbance was measured at 405 nm using a UV spectrophotometer against a blank without extract. Report as a percentage of inhibition.

### 4. Banana blossom kombucha production

#### 4.1 Study the ratio between banana blossom and water

In this study use 2 ratios, including 100 and 500 g of banana blossom/water 1 L for making kombucha by using moisture content of FBB to calculate DBB content in each ratio / 2 L of water.

#### 4.2 Kombucha production

DBB in a tea bag sterile at 110°C for 10 min, put in a sterile glass jar size 4 L, add 2 L of sterile sucrose solution and pure kombucha culture which including acetic acid bacteria, lactic acid bacteria, and yeast from the Specialized Research Unit: Probiotic and Prebiotics for Health, Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University, Thailand, then mix well and cover with cheesecloth and rubber. Incubated kombucha in a food incubator (INE 800, Memmert, Germany) at 30 ± 3°C. The sample was collected every 3 days until day 21.

#### 4.3 Total acid as acetic acid

Followed the standard method of AOAC (1998). 3 mL of kombucha was mixed with 100 mL of DI water. 0.01 N Phenolphthalein was used as an indicator. Then, titrated with 0.01 N sodium hydroxide, which was already standardized with potassium hydrogen phthalate, and titrated until the color was lightly pink and calculated a total acid as acetic acid (%).

### 5. Functional properties of kombucha

Kombucha samples were analyzed for functional properties including total phenolic content, following method 3.1 and reported as mg of gallic acid equivalents of DBB kombucha 1 mL (mg GAE/mL). Antioxidant activity of DPPH following methods 3.2, reported as mg of Trolox equivalents of DBB kombucha 1 mL(mg TE/mL), and  $\alpha$ - glucosidase inhibition assay following methods 3.3.

### 6. Statistical Analysis

All experiments use a completely randomized design; CRD with one-way analysis of variance by duplicate, report result as a mean ± SD (p<0.05) and considered statistically significant with Duncan's multiple range test (DMRT) performed using the IBM SPSS Statistic for Windows, version 26.0.

## RESULTS

### 1. DBB preparation

After size reduction, the FBB exhibits a yellowish-white appearance with a black border resulting from the oxidation of banana sap. It emits a distinct gas-like odor (**Figure 1, left**). The moisture content was found to be 91.67±0.94%. Conversely, the DBB is characterized by its dark brown color, dry, crispy texture, and fragrant aroma reminiscent of dried tea leaves (**Figure 1, right**).



**Figure 1.** FBB after size reduction and DBB

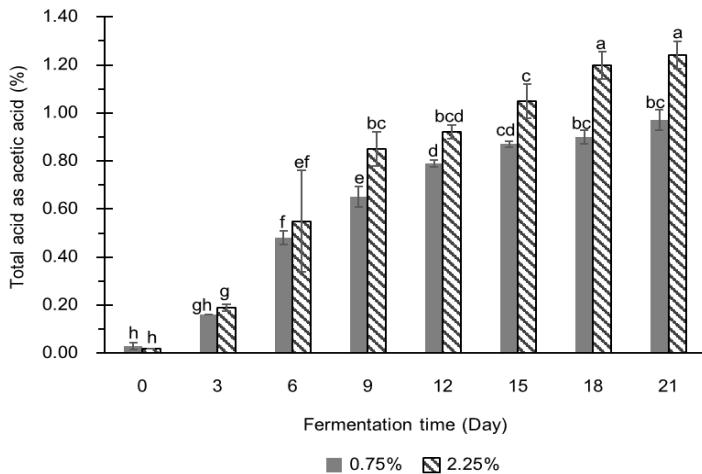
## 2. Chemical composition and functional properties of DBB

The moisture content of FBB was  $6.95 \pm 0.45\%$ , making it possible to know the ratio between BB and water. The ratio of 100 g of FBB/ 1 L of water is 15 g of DBB/2 L of water (0.75%), and the ratio of 500 g of FBB/ 1 L of water is 45 g of DBB/2 L of water (2.25%).

The composition of 100 g of DBB includes 62.62 g of carbohydrates, with 3.33 g of starch and 9.42 g of sugar. The remaining carbohydrates consist of 41.20 g of insoluble fiber, 5.49 g of soluble fiber, 8.81 g of cellulose, and 1.59 g of hemicellulose. Additionally, it contains 17.57 g of protein and 4.51 g of fat. The potassium content is 5.33 g, while the levels of magnesium, phosphorus, and calcium are 445.70 mg, 405.89 mg, and 332.66 mg respectively. Furthermore, DBB has a total phenolic content of  $38.66 \pm 2.37$  mg GAE/g, with an antioxidant activity of DPPH at  $4.69 \pm 0.15$  mg TE/g, and an  $\alpha$ -Glucosidase inhibition activity of 94.12%.

## 3. Total acid as acetic acid in BB kombucha

Analysis of total acid as acetic acid showed that the kombucha ratio of 50% had a statistically significant higher acid content than the ratio of 10% ( $p < 0.05$ ) on day 21, where 10% is 0.97% and 50% is 1.24%, as shown in **Figure 2**.



**Figure 2.** Total acid as acetic acid during BB kombucha fermentation,

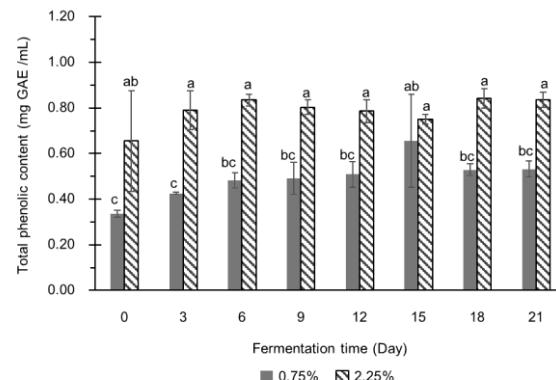
█ as BB kombucha in ratio 0.75% (w/v) and █ as BB kombucha in ratio 2.25% (w/v).

Different superscript letters indicate different statistical significance at  $p$ - value  $< 0.05$ .

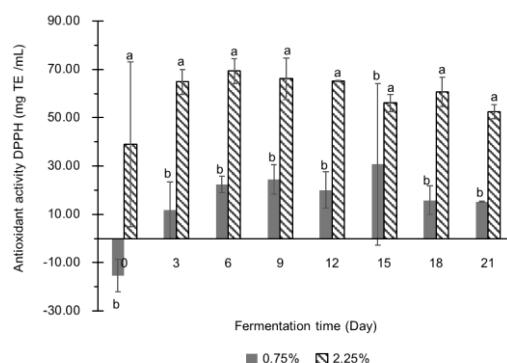
#### 4. Functional properties in BB kombucha

The phenolic content in kombucha 0.75% had significantly the highest total phenolic content on the 15th day ( $p < 0.05$ ) at 0.66 mg GAE/mL compared to other days. In comparison, 2.25% had the highest total phenolic content on day 18 at 0.84 mg GAE/mL and was not significant during fermentation. (Figure 3A) the antioxidant activity by the DPPH method, the BB kombucha at a ratio of 0.75% on day 0 had no antioxidant activity. Still, there increase on days 3 to 21 with no statistical difference ( $p < 0.05$ ). and had the highest on day 15 at 30.72 mg TE/mL. BB kombucha ratio at 2.25% had antioxidant activity on days 0 to day 21 were not statistically different, and the maximum value on day 6 was 69.33 mg TE/mL (Figure 3B). inhibition activity of  $\alpha$ - Glucosidase was found that kombucha at 0.75% and 2.25% had an inhibition percentage higher than 90% on the 15th and 21 days, with no statistical difference when compared to the 2 ratios and on the same production day (Figure 3C).

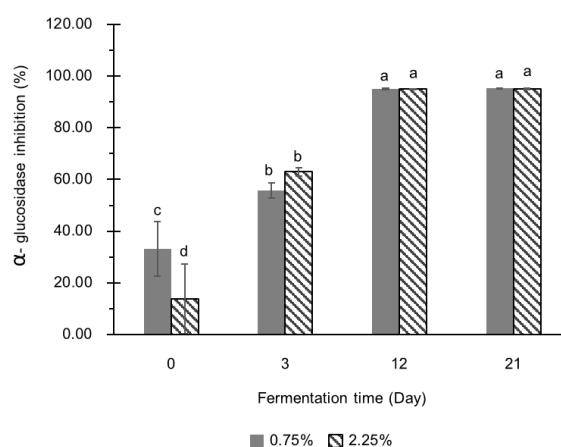
### A. Total phenolic content in BB kombucha



### B. Antioxidant activity by DPPH method



### C. $\alpha$ - glucosidase inhibition



**Figure 3.** Total phenolic content (A) Antioxidant activity by DPPH method (B)

and  $\alpha$ - Glucosidase inhibition (C) during BB kombucha fermentation,

■ as BB kombucha in ratio 0.75% (w/v) and ▨ as BB kombucha in ratio 2.25% (w/v).

Different superscript letters indicate different statistical significance at  $p$ - value  $< 0.05$ .

## DISCUSSION

Controlling blood sugar levels through medication has side effects and limitations<sup>19-20</sup>. Therefore, there are guidelines for finding substances to inhibit the activity of carbohydrate-digesting enzymes. These are the polyphenols in plants that have antioxidant and anti-inflammatory properties, reduce the accumulation of fat in the blood, stimulate insulin secretion in the body, and increase the efficiency of insulin activity<sup>21-22</sup>.

The chemical composition of DBB (Musa ABB, India) in previous study<sup>23</sup> was low in protein and more fat compared with DBB in this study. the benefit of BB to reduce risk factor of T2DM, Protein and fat from plant diet like BB influence the levels of HDL and LDL cholesterol, which impact to control blood pressure, insulin secretion, blood sugar control, and inflammation in the body<sup>21,24</sup>. The previous study showed plant protein that contain amino acid as glycine associated to lower hypertension risk and pulse pressure<sup>25</sup> also plant-based diet which rich in fiber, vitamin, polyphenols, potassium and unsaturated fatty acid can contributing to control the blood pressure<sup>26</sup> and decrease the level of cholesterol in T2DM patients<sup>27</sup>. In this study DBB rich in potassium compared with previous study (23). Potassium could contribute to insulin secretion and metabolism of carbohydrate nutrients by directly take glucose in blood stream into body cells<sup>21,28,29</sup>. Total phenolic content was higher when compared to BB extract of ABB (Namwa maliong) and BB *Musa* spp. (Poovan) (8.06 mg GAE/ g extract and 10.42 – 13.45 mg GAE/g, respectively. Previous studies showed that BB extracts had antioxidant activity higher than 70% and had an IC<sub>50</sub> value of 0.3 – 27.89 mg/mL<sup>30,31</sup>. From chemical and functional components in BB showed there is a possibility to slow the increase in blood sugar levels and cholesterol.

The polyphenols found in BB can be used as beneficial components in functional food and beverage products, such as kombucha. Kombucha is made by fermenting tea, or tea combined with sugar, using microbes such as acid-producing bacteria and yeast. This fermentation process typically takes 10 to 14 days and results in kombucha that has a sweet and sour taste. In addition to employing tea leaves, raw materials from plants and fruits are used instead of tea, which is called this product a kombucha-like beverage. Using raw materials to enhance taste, aroma, and functional properties including anti-inflammatory, reducing sugar levels, and antioxidants<sup>32-33</sup>. From the study of kombucha at banana blossom ratios of 0.75% and 2.25%, it was discovered that bacteria and yeast in kombucha leaven use sugar as a carbon source to generate alcohol and organic acids. When the curing time increased, acid content increased<sup>34</sup>. From day 0 to day 12 and day 15 to day 21, the total amount of acid began to stabilize significantly. Kombucha prepared from black tea, fermented for 15 days found total acid was 16.75 g/L which BB kombucha microbial produced acid less than previous study<sup>35</sup>. Total acid has depend on microbial community, fermentation condition and raw materials<sup>32</sup>. When considering the functional properties, kombucha made from tea leaves found total phenolic content 0.70 – 1.09 mg GAE/mL<sup>36</sup>, which BB kombucha at 2.25% had similar total phenolic content with previous studies. It was found that phenolic compounds and antioxidant activities increased. The increased presence of phenolic compounds and antioxidant activity in kombucha is a result of the release of functional ingredients and

metabolites from microbial growth. These components include organic acids and alcohol. In essence, the heightened acidity is a consequence of bacteria converting carbohydrates into acetic and lactic acids.

## CONCLUSION

Polyphenols and antioxidants are bioactive compounds from BB. When produced as a functional beverage, such as kombucha, it helps control blood sugar levels by inhibiting the activity of carbohydrate-digesting enzymes from bioactive compounds from BB and metabolites from bacteria and yeast growth. BB kombucha at a ratio of 2.25% gave better functional properties when compared with BB kombucha at a ratio of 0.75%, which can be the formular for functional kombucha producing to reduce factors of T2DM. For future, the study in clinical trials can be confirm the benefits of BB kombucha to prevention the T2DM risk factors in human.

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## Research Article (FF06)

### Effectiveness of Local Supplementary Feeding on Under-fives' Nutritional Status in Magelang Utara, Indonesia

Nara Citarani<sup>1\*</sup>, Retno Wulan Sari<sup>2</sup>

<sup>1</sup> Postgraduate Program in Public Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia

<sup>2</sup> Magelang Utara Primary Health Care, Magelang City, Indonesia

#### ABSTRACT

The Indonesian Ministry of Health initiated a local supplementary feeding program, namely PMT Lokal, to overcome the nation's rising prevalence of under-fives' wasting. This study aimed to assess the effect of the PMT Lokal program on under-fives' nutritional status in Magelang Utara Subdistrict. This study was an analysis of secondary data, collected by Magelang Utara Primary Health Care in 2023. The anthropometric data of 229 under-fives were collected longitudinally, before and after one, two, and three months of the program. The local supplementary food is ready-to-eat food prepared by a food service provider daily. The nutritional status changes were tested numerically with one tailed paired t-test and categorically with McNemar test. In a month, the PMT Lokal program increased under-fives' weight-for-age (mean difference = 0.15,  $p < 0.001$ ) and weight-for-height (mean difference = 0.25,  $p < 0.001$ ) index. After a month, underweight (McNemar OR = 7.25, 95% CI: 2.55-28.38,  $p < 0.001$ ) and wasted (McNemar OR = 3.75, 95% CI: 1.68-9.47,  $p = 0.0004$ ) under-fives were more likely to have normal WAZ and WHZ status compared to the opposite direction. The same results were found after two and three months of the program. No statistically significant improvement was found on under-fives' height-for-age index and stunted status. The PMT Lokal program improved under-fives' WAZ, WHZ, underweight, and wasted status in Magelang Utara Subdistrict.

**Key words:** wasting, underweight, under-fives, local supplementary feeding program, nutrition intervention

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\* Correspondence: naracitarani@mail.ugm.ac.id

## INTRODUCTION

Under-fives' undernutrition still one of the critical nutrition problem around the world. There are several forms of undernutrition: wasting, underweight, and stunting. Wasting refers to under-fives who are too thin for their height, underweight refers to the ones who were too thin for their age, while stunting refers to the ones who were too short for their age <sup>1, 2, 3</sup>. In Indonesia, the prevalence of wasting under-fives increased from 7.1% in 2021 to 7.7% in 2022 <sup>4, 5</sup>. During the same period, the prevalence of under-fives' underweight increased 0.1%. The Indonesian Ministry of Health initiated a nation-wide local supplementary feeding program, namely PMT Lokal, to overcome the problem<sup>6</sup>. Local supplementary feeding program was chosen because, in 2021, there were only 52.5% of under-fives in Indonesia who had minimum dietary diversity <sup>4</sup>. In fact, Indonesia has various types of foods that could be used to provide the nutritional needs of the under-fives. At least there are 77 types of carbohydrate sources, 30 types of fishes, 6 types of meats, 4 types of poultries, 4 types of eggs, 26 types of nuts, 389 types of fruits, 228 types of vegetables, and 110 types of spices and herbs <sup>6</sup>. The Ministry of Health wanted to encourage mother of under-fives to feed their children various food that are locally available. In 2023, the program was implemented by local primary health care in each subdistrict in Indonesia. The program's targets were under-five with specific criteria of undernutrition <sup>6</sup>. The participants were given local supplementary food, every day, for a month until three months, depends on their nutritional status. Under-fives nutritional status were collected before, and followed after one, two, and three months of the program. This study aimed to evaluate the effect of the PMT Lokal program on under-fives' nutritional status.

## MATERIALS AND METHODS

### The PMT Lokal Program

The objective of this program was to improve under-fives' nutritional status by providing local supplementary food <sup>6</sup>. The program's targets are under-five with wasted status, underweight status, or the ones who has stagnant weight for two months. The PMT Lokal program consists of the following components:

#### 1. Screening of Target

The screening was done by trained health cadres in each of neighbourhood. Standard procedures and kits were used as guided by The Decree of the Ministry of Health of Indonesia Number HK.01.07/MENKES/51/2022 about The Standard of Anthropometry Kit and Early Detection Kit for Child Development. Under-fives' weight and height were measured, then their nutritional status was calculated and analysed. If the toddler's weight didn't increase for 2 consecutive months or has wasted or underweight status according to the z-score index, then the toddler will be proposed as a program target.

## 2. Verification

The list of under-fives proposed as program targets by health cadres was given to nutritionists in Primary Health Care. Nutritionists verified the measurement of under-fives' nutritional status by re-measuring and re-analysing each target's nutritional status. Verified under-fives became the target of the PMT Lokal program.

## 3. Education to The Mothers of Under-fives

Mothers of under-fives who participated in the program were given education regarding undernutrition, its causes, prevention, and management by primary health care nutritionists. The concept and mechanism of the PMT Lokal program were also explained. The goal was that mothers of under-fives not only "accept" the PMT Local program, but also can adapt the habit of providing food with balanced nutrition as exemplified in the program.

## 4. Local Supplementary Feeding

Nutritionists worked with food catering providers to provide local supplementary food. They were explained about the provisions of nutritional content, food prices, and food distribution mechanism (**Table 1**). The local supplementary food is in the form of ready-to-eat daily food, cooked by the food providers everyday with different menu. The protein primarily comes from animal protein sources. The food catering delivered local supplementary food to health cadres in each of neighbourhood. The mothers of under-fives took the local supplementary food from the health cadre's house without cost. All program costs were funded by the Indonesian Government through Operational Health Assistance mechanism.

**Table 1.** Nutritional components of the local supplementary food each serving, each day <sup>6</sup>

<b>Nutritional Components</b>	<b>Group Age (months old)</b>		
	<b>6 – 11</b>	<b>12 – 23</b>	<b>24 – 59</b>
Calories (kcal)	175 – 200	225 – 275	300 – 450
Protein (grams)	3.5 – 8	4.5 – 11	6 – 18
Fat (grams)	4.4 – 13	5.6 – 17.9	7.5 – 29.3
Protein Energy Ratio		10-16%	

## 5. Evaluation

Every week, under-fives' weight and height are measured by trained health cadres. Local supplementary food was given for 4 weeks. If after 4 weeks the toddler's nutritional status has improved, then the toddler will be removed as a participant. The total program implementation time was 3 months. The health cadres were actually record the amount of supplementary food received each day, but this data was not collected by the primary health care.

## Design Study

This study was an analysis of secondary data, collected by Magelang Utara Primary Health Care in 2023. Data collection was conducted in Magelang Utara Subdistrict, the working area of Magelang Utara Primary Health Care, during the period of July to November 2023. Under-fives' anthropometric data was collected longitudinally, before and after one, two, and three months of the program.

## Participant and Sample

Screening and verification step found 299 under-fives of Magelang Utara Subdistrict eligible to join the program. The under-fives were given supplementary food and followed for three months. Every month, there were some under-fives who got a better nutritional status and then be taken out of the program. The remaining participants were reduced to 83 under-fives in second month and 33 under-fives in third month. This study used all of 299 participants data.

## Data Analysis

The data consisted of weight, height, sex, and age. The numeric variables were weight-for-height z-score (WHZ), weight-for-age z-score (WAZ), and height-for-age z-score (HAZ). The z-score indexes were based on The Regulation of The Ministry of Health of Indonesia Number 2 Year 2020 on Children Anthropometry Standard which is in accordance to WHO Growth Standards. The categoric variables were wasted, underweight, and stunted status (**Table 2**). The categories were also defined by the same regulation. The nutritional status changes were tested numerically with one tailed paired t-test and categorically with McNemar test. Stata 17 was used to analyse the data.

**Table 2.** Nutritional Components of the Local Supplementary Food Each Serving, Each Day (6)

Index	Nutritional Status Category	Z-score Threshold
WAZ	Severely underweight	< -3 SD
	Underweight	-3 SD until -2 SD
	Normal	-2 SD until +1 SD
	Risk of overweight	> +1 SD
HAZ	Severely stunted	< -3 SD
	Stunted	-3 SD until -2 SD
	Normal	-2 SD until +3 SD
	Tall	> +3 SD
WHZ	Severely wasted	< -3 SD
	Wasted	-3 SD until -2 SD
	Normal	-2 SD until +1 SD
	Possible risk of overweight	> +1 SD until +2 SD
	Overweight	> +1 SD until +2 SD
	Obesity	> +3 SD

## RESULTS

The demographic data of participants was showed in Table 3. The number of participants in the first, second, and third month of intervention were 229, 83, and 33 respectively. This was because some under-fives got better nutritional status and removed from the next intervention phase. It was found that the participants were rather balance on both sex. Before intervention, there were 36.7% underweight participants, 24.5% stunted participants, and 21.8% wasted participants. After one month, the proportions were lower, except for stunted status. Before the intervention, there were 51.5% under-fives with stagnant weight, 18.8% with one type of undernutrition, and 29.7% with more than one type of undernutrition. After one, two, and three months of intervention, there were 42.3%, 25.3%, and 30.3% under-fives with normal status, respectively (**Table 3**).

**Table 3.** Under-fives' Demographic and Nutritional Status Before and After Intervention (Categoric Data)

Variable N (%)	Before	1 <sup>st</sup> Month	2 <sup>nd</sup> Month	3 <sup>rd</sup> Month
	229 (100.0)	229 (100.0)	83 (100.0)	33 (100.0)
Sex				
Male	112 (48.9)	112 (48.9)	35 (42.2)	15 (45.5)
Female	117 (51.1)	117 (51.1)	48 (57.8)	18 (54.5)
Age Group				
6-11 months	6 (2.6)	2 (0.9)	1 (1.2)	0 (0.0)
12-23 months	58 (25.3)	55 (24.0)	25 (30.1)	5 (15.2)
24-59 months	165 (72.1)	172 (75.1)	57 (68.7)	28 (84.8)
Weight-for-age Category				
Normal	145 (63.3)	170 (74.2)	49 (59.0)	14 (42.4)
Underweight	84 (36.7)	59 (25.8)	34 (41.0)	19 (57.6)
Height-for-age Category				
Normal	173 (75.5)	166 (72.5)	53 (63.9)	21 (63.6)
Stunted	56 (24.5)	63 (27.5)	30 (36.1)	12 (36.4)
Weight-for-height Category				
Normal	179 (78.2)	201 (87.8)	73 (88.0)	27 (81.8)
Wasted	50 (21.8)	28 (12.2)	10 (12.0)	6 (18.2)
Undernutrition Status				
Normal	0 (0.0)	97 (42.3)	21 (25.3)	10 (30.3)
Stagnant Weight	118 (51.5)	40 (17.5)	20 (24.1)	2 (0.1)
One Type Undernutrition	43 (18.8)	38 (16.6)	7 (8.4)	6 (18.2)
More Than One Type Undernutrition	68 (29.7)	54 (23.6)	35 (42.2)	15 (45.5)

At the beginning, the participants mean age were 32.52 months, with mean WAZ of -1.54, mean HAZ of -1.38, and mean WHZ of -1.15. After a month of PMT Lokal program, mean WAZ and WHZ were higher, but mean HAZ was lower. It was also found that the lowest value of WAZ, HAZ, and WHZ were lower after one month (**Table 4**).

**Table 4.** Under-fives' demographic and nutritional status before and after one month of intervention.  
(Numeric Data)

Variable	Before					1 <sup>st</sup> Month				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Age (months)	229	32.58	12.96	8	58	229	33.58	12.96	9	59
Weight (kg)	229	11.10	2.19	6.7	17.7	229	11.51	2.26	6.9	17.7
Height (cm)	229	87.43	9.64	68	113	229	88.19	9.31	71	112
Weight-for-age	229	-1.54	0.90	-3.84	1.41	229	-1.39	0.88	-4.57	0.83
Height-for-age	229	-1.38	1.04	-4.23	2.26	229	-1.41	0.98	-4.4	2.94
Weight-for-height	229	-1.15	0.94	-4.18	0.85	229	-0.90	0.95	-4.19	1.73

The lowest value of WAZ, HAZ, and WHZ after two months were higher than one month of intervention. However, the mean of WAZ, HAZ, and WHZ were lower. In the third month of intervention, the participants were reduced to 33 under-fives, with lower mean of WAZ, HAZ, and WHZ (**Table 5**).

**Table 5.** Under-fives' Demographic and Nutritional Status After Two and Three Months of Intervention (Numeric Data)

Variable	2 <sup>nd</sup> Month					3 <sup>rd</sup> Month				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Age	83	31.93	12.69	11	59	33	34.39	11.04	12	56
Weight	83	10.90	2.28	7.2	18.8	33	10.90	1.76	7.36	14.5
Height	83	86.59	9.11	70.5	113.4	33	87.66	7.22	73.5	102.2
Weight-for-age	83	-1.66	0.90	-4.21	1.08	33	-1.89	0.84	-4.3	0.54
Height-for-age	83	-1.55	1.10	-4.28	1.96	33	-1.67	1.05	-4.2	0.66
Weight-for-height	83	-1.16	0.78	-3.36	0.68	33	-1.36	0.82	-3.39	0.35

It was found that the mean WAZ was statistically higher after first month compared to before the intervention ( $p < 0.001$ ), between first and second month of intervention ( $p = 0.0052$ ), and between second and third month of intervention ( $p = 0.0001$ ) (**Table 6**). The significance was not found if we compare before and after two or three months of intervention. There was no statistically significant mean difference of HAZ, except for between second and third month of intervention ( $p = 0.0004$ ). Notice that the PMT Lokal program was not specifically designed to tackle stunting. The mean of WHZ was statistically higher when we compared before and after first month of intervention ( $p < 0.001$ ), between first and second month of intervention ( $p = 0.0113$ ), and before and after third month of intervention ( $p = 0.0414$ ).

**Table 6.** Nutritional status change after intervention (numeric data, one tailed paired t-test)

Variable	Intervention Period	N	Mean	SE	SD	95% CI	P value
Weight-for-age	Before and after 1 <sup>st</sup> month	229	0.15	0.03	0.42	0.09-0.20	0.0000*
	Between 1 <sup>st</sup> and 2 <sup>nd</sup> month	83	0.10	0.04	0.36	0.02-0.18	0.0052*
	Before and after 2 <sup>nd</sup> month	83	0.05	0.05	0.50	-0.06-0.16	0.1801
	Between 2 <sup>nd</sup> and 3 <sup>rd</sup> month	33	0.22	0.05	0.29	0.11-0.32	0.0001*
	Before and after 3 <sup>rd</sup> month	33	0.13	0.12	0.68	-0.10-0.37	0.1306
Height-for-age	Before and after 1 <sup>st</sup> month	229	-0.03	0.04	0.61	-0.11-0.05	0.7694
	Between 1 <sup>st</sup> and 2 <sup>nd</sup> month	83	0.03	0.05	0.46	-0.06-0.13	0.2545
	Before and after 2 <sup>nd</sup> month	83	-0.02	0.08	0.75	-0.18-0.14	0.5836
	Between 2 <sup>nd</sup> and 3 <sup>rd</sup> month	33	0.31	0.08	0.48	0.14-0.48	0.0004*
	Before and after 3 <sup>rd</sup> month	33	0.08	0.12	0.72	-0.17-0.34	0.2564
Weight-for-height	Before and after 1 <sup>st</sup> month	229	0.25	0.04	0.66	0.16-0.33	0.0000*
	Between 1 <sup>st</sup> and 2 <sup>nd</sup> month	83	0.13	0.06	0.53	0.02-0.25	0.0113*
	Before and after 2 <sup>nd</sup> month	83	0.13	0.08	0.73	-0.03-0.29	0.0547
	Between 2 <sup>nd</sup> and 3 <sup>rd</sup> month	33	0.07	0.09	0.52	-0.11-0.25	0.2219
	Before and after 3 <sup>rd</sup> month	33	0.22	0.12	0.71	-0.03-0.47	0.0414*

\*p value < 0.05

Although there were already found that the mean of WAZ and WHZ was statistically significant higher after PMT Lokal intervention, we needed to know how the WAZ and WHZ increased was practically significant (**Table 7**). Therefore, categorical data analysis was performed with McNemar test. It was found that the odds of participants to have normal nutritional status (by WAZ) compared to the ones who became underweight after one month of intervention was 7.25 (95% CI: 2.55-28.38,  $p < 0.001$ ). The significance was also found after two and three months of intervention.

**Table 7.** Weight-for-age change after intervention (categoric data, McNemar Test)

Variable	Intervention Period	Before	After		Total	P value	McNemar OR (95% CI)
			Underweight	Normal			
Weight-for-age	Before and after	Underweight	55	29	84	0.0000*	7.25
		1 <sup>st</sup> month	Normal	4	141	145	(2.55-28.38)
			Total	59	170	229	
	2 <sup>nd</sup> month	Underweight	31	12	43	0.0201*	4
		Normal	3	37	40		(1.08-22.09)
			Total	34	49	83	
	3 <sup>rd</sup> month	Underweight	19	4	23	0.0455*	N/A
		Normal	0	10	10		
			Total	19	14	33	

The same analysis was done to HAZ and WHZ categorical data. However, there was no statistically significant nutritional change by HAZ ( $p > 0.05$ ) (**Table 8**). The odds of participants to have normal nutritional status (by WHZ) compared to the ones who became wasted after one month of intervention was 3.75 (95% CI: 1.68-9.47,  $p = 0.0004$ ). The significance was also found after two and three months of intervention. The *PMT Lokal* had succeeded in providing a positive effect on under-fives' nutritional status by WAZ and WHZ categoric status, but not by HAZ.

**Table 8.** Weight-for-height change after intervention (Categoric Data, using McNemar Test)

Variable	Intervention Period (Months)	Before	After		Total	P value	McNemar OR (95% CI)
			Wasted	Normal			
Weight-for-height	Before and after	Wasted	20	30	50	0.0004*	3.75
		1 <sup>st</sup> month	Normal	8	171	179	(1.68-9.47)
			Total	28	201	229	
	2 <sup>nd</sup> month	Wasted	7	19	26	0.0006*	6.33
		Normal	3	54	57		(1.86-33.41)
			Total	10	73	83	
	3 <sup>rd</sup> month	Wasted	6	9	15	0.0027*	N/A
		Normal	0	18	18		
			Total	6	27	33	

## DISCUSSION

The Local PMT program has successfully improved the nutritional status of children (according to WAZ and WHZ) in the Magelang Utara Subdistrict. The result of this study is in line with several studies in Indonesia, namely in Probolinggo Regency<sup>7</sup>, Bengkulu Regency<sup>8</sup>, and Agam Regency<sup>9</sup>. One of the program's strengths was the education on undernutrition for mothers of under-fives<sup>10,11</sup>. So, in addition to relying on the local supplementary food provided, mothers of under-fives can also try to imitate the menus and apply them in their daily lives. In fact, the local supplementary food was only given once a day, so at other meal times, children still get food from their mothers and it depends on each household.

When compared with the results of research with other countries in the Asian region, it turns out that the results are quite diverse. Local supplementary feeding program successfully improve the nutritional status of under-fives in Iran<sup>12</sup>, Pakistan<sup>13</sup>, and India<sup>14</sup>. While in Cambodia<sup>15</sup> local supplementary feeding program had not obtained positive results. No statistically significant improvement was found on under-fives' height-for-age index and stunted status. This is because from the beginning, the PMT Lokal program was intended to solve under-fives' wasting and underweight. Data analysis for stunting was still being carried out to find out whether the program has inadvertently had a positive impact on stunting status. However, it turned out that this program had not been able to have a positive impact on stunting status. Perhaps special supplementary food is needed to tackle stunting, such as foods high in animal source protein<sup>16,17,18</sup>, calcium<sup>19</sup>, or vitamin D supplements<sup>19,20,21</sup>.

There are several limitations of the study. First, the study used secondary data, so the variables that can be explored are quite limited and the number of samples cannot be changed. Second, the measurement of weight and height during the evaluation was carried out by nutritionists and trained health cadres. Trained health cadres still had limited ability, so the validity of the data cannot be ascertained. Further study needs to

## CONCLUSION

The PMT Lokal program improved under-fives' nutritional status in Magelang Utara Subdistrict. The improvement was found on WAZ, WHZ, underweight status, and wasted status. However, there isn't any statistically significant improvement on height-for-age index and stunted status.

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## Research Article (FF07)

### Local Food ad a Supplementary Feeding Program for Pregnant Women with Chronic Energy Deficiency: Evaluation in Yogyakarta, 2024

Aulia Rahmadini Saputri<sup>1\*</sup> Asma Rizkiyani<sup>1</sup> Khairani Fauziah<sup>1</sup>

<sup>1</sup>*Public Health Postgraduate Program; Faculty of Medicine, Public Health, and Nursing; Gadjah Mada University, Indonesia*

#### ABSTRACT

Chronic Energy Deficiency in pregnant women is a serious nutritional problem in Indonesia, posing significant health risks to both mothers and their unborn children. The Supplementary Feeding Program aims to address this deficiency. In recent years, the Indonesian government provided biscuits as supplementary food; however, only 50% of pregnant women consumed them due to their monotonous taste. To enhance consumption, the program has shifted to using varied local food ingredients that align better with local eating habits. This research evaluates the input, process, and output indicators of the local supplementary feeding program in Yogyakarta. This descriptive qualitative study was conducted from April 22 to June 28, 2024, involving 18 Community Health Centers in Yogyakarta. Research subjects included nutritionists, midwives, and heads of administration. Data were collected through monitoring and evaluation forms filled out by nutritionists and Focus Group Discussion to identify challenges in program implementation. Most input and process indicators achieved over 80%. However, only 44.44% of health centers developed clear terms of reference and formed an implementation team. Food safety measures were implemented in 77.78% of health centers. Variability in output indicators was observed due to differences in implementation schedules. Challenges included inadequate food safety and hygiene, along with delays in distribution. The local supplementary feeding program in Yogyakarta has made progress, particularly with local catering contributions. However, improvements in program management, food supervision are needed for optimal results.

**Key words:** chronic energy deficiency, pregnant women, local supplementary feeding, program evaluation, Yogyakarta

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\*Correspondence: auliarahmadinisaputri2000@mail.ugm.ac.id

## INTRODUCTION

According to the World Health Organization (WHO), chronic energy deficiency generally occurs in pregnancies between 35 and 75 percent worldwide, with higher rates in the third trimester compared to the first and second trimesters. The WHO also recorded 40% of maternal deaths in developing countries such as Bangladesh, India, Indonesia, Myanmar, Nepal, Sri Lanka, and Thailand. The highest number is in Bangladesh with 47%, while Indonesia ranks fourth highest after India with 35.5%, and Thailand ranks fifth highest with 15-25%<sup>1</sup>.

This situation is highly relevant for further analysis in the context of Indonesia, where malnutrition remains a major issue for Indonesian society due to its status as a developing country. One of the issues of malnutrition among pregnant women in Indonesia is chronic energy deficiency<sup>2</sup>. According to basic health research 2018, the prevalence of Chronic Energy Deficiency among pregnant women aged 15-49 years is 17.3%<sup>3</sup>. Chronic Energy Deficiency occurs due to an unbalanced diet, infectious diseases, and bleeding<sup>4</sup>. The condition of chronic energy deficiency in pregnant women is at risk of experiencing a decrease in muscle strength which can lead to prolonged labor, postpartum bleeding, and maternal death. Babies born to mothers with chronic energy deficiency are at risk of experiencing fetal death, prematurity, birth defects, low birth weight (LBW), and infant death. Additionally, Chronic Energy Deficiency also hinders physical growth (stunting), brain development, and metabolism in babies, which can lead to non-communicable diseases in adulthood<sup>5</sup>.

The Supplementary Feeding Program for pregnant women in Yogyakarta is a strategic step to improve the nutritional status of pregnant women and prevent Chronic Energy Deficiency during pregnancy. This program aims to provide additional nutritional intake needed by pregnant women to meet their nutritional needs and the growth and development of their fetus. Previously, supplementary Feeding was given in the form of biscuits, but they were often not finished, with only about 50% of chronic energy deficiency pregnant women consuming them. The reason they were not finished was because the taste of the biscuits was monotonous, causing the mothers to quickly get bored. Therefore, the provision of supplementary food in the form of biscuits was replaced with local food. Local food has several advantages, including the ability to be processed into various menu variations, making it more appealing to pregnant women and aligning with their eating habits in the area. This will help prevent the nutritional status of pregnant women with chronic energy deficiency from worsening, and it is hoped that the nutritional status of pregnant women will improve, thereby addressing the issue of malnutrition<sup>6</sup>.

In 2022, the prevalence of chronic energy deficiency among pregnant women in Yogyakarta was recorded at 12.04%<sup>7</sup>. Based on the results of the Specific Intervention Achievement for Stunting Handling in 2022 and 2023, there are several intervention indicators that have not been achieved, one of which is the percentage of pregnant women with CED who received additional nutritional intake. Although the target indicator was 80% in 2022, the achievement reached only 57.92%. In 2023, the target was

increased to 85%, but the recorded achievement was 78.61%. This shows that the targets set have not been fully achieved in both years.

It turns out that after being reviewed, the challenge faced is in the form of Budget Constraints: The main obstacle in achieving the target is the limited budget for providing supplementary food for pregnant women with chronic energy deficiency. City Budget (City Budget of Yogyakarta) is available but has not yet met several identified cases, Pregnant Women with chronic energy deficiency have not received additional food: In December, several pregnant women with chronic energy deficiency were found who had not yet received supplementary food, and some targets refused to accept additional nutritional intake, which could hinder the achievement of targets.

This condition indicates that the local food distribution strategy needs to be evaluated. Supplementary feeding is very important to address nutritional deficiencies in pregnant women. This is one of the health development targets in the National Medium-Term Development Plan 2020-2024, which aims to reduce the prevalence of pregnant women with chronic energy deficiency by 10% by 2024<sup>8</sup>. To achieve this goal, it is necessary to conduct an evaluation of the local supplementary feeding program for pregnant women with chronic energy deficiency. This research aims to evaluate the input, process, and output of the local supplementary feeding program for the 2024 period.

## MATERIALS AND METHODS

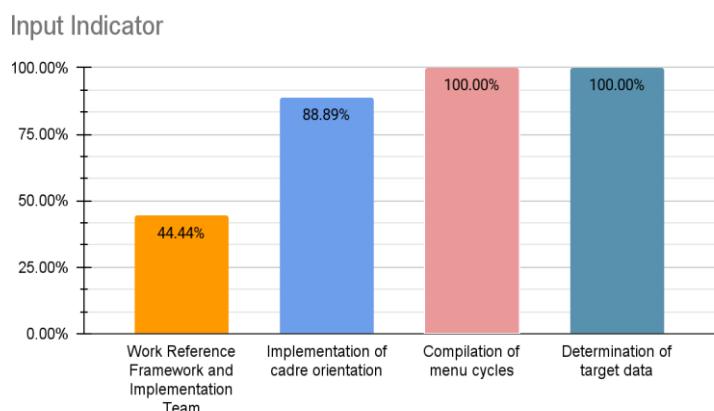
This supplementary feeding program from local food has received approval for implementation from the Head of the Health Service, which is stated in the Circular Letter Concerning the Implementation of Local Supplementary Feeding in the City of Yogyakarta in 2024 Number: 100.3.4/287. As one of the specific intervention efforts to accelerate stunting reduction and in the context of implementing Presidential Regulation Number 72 of 2021 concerning the Acceleration of Stunting Reduction, Decree of the Minister of Health of the Republic of Indonesia Number HK.01.07/MENKES/1928/2022 concerning National Guidelines for Medical Services for Stunting Management, and Regulations Director General of Public Health Number HK.02.02/B/1622/2023 of 2023 concerning Technical Instructions for Providing Additional Food Made from Local Food for Pregnant Women.

This research is a descriptive study with a qualitative approach, conducted from April 22 to June 28, 2024, at the Yogyakarta City Health Office. The research population consists of 18 community health centers located within the working area of the Yogyakarta Health Office. The research subjects included nutritionists, midwives, and administrative heads at the community health center. Data collection was carried out through monitoring and evaluation techniques using a pre-made form link filled out by nutritionist. Additionally, a Focus Group Discussion (FGD) was held to identify obstacles in the implementation of the program, involving nutritionists, midwives, and administrative heads. The instrument used is a Google Spreadsheets link containing monitoring and evaluation forms that include input, process, output, and outcome indicators, as well as monthly monitoring forms for program implementation used in (FGD).

## RESULTS

### 1. Results of data collection via the Program monitoring and evaluation form link

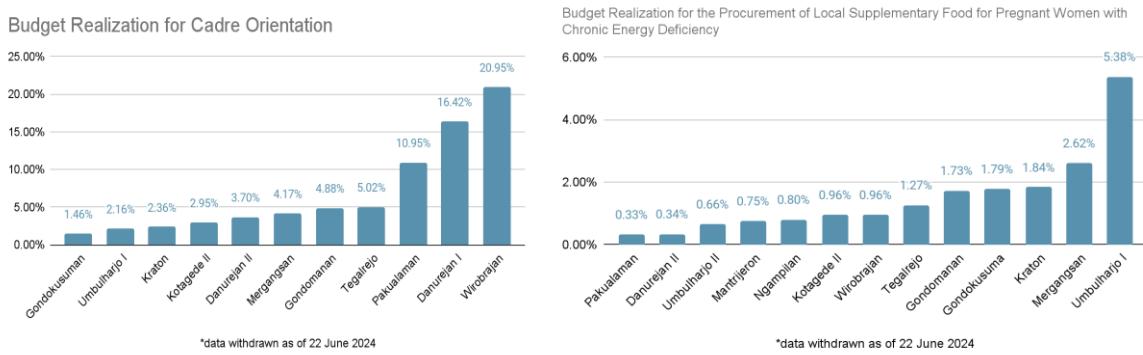
Monitoring and Evaluation of the Local Supplementary Feeding Program is conducted through the distribution of a monitoring and evaluation form Google Spreadsheets link that has been previously created, containing input, process, output, and outcome indicators to all community health centers under the auspices of the Yogyakarta Health Office. This form is filled out by each community health center and its completion is continuously monitored. Evaluation is also conducted on budget usage, by monitoring budget allocation and realization periodically, the Health Department can ensure that the funds provided are used effectively and efficiently to support program objectives. **Figure 1.** shows various input indicators in the implementation of the Local Food-Based Supplementary Feeding Program for pregnant women in Yogyakarta. What needs to be the main focus is the number of community health centers that have established a Work Reference Framework and Implementation Team, which is still less than 50%, precisely only 44.44%. This indicates that many community health centers are still not administratively ready.



\*data withdrawn as of 22 June 2024

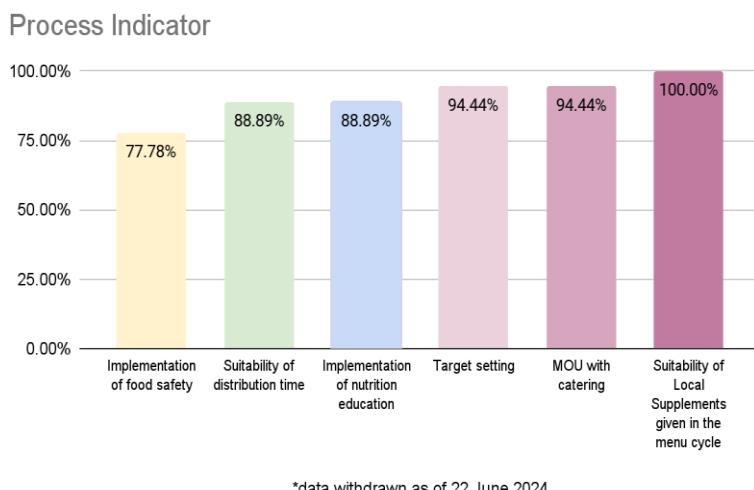
**Figure 1.** Input indicators from data collection results through the monitoring and evaluation program form link

Budget realization graph for cadre orientation in 11 community health centers reporting training budget usage (**Figure 2**). Although only 11 health centers reported, data from the input forms show that 16 out of 18 health centers (88.89%) have conducted cadre orientation. This indicates a discrepancy between the implementation of activities and budget reporting. The Wirobrajan community health center reported the highest budget usage for cadre orientation at 20.95%. In the budget utilization chart for the procurement of supplementary food based on local food for pregnant women with Chronic Energy Deficiency, only 13 community health centers have reported data. The highest realization was recorded at the Umbulharjo I community health center, amounting to 5.38% of the total allocated budget.



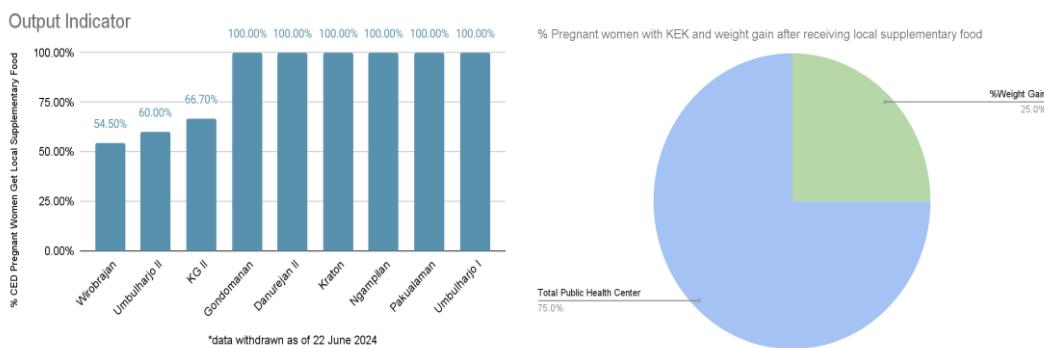
**Figure 2.** Budget Realization for Cadre Orientation and Budget utilization for the procurement of Local Food-Based Supplementary Feeding for Pregnant Women at community health centers

Almost all process indicators at the community health centers have achieved more than 80%, in Suitability of distribution time, Implementation of nutrition education, Target setting, MOU with catering, Suitability of Local Supplements given in the menu cycle has reached 100% (**Figure 3**). However, one indicator that still requires attention is the implementation of food safety, which only achieved 77.78%. This shows that, although the program has succeeded in many areas, the application of food safety standards is not yet optimal in some community health centers and requires improvement to ensure the program runs more safely and efficiently.



**Figure 3.** Process indicators from data collection results through the monitoring and evaluation program form link

The output indicator graph section shows the percentage of pregnant women with Chronic Energy Deficiency who receive local Supplementary Feeding (**Figure 4**). The Wirobrajan public health center has the lowest percentage, with only 54.50% (6 out of 11) of pregnant women with chronic energy deficiency receiving local supplementary food. In the output indicator graph section, only 6 out of 18 community health centers reported weight gain in pregnant women with chronic energy deficiency after receiving local supplementary food, which was 25%.



\*data ditarik per 22 Juni 2024

**Figure 4.** Output indicators from data collection results through the monitoring and evaluation program form link

## B. Results of the Forum Group Discussion

Besides distributing the monitoring form link, the Health Department also facilitates the implementation of structured discussions or Focus Group Discussions involving a small group of participants to identify obstacles hindering the success of the program in the field. By involving nutritionists, midwives, and the head of administration at the community health center, this approach not only helps in facilitating direct problem-solving but also serves as a reminder for the community health center to promptly complete the evaluation forms that have been previously distributed. Here are the challenges in the implementation of the program based on the results of the Focus Group Discussion with the Community Health Center:

### 1. Quality and Texture of Food

The Supplementary Feeding Program based on local food faces challenges related to the quality and texture of the food. Dishes made with flour tend to harden after cooling, the rice hardens, catfish dish is thorny. Some fish dishes that have a strong odor are only consumed in small quantities, and snacks like banana peels also have a strong odor.

### 2. Distribution of the Menu Implementation

The distribution of the Local Supplementary Food menu is facing obstacles; some community health center have replaced snacks with frozen ones because they do not want to cook them every day, resulting in an endless menu and inconsistent variations. Differences in perception also cause variations in the form of food and distribution times that do not always align.

### 3. Food Safety and Hygiene

Food safety and hygiene are not well maintained; some community health center do not conduct routine inspections. Reports indicate there were cardboard pieces in the food and stale salted eggs, which suggests suboptimal quality control.

### 4. Documentation and Administration

Many community health centers have not yet completed the necessary administrative procedures, even though the MOU is already in place. Several important documents, such as the terms of reference and the implementation team certificate, have not been prepared, and the documentation evidence for the Local Supplementary Feeding Program, which is crucial for monitoring and evaluation, has not been uploaded.

#### 5. Education and Socialization

Nutrition education for pregnant women is still lacking, many have not received adequate information despite being invited to the health center. Consumption monitoring is also not comprehensive, making it difficult to ensure the program achieves its objectives.

#### 6. Implementation and Coordination

The implementation of the program began in June due to obstacles in accommodating the community, who did not want to be burdened with debt and the thought of cooking every day. Some menu items are disliked and have not been replaced because the menu cycle does not repeat. Better coordination between community health centers and the Health Department is needed to address this challenge.

### DISCUSSION

The implementation of the Local Supplementary Food Program in Yogyakarta City in 2024 is carried out based on the Technical Guidelines and Circular Letter on the Implementation of Local Supplementary Food. The process of implementing this program begins with the planning stage, which includes several important steps. First, a framework for the implementation of activities was prepared as an operational guideline. Next, the Head of the Community Health Center establishes a general public implementation team, the composition of which is adjusted according to each region<sup>9</sup>. The target recipients of the program undergo verification or validation and assessment to ensure data accuracy. The target of this program is pregnant women with Chronic Energy Deficiency and pregnant women at risk of Chronic Energy Deficiency, with a target achievement of 90% each. The determination of target data is carried out by the Head of the Community Health Center through a Decree, using "by name by address" data accompanied by the date of data retrieval. The provision of supplementary food made from local ingredients will be carried out for 120 days, both for pregnant women suffering from chronic energy deficiency and those at risk of chronic energy deficiency.

Apart from that, the cycle of local supplementary food menus is arranged according to the applicable standards, using a 14-day menu cycle consisting of 10 days of high-animal-protein snack menus and 2 days of complete menus. This program also involves "Gandeng-Gendong" (GaGe) or Catering in the procurement of local supplementary food not by cadres. The innovation of local Gandeng-Gendong Catering not only aims to address nutritional issues but also to empower and improve the local economy<sup>10</sup>.

Finally, the drafting of the Cooperation Agreement (MOU) with the catering is carried out as part of the implementation of this program, thereby ensuring the effectiveness of the cooperation between the community health center and the local supplementary food providers.

The implementation of the Local Food-Based Supplementary Feeding Program for pregnant women in Yogyakarta shows varied results. What needs to be the main focus is the number of community health center that have established a Work Reference Framework and Implementation Team, which is still less than 50%, precisely only 44.44%, indicating a lack of administrative readiness. However, there are positive achievements: 88.89% have conducted cadre orientation, indicating strong staff preparation, and 100% have developed the menu cycle and set target data, demonstrating comprehensive planning. Although improvements are needed in the formation of the Terms of Reference and the Implementation Team, other indicators reflect a high readiness to support the success of the program.

A budget is a financial manifestation of a work program to achieve targets within a specified period. This can also be defined as a plan systematically prepared to cover all company activities, expressed in monetary units and applicable for a specific period in the future. Provision of Additional Food is funded by the Prawita Health Operational Assistance Fund, 2017<sup>11</sup>. Law Number 36 of 2009 on Health, health financing comes from the government, local governments, the community, the private sector, and other sources.

The results of budget realization for the cadre orientation program at various Community Health Centers in Yogyakarta. The percentage of budget realization varies at each community health center, with the highest percentage being at the Wirobrajan community health center at 20.95%, followed by Danurejan I at 16.42%. Other community health centers, such as Pakualaman, also show significant realization at 10.95%. Although only 11 community health centers reported the official use of the training budget, input forms indicate that 16 out of 18 community health centers, or about 88.89%, have conducted cadre orientation. This indicates that there are discrepancies in reporting, where some each community health center may not have reported the actual budget for cadre orientation.

The budget for providing local supplementary food for pregnant women with chronic energy deficiency at various community health centers in Yogyakarta shows variation according to regional needs. The community health center in Umbulharjo I recorded the highest realization, at 5.38% of the total, reflecting a larger number of pregnant women with chronic energy deficiency. On the contrary, the public health center in Pakualaman Danurejan II has a smaller budget, 0.33% and 0.34% respectively, because the target numbers are likely smaller. Several other public health centers also show variations in their budget realizations. The public health centers in Merangsang and Kraton, for example, realized 2.62% and 1.84% of the total budget, respectively. The percentage is still lower compared to Umbulharjo I, but it still shows a significant allocation in line with the needs of chronic energy deficiency among pregnant women in the area.

The process indicators of the Local Supplementary Feeding Program at the Community Health Center show varied results. Only 77.78% implement food safety effectively, indicating that 22.22% still require improvement in this area. However, all centers (100%) successfully provided local supplementary food according to the menu cycle, demonstrating full compliance with this aspect. Other indicators such as distribution time and nutrition education have been achieved by 88.89% across all community health centers, showing good performance and still requiring improvement. In addition, 94.44% have set precise targets and established MOUs with catering programs. Although there have been significant successes in several areas, improving food security remains a priority.

The output indicator percentage of pregnant women with chronic energy deficiency shows the percentage of pregnant women with chronic energy deficiency who receive local supplementary food at various community health centers. The public health center in Wirobrajan has the lowest percentage, with only 54.50% (6 out of 11) of pregnant women with chronic energy deficiency receiving local supplementary food. On the other hand, seven other community health centers, namely: Gondomanan, Danurejan II, Kraton, Ngampilan, Pakualaman, and Umbulharjo I, showed the best performance by achieving 100% of pregnant women with chronic energy deficiency receiving local supplementary food. Output indicator graph: % of pregnant women who experienced weight gain after receiving local supplementary food. Only 6 out of 18 community health centers reported weight gain in pregnant women with chronic energy deficiency after receiving local supplementary food, which was 25%.

Overall, these results indicate that although most community health centers have provided local supplementary food to pregnant women with chronic energy deficiency, only a few reported significant weight gain. The data in the graph was taken as of June 24 from the monitoring and evaluation aspect form link. The implementation of the program at each community health center has different schedules, so many health centers have not yet filled in their outputs because they are still in the monitoring phase.

Based on the results of the Focus Group Discussion with various Community Health Centers, there are several obstacles and issues faced in the implementation of the Program. One of the main challenges is the quality and texture of the food served. Some flour-based dishes tend to become hard after being cooled, and rice also becomes hard. In fact, there are reports of thorns in catfish dish, which of course reduce the comfort and safety of its consumption. Apart from that, fish-based menus often have a fishy smell which is not liked by pregnant women who end up consuming only a small amount of food. Local foods such as banana barongko (steamed banana cake), pudding, mento cake (meat pancake topped with coconut milk), and carang gesing (banana dessert) are also reported to be less popular among pregnant women, resulting in lower levels of consumption of these foods.

Food safety and hygiene remain a concern, as some public health centers do not consistently conduct inspections of the safety and hygiene of the food served. There are reports of cardboard pieces in the food and rotten salted eggs, indicating a gap in quality control. Food security is a societal need; as safe food is expected to protect the community from diseases or other health issues. The foundation of

food security is the efforts of hygiene, nutrition, and food safety<sup>12</sup>. In Government Regulation Number 86 of 2019 concerning Food Security, the implementation of security is carried out to provide protection to the community in consuming safe and healthy food, thus food management is conducted. needed, from production to food to consumption by consumers<sup>13</sup>.

Additionally, challenges arise in the distribution and implementation of the menu. Although the menu cycle follows the Health Service guidelines, some community health centers have difficulty implementing it. For example, some food providers replaced snacks with frozen foods like catfish dish and dumplings to avoid cooking every day, which resulted in low food acceptance and some menu items not being consumed. Variations in the form of local supplementary foods also occur due to differences in perception among service providers, leading to inconsistencies in the food served. In addition, there is also the issue of distribution timing, where some food providers do not distribute food on time, affecting the freshness and quality of the received food.

Administratively, several community health centers have incomplete documentation, some MOUs have not been signed, and there are no Terms of Reference or Decrees for the implementation team. In addition, several centers have not yet uploaded the necessary documentation for effective program monitoring and evaluation.

Education and socialization for pregnant women are still not optimal, even though they are invited to community health centers, many have not received adequate nutrition education. The provision of local supplementary food aims to meet the nutritional needs of mothers during pregnancy while continuing to consume a balanced nutritious family diet. This program is integrated with Antenatal Care services. According to Menglik (2019), the Local Supplementary Food Program is distributed at community health centers when pregnant women undergo integrated Antenatal Care examinations, starting with screening, counseling, and nutrition education before the provision of supplementary food. Monitoring of food consumption is incomplete, making it difficult to assess the program's impact on nutritional status. Improved coordination between the Public Health Center and the Health Office is necessary to address this challenge. According to the research by Alita & Ahyanti (2013), the success of the program is related to planning, implementation, recording, evaluation, and reporting<sup>14</sup>.

## CONCLUSION

The evaluation results show that the input and process aspects reached >80%, except for the formation of the Work Reference Framework and the Implementation Team, as well as the assessment of food safety in catering. For the output achievement indicators, each community health center varies because of the different schedules for the implementation of local supplementary feeding. The Local Supplementary Food Program in Yogyakarta City in 2024 involves "Gandeng-Gendong" or local catering as food providers, but there are still obstacles that need to be addressed, such as program management, food supervision, and education, which are still necessary to achieve optimal results. For the outcome

and impact indicators, measurement cannot be conducted at this time because the Local Supplementary Feeding Program in Yogyakarta City is still in the implementation stage.

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## Review Article (FF08)

# Factors Influencing Ultra-Processed Food Consumption Within Vulnerable Populations: A Scoping Review

Rina Chomawati<sup>1\*</sup>, Digna Niken Purwaningrum<sup>2</sup>

<sup>1</sup>*Postgraduate Program of Public Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia*

<sup>2</sup>*Department of Biostatistics, Epidemiology, and Population Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia*

## ABSTRACT

Consumption of ultra-processed food by vulnerable populations can lead to negative health outcomes such as obesity, diabetes, and other non-communicable diseases. Limited access to nutritious food causes those facing food insecurity to consume more ultra-processed foods, which poses health risks across various vulnerabilities and income levels. This study aims to identify factors influencing ultra-processed food consumption within vulnerable populations. This study used the Arksey and O'Malley framework, complying with the JBI guidance for scoping reviews. Eligibility criteria were considered based on the Population, Concept, and Context approach. Include peer-reviewed articles published after 2013, with full text available in English, and studies conducted in all income levels of countries. Ten articles identified in the review showed that the higher consumption of ultra-processed food was more prevalent among children (60%), followed by adolescents (30%) and mothers (10%). Children in the complementary feeding stage typically consume ultra-processed foods because they are affordable, convenient, and quick to prepare. As children progress through elementary and high school, they tend to have an uncontrolled intake of ultra-processed foods, particularly when they are away from home, using screens, and eating alone. Additionally, mothers experience difficulties in accessing local food sources due to increasing prices. Ultra-processed food is often chosen due to accessibility, availability, and affordability rather than nutritional needs, leading to poor dietary choices among vulnerable populations.

**Key words:** ultra-processed food, consumption, vulnerable

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\*Correspondence: rinachomawati@mail.ugm.ac.id

## INTRODUCTION

Hunger and malnutrition cause enormous suffering for humans and financial burdens in poor countries. Lack of access to nutritious food in vulnerable groups is a major contributor to the development of nutritional problems and related chronic illnesses. The rise in industrially processed food has led to an increase in obesity and non-communicable diseases worldwide<sup>1</sup>. According to recent studies, ultra-processed foods contribute 50-60% of the calories in the average US, Canadian, or British diet<sup>2-4</sup>.

More than half of the world's 100 largest economies are corporations, and an increasing proportion of global deaths are caused by exposure to highly processed foods, alcohol, tobacco, and air pollution<sup>5</sup>. The commercial determinants of health (CDoH) offer a unique opportunity to shift the dominant paradigm in public health, where inadequate environments drive individual behaviors. Corporations themselves may be affected by CDoH through the bad health of their workers, which might increase their absence from the workplace. They may also be affected by the bad health of communities in which they operate, which may decrease their purchase power and willingness to buy, and by the damages they do to the environment, which may affect their business operations by reducing their access to natural resources, for example<sup>6</sup>. CDoH is often used to specify the role and impact of corporations on human health. In contrast, the former has a wider remit that includes all activity of the private for-profit sector, consumer behavior, consumerism, individualism, the global risk society, and the political economy of globalization<sup>7</sup>.

Ultra-processed food is frequently used as a substitute for fresh food since it is convenient and ready to consume. It is defined as formulations of ingredients, usually for industrial application, created by a succession of industrial processes, many of which need advanced equipment and technology (thus 'ultra-processed'). Processes used to make ultra-processed foods include the fractionation of whole foods into substances, chemical modifications of these substances, assembly of unmodified and modified food substances using industrial techniques such as extrusion, molding, and pre-frying; use of additives at various stages of manufacture to make the final product palatable or hyper-palatable; and sophisticated packaging, usually with plastic and other synthetic materials<sup>8</sup>.

Many enterprises that make ultra-processed foods have a global presence. As higher-income countries reach saturation, there is evidence of "problem shifting" to lower-income countries, which have emerged as growth markets. Growing evidence links higher intake of ultra-processed foods to an increased risk of non-communicable diseases<sup>7</sup>. This study aims to identify factors influencing ultra-processed food consumption in vulnerable populations, identifying common themes across the world that highlight the root causes of low uptake of nutritious food within vulnerable populations and any particular characteristics that are specifically relevant. Also to explore the social and cultural factors that affect food choices.

## MATERIALS AND METHODS

### *Identifying the research question*

This scoping review uses the Arksey and O'Malley framework for conducting scoping reviews<sup>9</sup> and updated 2020 guidance on conducting scoping reviews<sup>10</sup>. It applies the PCC (Population, Concept, Context) framework recommended by the Joanna Briggs Institute for Scoping Reviews. This research examines what is considered part of the vulnerable populations, and what factors influence their consumption of ultra-processed food.

### *Identifying relevant studies*

The following databases were searched Google Scholar, Scopus, PubMed, and EBSCO. The following search terms were applied, using a variation of MeSH terms, title/abstract/keywords, text words, or subject terms. The keywords: vulnerability OR vulnerabilities AND ultra processed OR ultraprocessed OR ultra-processed OR ultra process\* OR ultraprocess\* were combined as medical subject heading (MeSH) terms and text words. The articles chosen for screening in Google Scholar, PubMed, and EBSCO were limited to the first ten pages of the results or 100 articles. Despite this, all search strategy results from the Scopus database were screened.

### *Study selection*

Eligibility criteria were determined using the population, concept, and context (PCC) approach. Population: representing vulnerable groups (children, girls, women, youth, the elderly, individuals with disabilities, Indigenous people, and human migration); Concept: any socio-demographic measure that might be affected. Context: the rationale for ultra-processed food consumption, either absolute or relative. Inclusion criteria were established at the beginning, and articles considered appropriate to include were peer-reviewed articles published in 2013 and afterward until March 2024, with full text available in English, studies conducted in all income levels of countries, and all types of analyses (qualitative, quantitative, and interventional). Gray literature, opinion pieces, case reports, editorials, and commentary were all excluded. Articles were assessed for quality using the JBI QARI critical appraisal.

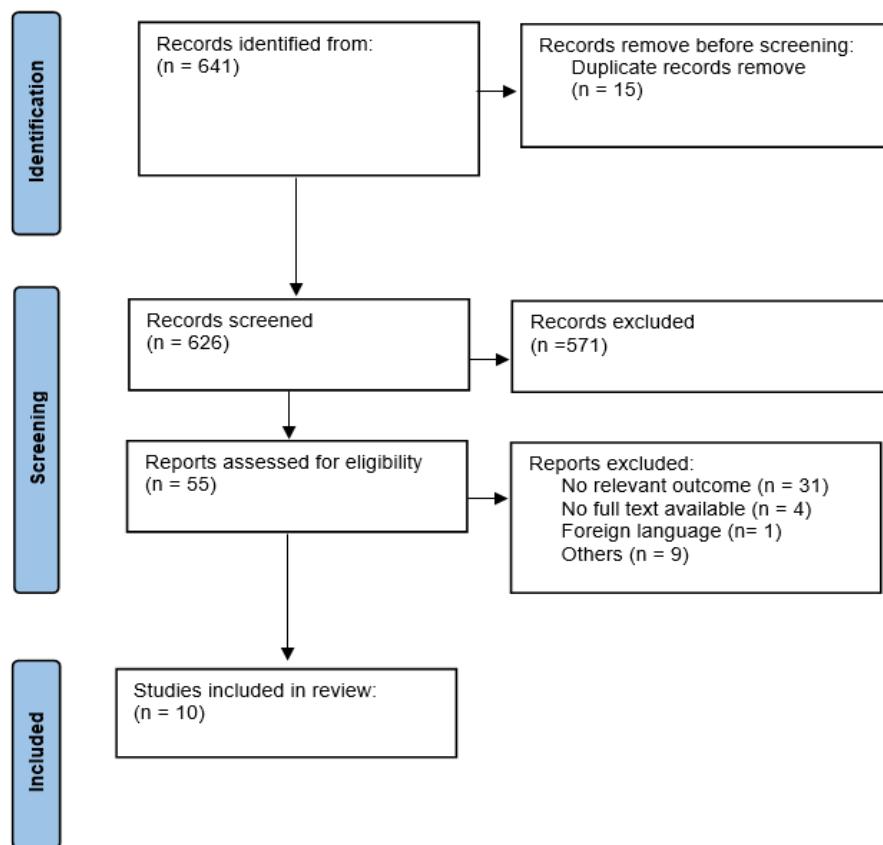
### *Data charting*

Relevant studies were identified in the database search and duplicate articles were removed before beginning the eligibility screening using Rayyan, a web-based tool that supports the process of screening and selecting studies.

## RESULTS

The full study selection process is represented in the PRISMA flow diagram, presented in Figure 1. As seen in **Table 1**, vulnerable groups in this review include children (60%), adolescents (30%), and mothers (10%). The country setting featured most is Brazil (70%), followed by the United Kingdom, Colombia, and Ethiopia. This review includes 8 quantitative studies and 2 qualitative studies. The most consumed ultra-processed foods by the population include soft drinks/sweetened beverages, fast food,

packaged bread, and salty biscuits/crackers. The final 10 articles were assessed for quality using the JBI QARI critical appraisal, defined as Good (80%) and Fair (20%).



**Figure 1.** PRISMA diagram

## DISCUSSION

This scoping review highlights the fact that vulnerable populations consume ultra-processed foods. Three vulnerable groups have a significant amount of consumption, those are children, adolescents, and women who are mothers. Soft drinks/sweetened beverages, fast food, packaged bread, and salty biscuits/crackers are among the most consumed ultra-processed foods. Found varying considerations on how the vulnerable groups select ultra-processed food, including their perspective on accessibility, availability, and affordability in their neighborhood.

**Table 1.** Characteristics of studies

No.	Authors	Year of publication	Setting	Study designs	Population	Ultra-processed food type	Consumption rationale	Quality of the study
1	Cainelli, E.C. et al. <sup>11</sup>	2021	Piracicaba, Brazil	Cross-sectional study	Children aged 6 months to 2 years old	Hamburger and/or cold meats (ham, mortadella, salami, and bologna or other sausages); sweetened beverages (soda, processed fruit juice, powdered juice, processed coconut water, guarana or redcurrant syrup, and sugar-sweetened fruit juice); instant pasta, chips or salty biscuits, cream-filled biscuits, sweets or treats.	<ul style="list-style-type: none"><li>• Living with more than four people in families granted government benefits</li><li>• Sociodemographic and demographic factors during complementary feeding</li></ul>	Good
2	Onita, B.M. et al. <sup>12</sup>	2021	United Kingdom (England, Wales, Scotland and Northern Ireland)	Cross-sectional study	Children aged 4 to 10 years old	Cookies, ice cream, candies, sugary breakfast cereals, instant noodles and spices, snacks, soft drinks, sugar-sweetened drinks, sweetened yogurts, dairy drinks, consumption ready or semi-ready meals, sausage, and other sausages, among others (Monteiro et al., 2018).	<ul style="list-style-type: none"><li>• Eating with family while watching TV</li><li>• Eating away from home, and</li><li>• Eating alone in the bedroom</li></ul>	Good
3	Gonçalves, H.V.B. et al. <sup>13</sup>	2023	Brazil	Cross-sectional study	Adolescents 13 to 17 years old (final years of elementary and high school)	Crackers, cookies, bread, soft drinks, and margarine.	<ul style="list-style-type: none"><li>• Enrolled in private schools</li><li>• Living in non-capital</li><li>• Over 13 years of age</li><li>• Residents in the north region, and</li><li>• Living with a father and/or mother who had no education other than those in the North region.</li></ul>	Good
4	Khandpur, N. et al. <sup>14</sup>	2020	Colombia	Cross-sectional study	All individuals in the National Survey of the Nutritional Status (including	Industrialized bread, snacks, and sugary drinks.	Children and adolescents residing in urban areas and households with greater purchasing power	Fair

No.	Authors	Year of publication	Setting	Study designs	Population	Ultra-processed food type	Consumption rationale	Quality of the study
					children and adolescents)			
5	Tadesse, E et al. <sup>15</sup>	2023	Oromia, Ethiopia	Qualitative study	Children aged 6-23 months	Fenugreek or cabbage fluid, sugared water, tea, soft drinks, packed juice, or biscuits dissolved in water	<ul style="list-style-type: none"><li>● A pattern of suboptimal complementary feeding, including early and late initiation of complementary foods.</li><li>● Ultra-processed food (juice, biscuits, and lipid-based nutrient supplements) was diluted with or dissolved in water and fed to infants via bottle, often before the recommended age of initiation of 6 months.</li><li>● Mothers and caregivers perceived the products to be affordably priced and packaged, ready to use, and convenient given their time constraints.</li></ul>	Fair
6	Oliveira, G.A.L. et al. <sup>16</sup>	2024	Brazil	Cross-sectional study	School children (elementary school, particularly the first to fifth grades, in public and private schools)	Soda, industrialized juices in cartons, chocolate milk or flavored yogurt, packaged bread, packaged salty snacks or crackers; cookie or packaged sweet cake; chocolate, ice cream, gelatin or candy; salami, sausage, baloney, or ham; margarine, mayonnaise, or ketchup; instant noodles, frozen lasagna, or pizza	<ul style="list-style-type: none"><li>● Excessive screen time use</li><li>● Screens during meals</li><li>● Eating alone</li><li>● Not eating at regular times</li><li>● Not participating in household activities involving meal preparation</li><li>● Not consuming three main meals,</li><li>● Skipping breakfast</li></ul>	Good
7	Sato, P.M. et al. <sup>17</sup>	2020	Cruzeiro do Sul, Acre, Brazil	Qualitative study	Women (mothers who gave birth between July 2015 and July 2016) aged 17 to 43 years old, with a mean of 26,7 years	Fast food	<ul style="list-style-type: none"><li>● Prices of regional foods have been increasing</li><li>● Cheap ultra-processed foods, low in quality</li><li>● Lack of resources for food.</li><li>● Foods were not chosen for their palatability, as were eating out and chocolates, but for affordability.</li></ul>	Good

No.	Authors	Year of publication	Setting	Study designs	Population	Ultra-processed food type	Consumption rationale	Quality of the study
					old			
8	Mesas, A.E et al. <sup>18</sup>	2024	Brazil	Cross-sectional study	Students aged 13 to 17 years old (adolescents)	Soft drinks, industrialized fruit juice, powdered soft drinks, chocolate drink, flavored yogurt, salty snacks (e.g., packaged chips or crackers), sweet snacks (e.g., sweet cookie, cream cookie, or packet cake), industrialized desserts (e.g., chocolate, ice cream, gelatin, flan), processed meat products (e.g., sausage, mortadella or ham), industrialized bread (e.g., flatbread, hot dog bun or hamburger bun), margarine, industrialized sauces (e.g., mayonnaise, ketchup), and industrialized ready meals (e.g., instant noodles, packaged soups, frozen lasagna).	<ul style="list-style-type: none"><li>● Experience of violence, potentially influenced by the use of alcohol and other addictive substances.</li><li>● Lifestyle patterns in adolescence, such as the number of close friends, the use of various types of psychoactive substances, and mental health symptoms</li></ul>	Good
9	Silva-Neto, L.G.R. et al. <sup>19</sup>	2024	Maceio, The capital of the state of Alagoas, Northeast of Brazil	Cross-sectional study	Children under 59 months	Soft drinks, powdered soft drink mix, and chocolate drinks	Children introduced to soft drinks in their diet in the first year of life	Good
10	Gomes, J.M.R., et al. <sup>20</sup>	2024	Maceio, The capital of the state of Alagoas, Northeast of Brazil	Cross-sectional study	Children under 5 years living in the ninety-four subnormal settlements	Chocolate milk, candies/lollipops, cookies/crackers, cream-filled cookies, chocolate, jelly, creamy yogurt, soft drinks, packaged salty snacks, dried soup mix, ice cream, and powder refreshment mixture.	<ul style="list-style-type: none"><li>● Early food introduction in the first year of life. The three most introduced were creamy yogurt, cookies/crackers, and cream-filled cookies</li><li>● Maternal years of schooling</li><li>● Maternal parity</li><li>● Beneficiary of a Brazilian government cash transfer program and income.</li></ul>	Good

According to the World Health Organization, certain demographic groups are more vulnerable to catastrophes because of factors such as age, gender, sexual identity, race, culture, religion, handicap, socioeconomic level, geographical location, or migration status<sup>21</sup>. Food and nutrition insecurity is an

individual-, household-, and neighborhood-level economic and social condition describing limited or uncertain access to adequate and affordable nutritious foods and is a major public health concern. In 2020, almost 15% of U.S. households were considered food insecure at some point in time. In nearly half of these households, children were also food insecure, which has implications for human development and school experience. Food insecurity disproportionately affects persons from racial and ethnic minorities and socioeconomically disadvantaged populations<sup>22</sup>.

Identifying a vulnerable community can be based on one or more of the following characteristics or parameters: lack of access to primary care services; poor economy, high unemployment rates, and limited economic resources; high rates of uninsurance and underinsurance; cultural differences that may pose challenges, such as social, cultural, and linguistic barriers that may prevent patients from accessing care; low education or health literacy levels; and environmental challenges<sup>23</sup>. ProMedica Health System in Ohio determined that one of the root causes of the problem was food insecurity, particularly a lack of access to nutritious, affordable food. As such, they began providing educational programs on nutrition at schools and to parents, including recommendations for how families could purchase healthy food on minimal budgets<sup>24</sup>.

Children in the complementary feeding stage usually consume ultra-processed foods due to their affordability, convenience, and quick preparation<sup>11,15,19-20</sup>. To encourage improved eating habits among vulnerable individuals, nutrition education and cooking workshops must be implemented to promote healthy options and decrease reliance on ultra-processed foods. As children grow up and go to elementary and high school (adolescents), they tend to have an uncontrolled intake of ultra-processed foods when they are away from home, often while engaging in screen time or eating alone<sup>12-14,16</sup>. Adolescents who experience violence and have lifestyle habits such as the number of close friends, psychoactive substance abuse, and mental health issues are considered to eat more ultra-processed foods<sup>17</sup>. Collaborating with schools to provide better lunch alternatives and working with local businesses to develop nutritional options, can help these efforts succeed. Meanwhile women, especially mothers, experience difficulties in accessing regional food sources due to rising prices<sup>18</sup>. Furthermore, food insecurity remains a significant concern in impoverished communities, since families lack access to quality and inexpensive food. Improving access to fresh produce through community gardens and mobile marketplaces is crucial to establishing healthier food decisions.

The National Institute on Minority Health and Health Disparities reports that in 2021, 16% of Hispanic/Latino households and 20% of Black/African American households experienced food insecurity, compared to 7% of White households. This is in line with a Gonçalves et al. (2023) study that found adolescents of mixed races, black, Asian, and Indigenous descent were more likely than white adolescents to consume industrialized sweets. Nonetheless, compared to white teenagers, these groups consumed fewer boxed or canned juice and powdered beverages<sup>13</sup>. Food insecurity is inextricably linked to poverty, with 35.3 % of households with incomes below the federal poverty line being food insecure<sup>22</sup>.

Mothers in Brazil affirmed that prices of regional foods have been increasing, and for some of them those had become unaffordable<sup>17</sup>.

Public health efforts should focus on wider determinants of consumption rather than selected nutrients or individual behaviors<sup>7</sup>. Ultra-processed food consumption tends to be higher in low-income or food-insecure groups. Vulnerable populations that consume a lot of ultra-processed food may experience adverse health effects like obesity, diabetes, and other non-communicable diseases. Ultra-processed food consumption is more common in populations facing food insecurity. While disadvantaged communities are disproportionately affected by food insecurity, ultra-processed foods pose serious health concerns to people of all economic levels, even those with high incomes who may be vulnerable in various ways. To overcome these inequalities, comprehensive strategies for the social and cultural elements that influence food choices must be implemented, as well as increased access to healthy foods and nutrition education. Campaigning for regulation that promotes healthy eating and enforces distinct labeling of ultra-processed foods can help customers make more educated purchase decisions. Furthermore, organizing peer support groups and conducting future studies to investigate dietary trends may aid in creating a supportive environment for better nutrition.

## CONCLUSION

Ultra-processed foods are frequently consumed by children, adolescents, and women who are mothers. Ultra-processed food is often chosen due to accessibility, availability, and affordability rather than nutritional needs, leading to poor intake choices in vulnerable populations. The most consumed ultra-processed foods by the vulnerable population include soft drinks/sweetened beverages, fast food, packaged bread, and salty biscuits/crackers.

This study maps the available evidence on the consumption of ultra-processed foods by vulnerable populations. There are a few important points to consider. First, there is a limited number of studies addressing vulnerable populations in Asia, thus further research is needed. Furthermore, the majority of the studies included in the analysis were conducted in the Americas, which may not truly represent vulnerable populations worldwide. Future studies should consider the various geographical settings when determining vulnerable populations.

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## Research Article (FF09)

### Study of Nutritional, Chemical, and Microbiological Properties, and *In Vitro* Effects on Blood Sugar Control of Freeze-Dried Banana Blossoms

Nichaphat Chotiprakornkul<sup>1</sup>, Wilawan Sintuprapa<sup>1</sup>, Sunee Nitisinprasert<sup>1</sup>,

Paiboon Tunsagool<sup>1</sup>, Morrakot Suwannakarn<sup>2</sup>, Bandhita Wanikorn<sup>1\*</sup>

<sup>1</sup>Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University, Bangkok 10900, Thailand.

<sup>2</sup>Chulabhorn Chalermpakiet Medical Center, Bangkok 10210, Thailand.

#### ABSTRACT

The prevalence of ischemic heart disease (IHD) is currently growing. The majority of cases are related to type 2 diabetes, which is caused by lifestyle choices such as consuming a high-sugar and high-carbohydrate diet that elevates blood sugar levels. Previous research has demonstrated the nutritional and chemical benefits of banana blossoms (BB), including their antioxidant and blood sugar-lowering properties. However, the nutritional value of banana blossoms can degrade due to quick oxidation after harvest. Freeze-drying is an efficient preservation process that prevents oxidative damage while maintaining the nutritional integrity of the banana blossom. In this study, freeze-dried banana blossom powder (FBP) was evaluated for its chemical composition and the presence of pathogenic microorganisms, as well as its bioactive compound content, antioxidant activity, and antihyperglycemic activity through alpha-amylase and alpha-glucosidase inhibition tests. The FBP was high in soluble and insoluble dietary fiber, while also meeting pathogen safety criteria. It exhibited a high total phenolic content (38.66±2.37 mg GAE/g) and antioxidant activity (4.69±0.15 mg TE/g). Additionally, it showed significant inhibitory effects on alpha-glucosidase and alpha-amylase enzymes, with IC<sub>50</sub> values of 0.35±0.09 µg/mL and 0.05±0.00 µg/mL, respectively. These findings indicate that banana blossoms have significant promise as a functional ingredient in foods and nutraceuticals, particularly for controlling blood sugar levels and reducing oxidative stress.

**Key words:** Banana blossom, freeze drying, nutrition, antioxidant activity, antihyperglycemic activity

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\* Correspondence : fagibtw@ku.ac.th

## INTRODUCTION

Approximately one-third of deaths globally are attributable to cardiovascular disorders (CVD). According to WHO<sup>1</sup>, ischemic heart disease (IHD) is the most common CVD<sup>2</sup>, responsible for 32% of all deaths in 2019. The global burden of IHD is projected to rise significantly by 2050, with expected increases in incidence (67.3 million), prevalence (510 million), deaths (16 million), and DALYs (302 million), representing growths of 116%, 106%, 80%, and 62% respectively from 2021<sup>3</sup>. Lifestyle behaviors such as a high carbohydrate and sugar diet and a lack of exercise raise blood sugar levels, increasing the risk of CVD by promoting blood sugar levels. Modern medical treatments that disintegrate blood clots, like cardiac angioplasty (balloon) and coronary artery bypass surgery (bypass), are expensive<sup>4</sup> and need to be imported from overseas, which results in a large amount of medical expenses. Therefore, choosing a healthy diet is an important first step in preventing IHD. Furthermore, type 2 diabetes mellitus (T2DM) prognosis and disease progression are greatly concerned with IHD (4). Insulin resistance and elevated blood sugar levels are characteristics of T2DM. Previous studies have shown that CVD affects people with T2DM by up to 32.2%<sup>5</sup>.

Banana (*Musa sapientum* L.) is an economic crop in Thailand. Department of Agriculture (2019) reports annual banana production at over 114 million tons<sup>6</sup>. By-products from banana plantations such as banana blossoms (BB) have high nutritional but low economic value. BB is mostly consumed as a vegetable and used as an ingredient in breast milk supplements. Previous studies have found that BB is rich in health-promoting substances such as fiber and also contains phenolic compounds that have antioxidant properties<sup>7</sup>.

Phenolic compounds are secondary metabolites found in plants with many biological properties including health benefits. An antioxidant is a stable molecule that donates an electron to a rampaging free radical and neutralizes it, thus inhibiting cellular damage<sup>8</sup>. Antioxidants can also lower blood pressure and reduce blood sugar levels<sup>9</sup>. However, the management of banana blossoms after cutting from the banana tree is very challenging because, when cutting from the banana tree, the oxidation reaction occurs rapidly, which causes the banana blossom to turn brown. This reaction harms consumer acceptance and reduces the nutritional value<sup>10</sup>. Drying methods are used to maintain the best nutritional value. Among the drying methods, freeze-drying is a prominent technique, as it can prevent oxidative damage by reducing the change in chemical composition and reducing the shrinkage and dissolution of the dissolved substances. In addition, freeze-drying helps preserve volatile compounds, such as phenolic compounds and antioxidants<sup>11</sup>.

Therefore, this research aims to study the nutritional value, chemical composition, biological properties, antioxidant activity, and antihyperglycemic activity of freeze-dried banana blossom powder (FBP) *in vitro*. Then, encourage their use as a value-added, functional nutraceutical ingredient that adheres to the BCG model of the bio-circular economy.

## MATERIALS AND METHODS

### 1. Chemical

Standard reagents such as 2-diphenyl-1-picrylhydrazyl (DPPH), Folin–Ciocalteu, Trolox,  $\alpha$ -glucosidase (14 U/mg protein), and acarbose were purchased from Sigma-Aldrich (St. Louis, MO, USA).

### 2. Plant material

BB from the banana species *Musa sapientum* L. was obtained from Ban Rai Saen Suk Community, Khok Mon Subdistrict, Nam Nao District, Phetchabun Province, Thailand. The BB is cut when the last banana bears fruit, a length of 9-12 inches and a circumference of 9-12 inches were selected for further study.

### 3. Preparation of samples

The BB removed 1-5 red peeled, cut into dimensions ranging between 0.5 to 0.8 mm, and underwent a controlled drying procedure utilizing a freeze dryer (GFD200S, Grisrianthong, Thailand) in temperature ranged between -30°C to 50°C for 30 h. Then the grinding process to achieve a fine particulate consistency into banana blossom powder (FBP) in an 80-mesh screen packed in an aluminum foil bag, and stored at room temperature for further analysis.

### 4. Quantitative chemical and nutritional composition determination

All variants of samples analyzed for total fat (AOAC 2023, 922.06), saturated fat (in-house method TE-CH-169 based on AOAC 2023, 996.06), cholesterol (in-house method TE-CH-169 based on AOAC 2023, 994.10), protein (AOAC 2023, 981.10), dietary fiber (In-house method TE-CH-169 based on AOAC 2023, 985.29), sugar (AOAC 2023, 977.20), sodium (in-house method TE-CH-169 based on AOAC 2023, 984.27 by ICP-OES technique), potassium (in-house method TE-CH-169 based on AOAC 2023, 984.27 by ICP-OES technique), vitamin B1 (In-house method TE-CH-169 based on AOAC 2023, 942.23), calcium (in-house method TE-CH-169 based on AOAC 2023, 984.27 by ICP-OES technique), iron (in-house method TE-CH-169 based on AOAC 2023, 999.10 by ICP-OES technique), ash (AOAC 2023, 920.153), moisture (AOAC 2023, 925.45A), insoluble dietary fiber (in-house method TE-CH-169 based on AOAC 2023, 991.43), total phosphorus (as P) (AOAC 2023, 986.24), soluble dietary fiber (In-house method TE-CH-169 based on AOAC 2023, 991.43), copper (Cu) (in-house method TE-CH-169 based on AOAC 2023,

999.10 by ICP-OES technique), magnesium (Mg) (in-house method TE-CH-169 based on AOAC 2023, 984.27. by ICP-OES technique) were determined through AOAC (2023) methods<sup>12</sup>. Vitamin A (Calculated from beta-carotene) and Beta-carotene (AOAC 2011.07, 2001.13) were determined through AOAC (2019) methods<sup>13</sup>. Total energy, energy from fat, and carbohydrate were determined through the in-house method TE-CH-169 based on the Method of Analysis for Nutrition Labeling (1993)<sup>14</sup>. Vitamin B2 was determined through the Journal of Agricultural and Food Chemistry (1984)<sup>15</sup>. Cellulose and Hemicellulose were determined through Maynard and Loosli. (1969). Starch was determined through Commission Regulation (EC) No.152/2009<sup>16</sup>.

## 5. Quantitative analysis of microbial composition

All variants of samples analyzed for aerobic plate count were determined through FDA BAM Online, 2001. (Chapter 3)<sup>17</sup>. Escherichia coli was determined through Standard Methods for the Examination of Water and Wastewater 23<sup>rd</sup> Edition, 2017<sup>18</sup>. Salmonella spp. was determined through ISO 6579-1: 2017/Amd.1: 2020 (19). Staphylococcus aureus (AOAC 2003.07), yeasts and molds (AOAC 997.02) were determined through AOAC (2023)<sup>12</sup>.

## 6. Quantitative analysis of bioactive compounds and antioxidant activities

### 6.1 Extraction of substances for analysis

The extraction method followed laboratory (code FSH: Aox01) adapted from van Amsterdam et al., 1992 and Laboratory (code FSH: Tpc01) adapted from Bozin et al., 2008. Weigh a 0.1 g sample and mix with 10 mL of distilled water. The extract is placed in a shaking incubator (Vision Scientific, Korea) at 250 rpm for 15 min and centrifuged (Thermo Scientific, Massachusetts, USA) at 3,857 g for 10 min. Then, use supernatant for analysis.

### 6.2 Quantitative analysis of BBP phenolic content

Total phenolic content (TPC) was determined according to the method by the Folin-Ciocalteu method of Ademiluyi et al. (2018)<sup>20</sup>. Briefly, 20 µL of crude extract solution was mixed with 100 µL of 10% (w/v) Folin-Ciocalteu reagent. After 8 min, 80 µL of Na<sub>2</sub>CO<sub>3</sub> (7.5%) was added and the mixture was incubated in the dark at 40°C for 30 min. The absorbance was measured by a UV spectrophotometer at 765 nm against a blank without extract. Results were expressed as mg/g of gallic acid equivalent in milligrams per gram (mg GAE/g) of dry extract.

### 6.3 Quantitative analysis of BBP DPPH<sup>•</sup> radical scavenging activity

The method of Brand-Williams et al. (1995)<sup>21</sup>, based on the reduction of DPPH radical solution in the presence of hydrogen-donating antioxidants, was used with some modifications. A 0.8 mM DPPH radical solution in 95% ethanol was prepared. Four hundred microliters of the extract

were diluted to 5.4 mL using deionized water and 95% ethanol (1:1) before adding 0.6 ml DPPH solution and shaking vigorously. The decrease of absorbance was recorded at 1, 5, 10, and 30 min after mixing. Trolox (0-50 µg) was used as a standard. The concentration of a selected extract was varied to determine the concentration at 50% inhibition (IC<sub>50</sub>). The DPPH radical scavenging activity was calculated using Equation 2.

$$\text{DPPH radical scavenging activity (\%)} = ((\text{Absorbance of the control} - \text{Absorbance of the test well}) / (\text{Absorbance of the control})) \times 100 \text{ (Equation 2)}$$

## 7. Determination of antihyperglycemic activity in vitro

### 7.1 Alpha-amylase inhibition assay.

The alpha-amylase inhibitory potential was investigated by reacting different concentrations of the extracts with alpha-amylase enzyme and starch solution<sup>22</sup>. A mixture of 50 µL phosphate buffer (100 mM, pH 6.8) and 20 µL of samples containing 10 µL of alpha-amylase (2 U/ml) was incubated at 37°C for 20 min in a 96-well plate. Then, 10 µL of 1% starch solution was added and further incubated for 30 min. Thereafter, 100 µL of dinitrosalicylic acid (DNS) was added, and the mixture was boiled at 95°C for 15 min. Acarbose (2-10 µg/mL) was used as the positive control (Equation 3).

### 7.2 Alpha-glucosidase inhibition assay

The alpha-glucosidase inhibitory activity of the sample was conducted following the standard method with slight modifications<sup>23</sup>. Fifty microliters of phosphate buffer (100 mM, pH 6.8), 10 µL of alpha-glucosidase (1 U/mL), and 20 µL of samples and standard (acarbose) were incubated at 37°C for 15 min in a 96-well plate. Then, 20 µL of 5 mM substrate (4-nitrophenyl  $\beta$ -D-glucopyranoside) was added and left to incubate for 20 min. The reaction mixture was stopped after incubation by adding 50 µL of 0.1 M sodium carbonate. The release of p-nitrophenol into the reaction mixture relating to the activity of the enzyme was read at a wavelength of 405 nm (Equation 3).

$$\% \text{ Inhibition} = [(A_{\text{control}} - A_{\text{sample}}) / A_{\text{control}}] \times 100 \text{ (Equation 3)}$$

## 8. Statistical analysis

All statistic comparisons were performed using IBM SPSS Statistics for Windows, Version 26, with significance analyzed by one-way ANOVA. Data were expressed as mean  $\pm$  SEM,  $n > 3$ , with  $P < 0.05$  considered statistically significant.

## RESULTS

### 1. Nutritional and chemical properties of FBP

The experiment involved drying the BB of Banana (*Musa sapientum* L.) by freezing it in a freezer at -30 to -50 degrees Celsius for 30 hours, as shown in **Figure 1A**. Afterward, the BB was reduced in size to an 80-mesh sieve, resulting in FBP which was a fine, light brown powder, as shown in **Figure 1B**.



**Figure 1.** (A) Freeze-dried banana blossoms (FBB)  
(B) Freeze-dried banana blossoms powder (FBP)

The nutritional value of FBP per 100 g showed that had low total energy ( $361.27 \pm 2.81$  kcal in g/100 g), high levels of carbohydrate ( $62.62 \pm 0.56$  g/100 g), total dietary fiber ( $46.69 \pm 7.02$  g/100 g), protein ( $17.57 \pm 0.19$  g/100 g), and ash ( $14.10 \pm 0.73$  g/100 g) as shown in **Table 1**.

**Table 1.** Nutritional values of FBP

Parameters	Content per 100 g
Total energy (kcal)	361.27±2.81
Energy from fat (kcal)	40.55±0.19
Carbohydrate (g)	62.62±0.56
Total dietary fiber (g)	46.69±7.02
Protein (g) (%N*6.25)	17.57±0.19
Ash (g)	14.10±0.73
Total fat (g)	4.51±0.02
Saturated fat (g)	1.53±0.40
Cholesterol (mg)	ND
Sugar (g)	9.42±0.98
Sodium (mg)	13.21±0.47
Potassium (g)	5.33±0.06
Calcium (mg)	332.66±6.96
Iron (mg)	3.265±0.15
Vitamin A (μg) (calculated from beta-carotene)	81.85±0.94
Beta-carotene (μg)	489±5.66
Vitamin B1 (mg)	ND
Vitamin B2 (mg)	ND
Moisture (g)	1.22±0.00

\*All data are reported as mean (n=2) ± SD (standard deviation) ND = Not detected.

The chemical composition of FBP per 100 g showed that it contained both soluble and insoluble dietary fibers (41.20±1.87 g/100 g and 5.49±5.15 g/100 g, respectively), as well as cellulose (8.81±0.50 g/100 g) and hemicellulose (1.59±0.37 g/100 g) as shown in **Table 2**. The total phosphorus content was also found high level (405.89±17.09 mg/100 g).

## 2. Microorganisms in FBP

The number of pathogens in FBP showed that the freezing process could also inhibit the growth of pathogenic microorganisms as shown in **Table 3**.

**Table 2.** Chemical properties of FBP

Parameters	Content per 100 g
Total Dietary fiber (g)	46.69±7.02
Insoluble dietary fiber (g)	41.20±1.87
Soluble dietary fiber (g)	5.49±5.15
Cellulose (g)	8.81±0.50
Hemicellulose (g)	1.59±0.37
Starch (g)	3.33±0.11
Magnesium (Mg) (mg)	445.70±4.09
Total phosphorus (as P) (mg)	405.89±17.09
Copper (Cu) (mg)	0.44±0.01

\*All data are reported as mean (n=2) ± SD (standard deviation) ND = Not detected.

**Table 3.** The number of pathogens in FBP

Parameters	Pathogenicity
Aerobic Plate Count (cfu/g)	3x10 <sup>3</sup>
<i>Escherichia coli</i> (MPN/g)	<3.0
<i>Salmonella spp.</i> (per 25 g)	ND
<i>Staphylococcus aureus</i> (cfu/g)	<100est.
Yeast and Molds	<100est.

ND = Not detected. est = estimated count.

### 3. Functional properties of FBP

The quantification of bioactive compounds by the Folin-Ciocalteu method and the antioxidant activity by DPPH• radical-scavenging activity of FBP showed that the total phenolic content was 38.66±2.37 mg GAE/g sample and the antioxidant activity was 4.69±0.15 mg TE/g sample as shown in

**Table 4.**

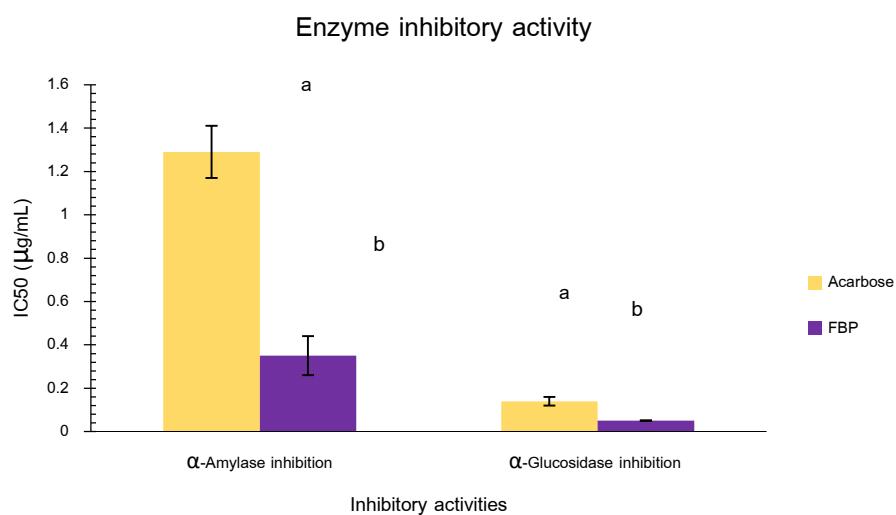
**Table 4.** Bioactive compounds content and antioxidant activity in FBP

Sample	TPC (mg GAE/g sample)	DPPH (mg TE/g sample)
BBP	38.66±2.37	4.69±0.15

\*All data are reported as mean (n=3) ± SD (standard deviation).

#### 4. Enzyme inhibitory activity of FBP

The inhibitory effects of FBP on alpha-amylase and alpha-glucosidase were investigated, with acarbose used as a positive control. The alpha-amylase inhibition assay revealed that FBP exhibited a significant difference ( $p < 0.05$ ) in the inhibition of alpha-amylase, with an  $IC_{50}$  value of  $0.35\pm0.09$   $\mu\text{g/mL}$ , compared to acarbose, which had an  $IC_{50}$  value of  $1.29\pm0.12$   $\mu\text{g/mL}$  ( $p < 0.05$ ). The alpha-glucosidase inhibition assay showed that FBP exhibited a significant difference ( $p < 0.05$ ) in the inhibition of alpha-glucosidase, with an  $IC_{50}$  value of  $0.05\pm0.00$   $\mu\text{g/mL}$ , compared to acarbose, which had an  $IC_{50}$  value of  $0.14\pm0.02$   $\mu\text{g/mL}$  ( $p < 0.05$ ). This indicated that FBP had a high potential to inhibit both alpha-amylase and alpha-glucosidase, as shown in **Figure 2**.

**Figure 2.** Inhibitory activities of FBP

## DISCUSSION

The consumption of banana blossoms (BB) in Thailand dates back to ancient times, with *Musa sapientum* L. cv. Kluai Namwa is the most commonly used banana species for this purpose. When BB were harvested, they underwent a rapid enzymatic browning process. This occurred when the enzyme polyphenol oxidase (PPO) catalyzed the oxidation of colorless phenolic compounds in the blossoms upon exposure to oxygen, leading to the production of brown pigments<sup>24</sup>. This browning reaction, which also involved amino acids or proteins, was generally considered undesirable by consumers as it affected the visual appeal, reduced the nutritional value, and shortened the storage period of the BB. (11). To prevent browning, the binding of PPO to phenolic compounds had to be prevented, often achieved by applying high heat. When freeze-dried banana blossom powder (FBP) was compared to fresh BB by Wickramarachchi et al. (2005)<sup>25</sup> and heat-drying of BB by Tasnim T. et al. (2020)<sup>7</sup>, freeze-drying preserved more nutritional values of BB, particularly carbohydrate, fiber, protein, and ash, while reducing moisture content, which was important in preventing microbial spoilage and pathogen growth<sup>26</sup>.

A key finding of this study is the high fiber content of the FBP. The total dietary fiber content was  $46.69 \pm 7.02$  g/100g, which is notably high. This total can be further broken down into insoluble dietary fiber ( $41.20 \pm 1.87$  g/100g) and soluble dietary fiber ( $5.49 \pm 5.15$  g/100g). The predominance of insoluble fiber is particularly interesting and could have significant implications for digestive health and blood sugar regulation. The dietary fiber helps regulate blood sugar levels and improves insulin sensitivity<sup>27</sup>. It increased the viscosity of the gastrointestinal tract, which in turn stimulated the release of the hormone Glucagon-like Peptide-1 (GLP-1) from L-cells in the distal small intestine. GLP-1 helped stimulate insulin secretion, inhibit glucagon secretion, and reduce gastrointestinal motility. Another hormone, Peptide YY (PYY), also produced by L-cells in the distal small intestine, slowed gastric function and promoted insulin secretion<sup>28</sup>. Regular consumption of dietary fiber supported digestive health and was associated with numerous health benefits, including weight management, a reduced risk of heart disease and stroke, lower blood pressure, and a decreased risk of T2DM and high cholesterol levels<sup>29</sup>. Both magnesium and potassium are essential for maintaining healthy blood sugar levels. Magnesium directly influenced insulin action and sensitivity, while potassium supported insulin secretion and overall metabolic health. Adequate intake of these minerals, through diet or supplementation, could help in the prevention and management of insulin resistance and T2DM<sup>30-31</sup>.

Free radicals are unstable molecules that could damage cells by stealing electrons, leading to oxidative stress. This stress inhibited insulin signaling, contributing to insulin resistance and higher blood glucose levels, which could increase the risk of T2DM and heart disease. Antioxidants counteracted this process by neutralizing free radicals, reducing oxidative stress, and improving insulin sensitivity. This

protective mechanism helped lower the risk of developing these metabolic disorders<sup>32</sup>. According to research, boosting antioxidant consumption through diet or supplements might have helped manage blood sugar levels and lower the risk of diabetes and its complications<sup>33</sup>. Phenolic chemicals were significant antioxidants that demonstrated activity through numerous methods, such as donating hydrogen atoms to free radicals, scavenging other reactive species, or binding transition metal ions (especially iron and copper)<sup>34</sup>. Some natural chemicals, including polyphenols, act as both antioxidants and enzyme inhibitors. These chemicals can block alpha-amylase and alpha-glucosidase while also reducing oxidative stress, which helps to lower glucose levels and protect pancreatic beta cells<sup>35</sup>. The results showed that when FBP was compared to heat-drying of BB by E. Elaveniya & Jayamuthunagai J. (2014)<sup>36</sup>, the reduction capacity of DPPH in freeze-drying better preserved the antioxidant activity in DPPH, which was reduced by the free radical. This approach was primarily used to assess the antioxidant potential of plant extracts, demonstrating FBP's superior scavenging capacity.

The body digested carbohydrates via two key enzymes: alpha-amylase, which broke down alpha-(1-4) glycosidic bonds to dextrin, maltose, or maltotriose, and alpha-glucosidase, which hydrolyzed 1-4 connected alpha-glucose to produce glucose molecules<sup>37</sup>. Inhibiting these enzymes reduces glucose absorption in the gut, thereby lowering blood glucose levels after a meal. This was notably beneficial in the treatment of T2DM because it improved blood sugar control<sup>38</sup>. Over the last decade, synthetic inhibitors have proven to be the most successful pharmacological treatment for high blood sugar; however, finding alternative enzyme inhibitors with potentially fewer harmful side effects was critical. Natural substances (such as dietary components) were preferred over synthetic inhibitors because they were safer, more diverse, and less expensive<sup>39</sup>. When compared to positive control, FBP demonstrated a high capability to block both alpha-amylase and alpha-glucosidase. Thus, FBP showed a high potential for glycemic control. Overall, the findings indicated that FBP had antihyperglycemic and antioxidant properties, as well as the presence of bioactive substances.

## CONCLUSION

The study found that freezing preserved the high nutritional content of BB, particularly its fiber, which not only promoted health but also helped regulate blood sugar and cholesterol levels, potentially lowering the risk of chronic conditions such as diabetes, heart disease, and certain cancers. Soluble fiber, which dissolved in water and formed a gel-like substance, helped lower cholesterol levels and regulated blood sugar by slowing glucose absorption. This was particularly important for reducing the risk of heart disease and managing diabetes. Insoluble fiber, which did not dissolve in water, added bulk to stool, promoting healthy digestion and preventing constipation. It also lowered the risk of colon cancer by encouraging regular bowel movements. In addition, freeze-drying maintained the safety standards of

pathogens, preserved the antioxidant properties of BB, and helped regulate blood sugar levels. Therefore, BB could be used as a functional food ingredient in the food industry, especially in the production of health food and dietary supplements. However, further research on experimental animals or humans was needed to confirm the results of this study.

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## Research Article (FF10)

# The Evaluation of Training Programs for Community Health Worker in Monitoring Toddler Growth and Development in Yogyakarta, Indonesia

Dini Tri wahyuni<sup>1\*</sup>, Ayudiva Rizky Anugraheni<sup>2</sup>

<sup>1</sup>Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

<sup>2</sup>Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada; Indonesia

## ABSTRACT

Monitoring growth and development is crucial for identifying and addressing disorders early, thereby facilitating timely interventions. Community health worker plays a significant role in overseeing toddler growth and development at integrated health posts. However, technical errors in managing these health posts have been observed, leading to decreased data validity. To address these issues, it is essential to implement training programs focused on enhancing the knowledge and skills of community health workers in growth and development monitoring. The training program was conducted from February to May 2024, covering key topics such as anthropometric measurements, infant and young child feeding practices, developmental screening, and plotting and completing growth charts in the Maternal and Child Health (MCH) handbook. The evaluation was conducted in June 2024 using the Center of Excellence (CoE) instrument, with data collected from integrated health posts selected through convenience sampling. The evaluation was conducted at 17 selected integrated health posts. Post-training assessments indicated that 90% of the community health workers demonstrated proficiency in skills and knowledge related to anthropometric measurements. However, the performance in other areas was found to be suboptimal: only 54% of the community health workers effectively plotted growth charts in the MCH handbook, 35% demonstrated an adequate understanding of infant and young child feeding education, and merely 11% were proficient in developmental screening. The training program aimed to improve community health worker skills and knowledge in monitoring toddler growth and development. Improvements were noted only in anthropometric measurements and other areas remained inadequate. To address these gaps, periodic, targeted training sessions should be implemented to ensure that content is effectively tailored to the needs of specific participants.

**Key words:** toddler, community health worker, integrated health post, growth, development

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\*Correspondence: dini.tri wahyuni@mail.ugm.ac.id

## INTRODUCTION

The 2023 Indonesian Health Survey reports that the national stunting rate was 21.5%, a slight 0.1% drop from the data in 2022<sup>1-2</sup>. This result remains far from the expected target of 14% by 2024. The prevalence of stunting in Yogyakarta City increased from 13.8% in 2022 to 16.8% in 2023<sup>1-2</sup>. The Health Department plays a key role in implementing specific interventions to address the determinants of stunting within the health sector. One specific intervention for toddlers involves monitoring their growth and development at the integrated health post and other health facilities.

Growth and development monitoring is conducted to assess toddlers, enabling the early detection of abnormalities and timely follow-up interventions<sup>3</sup>. In Indonesia, community health workers routinely monitor the growth and development of children under five. The results serve as nutritional surveillance data, providing policymakers with insights into trends in nutritional status and child growth<sup>4</sup>.

Nutritional surveillance in Indonesia is assessed using the SKDN indicators, based on monthly weighings. These indicators include S for registered toddlers, K for those with the Maternal and Child Health (MCH) handbook, D for toddlers who are weighed, and N for toddlers showing weight gain<sup>5</sup>. In Yogyakarta City, community participation in growth monitoring is strong, with a D/S index of 82.49%. However, the success rate, reflected by the N/D index, remains below the national target of 44.87%.

According to Simanjuntak<sup>6</sup>, the effectiveness of integrated health post activities depends on the dedication of community health workers who volunteer to manage these posts. However, technical errors persist in measuring weight, height, upper arm circumference, and head circumference, leading to inaccuracies in the collected data. These errors are often due to factors such as heavy clothing, diapers, or other accessories. Additionally, growth monitoring results in the MCH handbook are frequently incomplete, hindering the early identification of growth issues at the integrated health post.

To address these challenges, it is crucial to provide training for community health workers to improve their skills in growth and development monitoring. The effectiveness of this training is influenced by various technical factors such as teaching methods, instructional materials, and the training environment<sup>7-9</sup>. This study aims to evaluate the skills and knowledge of community health workers in monitoring toddler growth and development following such a training program.

## MATERIALS AND METHODS

The training program was targeted at community health workers within the Yogyakarta City Health Department. These community health workers act as nutrition implementers, collaborating with health workers and other cadres to monitor growth and achieve optimal nutritional and health status for toddlers at integrated health posts<sup>10</sup>. The growth and development monitoring training involves resources from both the Health Department and community health centers within the service area.

The Health Department, as the training organizer, is responsible for planning, implementation, and reporting. Trainers and evaluators were drawn from the Health Department team. Community health centers were tasked with contacting integrated health posts in their respective areas to send participant representatives, provide venues and infrastructure, and coordinate the execution of the training.

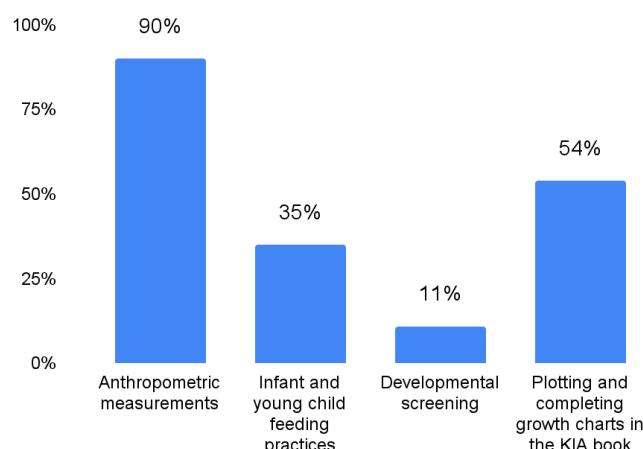
The training covered key topics including anthropometric measurements, growth monitoring, developmental monitoring, and Infant and Young Child Feeding (IYCF). Initial learning materials included the MCH handbook, Child Health Card displays, and the Ministry of Health standardized anthropometry kit. The training was conducted offline and utilized various delivery methods, such as lectures, case studies, group discussions, and practical exercises.

The training took place from February to May 2024 at 18 Community Health Centers across Yogyakarta City. Each Community Health Center oversees integrated health posts that operate at the village level. The evaluation was carried out in June 2024 at 17 selected integrated health posts to assess the skills and knowledge of community health workers. These integrated health posts were chosen using convenience sampling, based on their activity schedules, which aligned with the evaluation timeline of the study.

The instrument utilized for evaluation was the Center of Excellence (CoE) Posyandu Development Form, which assesses four key aspects of community health workers' knowledge and skills. The examination covers anthropometric measurements, IYCF education, developmental screening, and the plotting and completion of growth charts in the MCH handbook. Levels of knowledge and skills were categorized as inadequate (<56%), sufficient (56-75%), or good (76-100%)<sup>11</sup>. These four key aspects were subsequently broken down into competency criteria, which were statistically analyzed using the average scores of skills and knowledge.

## RESULTS

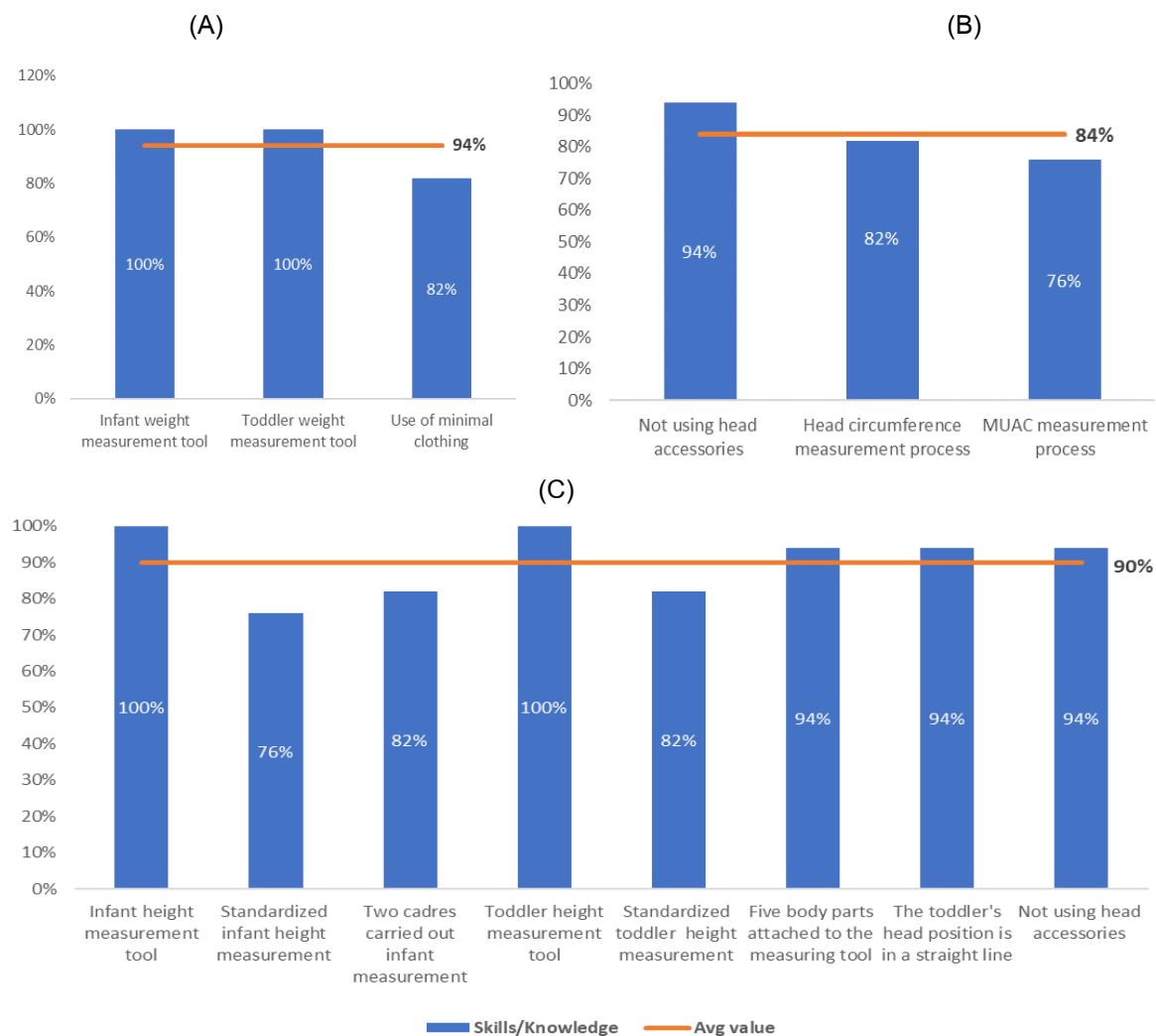
Data from the post-training monitoring of community health worker's knowledge and skills are presented in **Figure 1**.



**Figure 1.** Percentage of knowledge and skills aspects of community health worker

Community health workers' knowledge and skills in anthropometric measurements are classified as good, with a total score of 90%. IYCF education, assessed as part of the knowledge aspect, is considered inadequate, with a total score of 35%. Developmental screening is assessed for both skills and knowledge, receiving a score of 11%, and is classified as inadequate. Furthermore, the skills and knowledge score for plotting and completing the growth chart in the MCH handbook received a total score of 54%, classifying it as inadequate. It can be concluded that the only aspect of knowledge and skills classified as good in practice is anthropometric measurement.

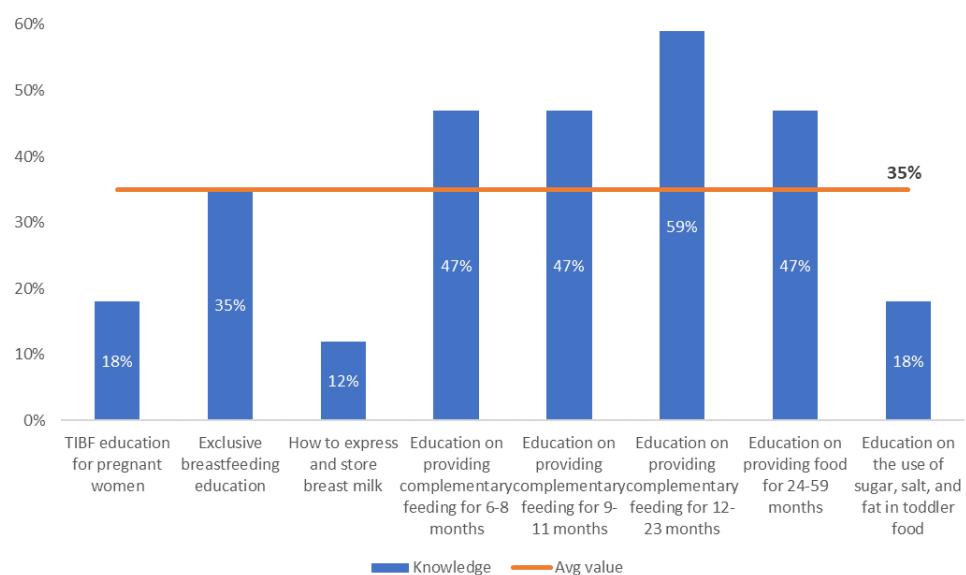
In evaluating knowledge and skills using these four aspects, a competency checklist must be utilized by the community health worker. Anthropometric measurement skills are evaluated through several components, including weight measurement, height measurement, head circumference (HC) measurement, and mid-upper arm circumference (MUAC) measurement. The competencies in anthropometric measurement skills are presented in **Figure 2**.



**Figure 2.** Anthropometric Measurement: (A) Weight Measurement; (B) MUAC (Mid Upper Arm Circumference) & HC (Head Circumference) Measurement; (C) Height Measurement

The average score for weight measurement skills is 94%, with the least attention given to the use of minimal clothing. The average score for MUAC and HC measurement skills is 84%, with particular attention needed on the proper measurement procedures. For HC measurement, the tool must be positioned around the toddler's head, crossing the forehead above the eyebrows, passing above both ears, and at the back of the head. The main issue with MUAC measurement lies in correctly positioning the tape around the arm's midpoint. The average score for height measurement skills is 90%, with attention needed regarding the use of correction factors in height calculation standards and the number of community health workers involved in the process.

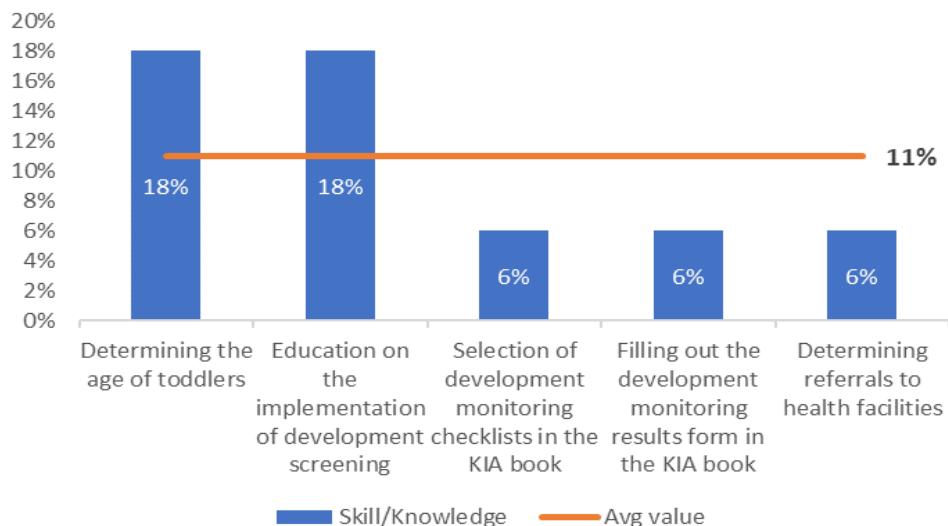
The Infant and Young Child Feeding (IYCF) education component comprises education on timely initiation of breastfeeding (TIBF), exclusive breastfeeding, and complementary feeding. Knowledge competencies in IYCF education are presented in **Figure 3**.



**Figure 3.** Infant and Child Feeding Education

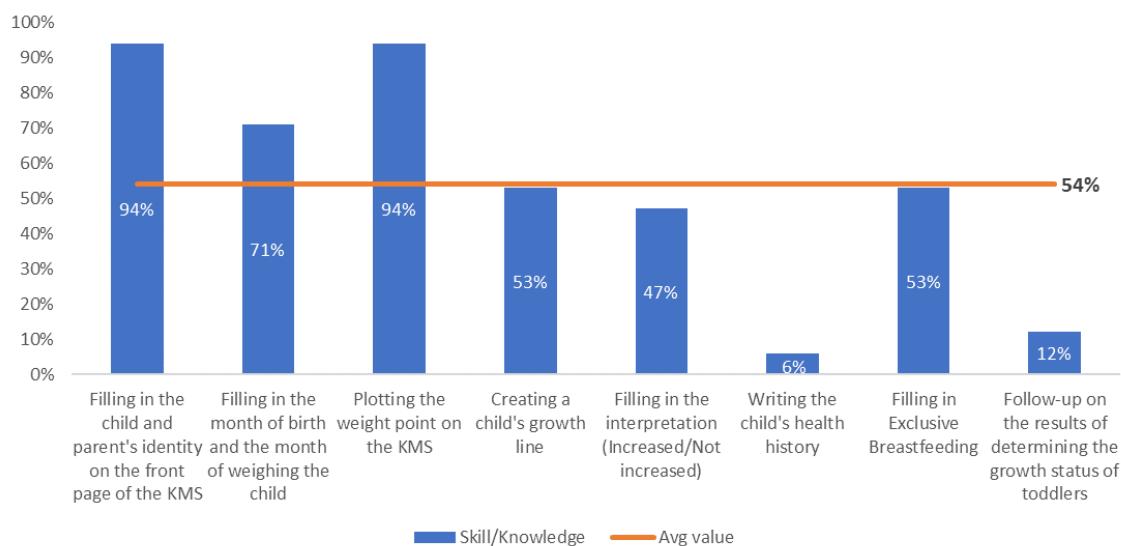
Education on timely initiation of breastfeeding (TIBF) and the correct methods for expressing and storing breast milk, including storage locations, temperatures, and durations has not been optimally implemented by community health workers. Furthermore, the education regarding the recommended use of sugar, salt, and fat, along with their health impacts, has not been effectively delivered.

Developmental screening involves multiple components that assess the skills and knowledge of community health workers, with their competencies in conducting such screenings illustrated in **Figure 4**.



**Figure 4. Developmental Screening**

The competency that requires consideration is the selection and completion of the development monitoring results form in the MCH handbook, filling out the development monitoring results form in the MCH handbook, and determining referrals to health facilities.



**Figure 5. Plotting and Completing Growth Charts in the MCH Handbook**

Community health workers must understand the importance of thoroughly documenting the results of growth and development monitoring. Based on **Figure 5**, the key competencies requiring evaluation include creating growth charts, interpreting growth measurement results, documenting health and exclusive breastfeeding histories, and determining appropriate follow-up actions regarding the child's developmental status.

## DISCUSSION

Community health workers play a crucial role due to the limited number of health workers at community health centers to assist parents of infants and toddlers in regularly monitoring their children's growth and development<sup>13</sup>. Training is essential to ensure that community health workers remain updated on any technical and scientific advancements related to the implementation of child growth monitoring activities. Such training has been shown to significantly enhance the knowledge, attitudes, and efficacy of community health workers, particularly in intervention groups compared to control groups<sup>14</sup>.

This study indicates that community health workers require improvements in skills and knowledge related to the monitoring of toddler growth and development, particularly in the areas of IYCF education, developmental screening, and plotting and completing growth charts in the MCH Handbook. Competence in delivering IYCF education is critical to help mothers provide appropriate nutrition and prevent malnutrition risks<sup>15</sup>.

Additionally, competencies in developmental screening and growth chart plotting are crucial, as community health workers are responsible for interpreting and categorizing child development results. When monitoring results deviate from developmental milestones, immediate referral to a healthcare facility is necessary. Accurate documentation of growth and development monitoring is also essential as it provides a reliable record of the child's health history, supporting healthcare workers in data analysis and the provision of appropriate interventions<sup>16</sup>.

This study aims to examine the implementation of child growth and development training for community health workers. Based on observations, community health workers received only two days of training covering four main topics: anthropometric measurements, IYCF education, developmental screening, and plotting and completing growth charts in the MCH handbook. Research suggests that extending the duration of training may lead to better knowledge retention and improved scores<sup>17</sup>. This raises a concern for the Health Department in determining the training duration proportionately by considering the capacity of community health workers to receive the material. Training topics could be further specified based on priorities where community health worker' skills and knowledge are still insufficient, particularly in areas where competency checklists score below average.

Community health workers are proficient in anthropometric measurements; however, they are lacking in IYCF education, developmental screening, and the plotting and completion of growth charts. Training for anthropometric measurement utilized a combination of lecture, demonstration, and role-play learning methods, whereas other training sessions consisted solely of lectures. Previous research suggests that the role-play learning method can enhance participant engagement and knowledge more effectively than the lecture method<sup>7</sup>. Role-playing and demonstrations help to reduce the audience's boredom and boost their enthusiasm. These methods particularly rely on body language and motion to acquire new information. However, it is important to note that role-playing and redemonstration can be time-consuming<sup>18</sup>.

The suboptimal results in several community health worker competencies may also be attributed to the absence of booklets or training guides. This may hinder the effective communication of detailed information regarding the diverse age characteristics of the community health worker. Booklets, being portable and easily accessible, can provide concise and structured information on specific topics, thereby improving comprehension<sup>8</sup>.

Additionally, observations during training sessions revealed that inadequate room conditions negatively impacted participants' enthusiasm and focus. Issues such as the absence of tables, poor ventilation, and limited visibility or audibility likely diminished participants' ability to engage with the material. Research has shown that a positive learning environment improves students' motivation and cognitive function, leading to better knowledge retention and application in practice<sup>9</sup>.

This study aimed to evaluate the implementation of growth and development monitoring training for community health workers and assess post-training outcomes without providing additional interventions. As such, this research does not provide conclusive insights into the overall effectiveness of the training on the community health workers' knowledge levels. Several limitations were also noted, including the inability to generalize findings and the potential influence of external factors on the outcomes. Future research should consider incorporating pre-tests and post-tests to more effectively measure training impact. Despite these limitations, the findings offer valuable insights for improving training programs in Indonesia.

## CONCLUSION

The findings of this study indicate that, of the four training topics evaluated, only one was categorized as effectively implemented in the monitoring of child growth by community health workers in Yogyakarta. Several factors were identified as contributing to the suboptimal implementation of the other topics post-training. Therefore, training organizers need to address these issues and focus on improving the skills and knowledge of community health workers to enhance the overall effectiveness of future training programs.

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## Research Article (FF11)

# GEMILANG: Best Practices in Health Worker-Community Collaboration to Reduce Anemia in Stunted Toddlers in Sleman, Indonesia

Khalisa Khairani<sup>1\*</sup>, Azmia Naufala Zahra<sup>1</sup>

<sup>1</sup>*Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia*

## ABSTRACT

Data from the Gamping 1 Public Health Center showed that 24% of stunted toddlers suffered from anemia in 2022. This alarming situation prompted the launch of the GEMILANG program, an iron supplementation intervention targeting stunted toddlers under five with anemia. The program aims to reduce the prevalence of anemia in these toddlers through collaboration between health workers, community members, and health cadres. This study examines whether this collaborative effort decreases anemia in stunted children. The program's effectiveness was assessed by evaluating improvements in anemia status during the intervention period and changes in stunting status in the subsequent year. A mean difference test was conducted to identify significant improvements in anemia status. Field observations were carried out to assess the program's implementation. In 2022, following the intervention, 23 out of 30 stunted toddlers with anemia showed significant improvement, recovering from anemia with a significant increase in hemoglobin levels ( $p<0.001$ ) and overcoming stunting by the end of the year. Key factors contributing to the program's success include active community involvement in nutrition education, regular monitoring, and social support, all of which were implemented by various stakeholders. Collaboration among health workers, health cadres, and the community in the GEMILANG program has proven effective in reducing anemia among stunted toddlers. Strengthening the roles of all members is crucial to ensuring the program's sustainability.

**Key words:** collaboration, stunting, anemia, iron supplementation, Indonesia

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\*Correspondence: khalisa.khairani@mail.ugm.ac.id

## INTRODUCTION

Child malnutrition continues to be a global issue, affecting both developed and developing countries. In toddlers, malnutrition can present as various conditions, such as stunting and anemia, which occur due to a lack of macro and micronutrients<sup>1</sup>. In 2019, the World Health Organization (WHO) reported that 269 million children aged 6-59 months, or 39.8%, were affected by anemia, with iron deficiency anemia being the most prevalent cause<sup>2</sup>. In Damot Sore District, Southern Ethiopia, 31.7% of the 477 children studied were stunted, and 52% were anemic<sup>3</sup>. Anemia and stunting are two critical public health challenges in Indonesia. The recent prevalence showed 27.7% of children under the age of five were stunted, and an estimated 38.4% suffered from anemia<sup>4</sup>. Children with anemia have a 1.4 times higher risk of stunting than non-anemic children<sup>5</sup>. These findings demonstrate that the problem of anemia and stunted children necessitates a comprehensive intervention strategy due to the coexistence of double malnutrition.

Anemia and stunting often occur together due to shared causal factors, such as micronutrient deficiencies, poverty, low socioeconomic status, limited education, and lack of access to healthcare services<sup>6-8</sup>. A syndemic is a condition where two interconnected diseases occur simultaneously, often emerging in impoverished endemic areas due to social and environmental factors<sup>9</sup>. In 2022, Gosdin conducted a joint modeling of anemia and stunting (CAS, co-occurrence of anemia and stunting) in children under five, concluding that there is a significant positive relationship between anemia and stunting<sup>10</sup>.

Both anemia and stunting in early childhood can have profound and lasting impacts on an individual's health, development, and social outcomes later in life. Children who are stunted at the age of two tend to experience several adverse outcomes later in life, such as shorter stature as adults, lower levels of educational achievement, reduced earnings, and a higher likelihood that their children will be born with lower birth weight<sup>11-12</sup>. Meanwhile, hemoglobin levels in early childhood are associated with cognitive development and academic performance in later years<sup>13</sup>. If these two nutritional problems occur in a syndemic, it can exacerbate their severity. Therefore, these two health issues are studied together using a syndemic approach, recognized as an effective new method for understanding, preventing, and treating conditions that occur together<sup>14</sup>.

According to data from the Gamping 1 Health Center, 24% of stunted children also suffered anemia in 2022. These findings prompted the launch of the GEMILANG program, an iron supplementation intervention targeting stunted children under five with anemia. It is a collaborative initiative between health workers and the community aimed at reducing anemia in stunted toddlers. This collaborative initiative focuses on providing iron supplements and mentorship to stunted children with anemia over a three-month period. It is thought that by treating anemia in toddlers for three months, the Gamping 1 Health Center area may be able to improve stunting rates in the long run.

Iron supplementation is commonly used to reduce iron deficiency anemia, particularly among adolescent girls. A systematic review found that iron supplementation can enhance hemoglobin concentration, increase plasma/serum ferritin levels, and reduce the risk of iron deficiency and iron deficiency anemia<sup>15</sup>. Daily iron supplementation in children aged 2 to 5 years also has the same effect that can boost hemoglobin and ferritin levels<sup>16</sup>. The objective of this study is to examine the implementation of the GEMILANG program and its impact on stunted toddlers with anemia in Gamping Regency, Indonesia.

## MATERIALS AND METHODS

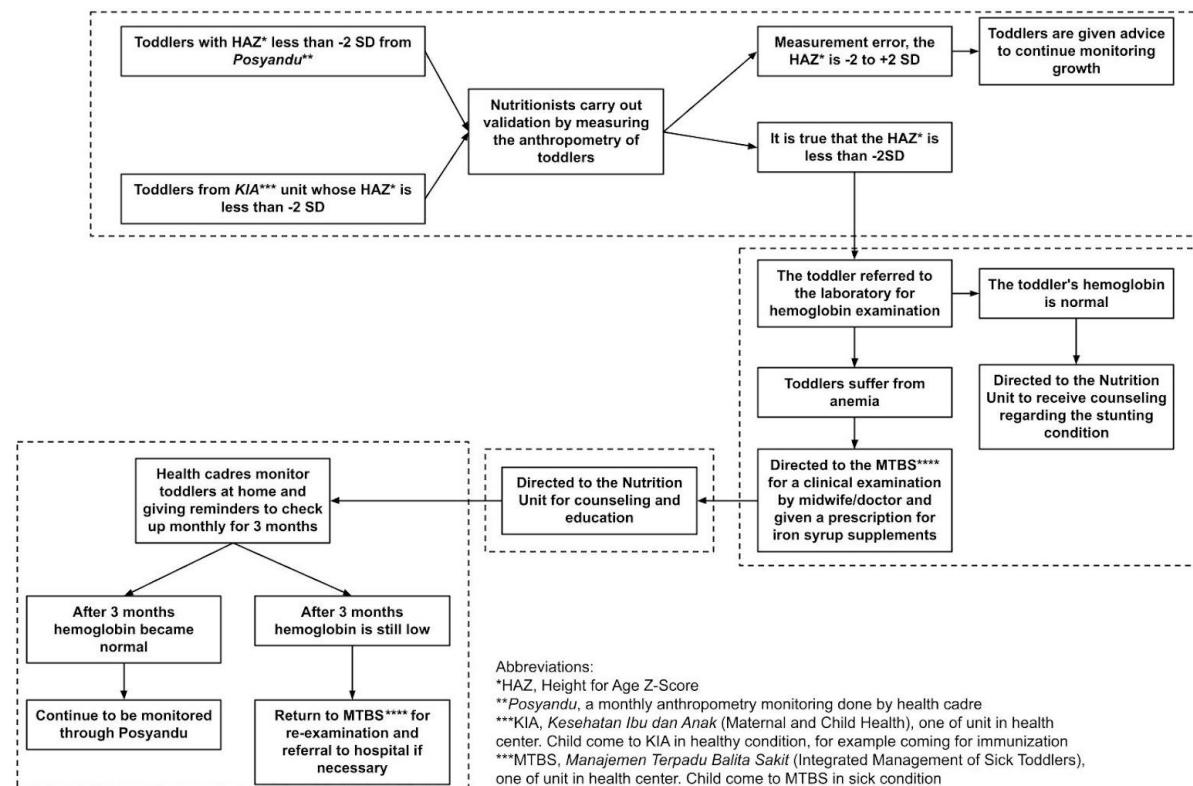
GEMILANG, a program initiated in 2019, targets stunted toddlers with anemia in the Gamping I Health Center, Sleman, Yogyakarta. This program has received approval for implementation from the head of the Gamping 1 Health Center, as formalized in the Head of the Health Center's Decree Number: 188/061.A/2019. Led by a nutritionist, the program collaborates with other health workers and health cadres from various sectors. The long-term goal of the program is to reduce stunting rates, while its short-term goals are reducing the percentage of anemia in stunted toddlers; gaining support and enhancing collaboration to combat stunting; and improving the skills and roles of health cadres.

This study is an observational research project that incorporates both qualitative and quantitative data. Qualitative data is used to obtain an overview of the implementation, achievements, difficulties faced during the program, and opinions of the people involved in the program. For this qualitative data collection, direct observation was conducted to observe the progress of the program and through interviews with nutritionists, health cadres and parents of children who were the targets of the program. Document review was conducted to understand the workflow of GEMILANG.

The quantitative data were obtained from secondary data provided by Gamping 1 Health Center including measurements of children's height and hemoglobin levels during one program period spanned from 2022 to 2023. The population in this study consisted of stunted toddlers at Gamping 1 Health Center, defined according to WHO standards as having a height or length-for-age below -2SD. A total sampling method was employed, including all stunted toddlers with anemia, characterized by hemoglobin levels below 11 mg/dL<sup>17</sup>. Exclusion criteria were applied to toddlers with specific health conditions that could lead to low hemoglobin levels. Height measurement data in the following year was obtained from cohort data in *Sistem Informasi Gizi Terpadu* or the integrated nutrition information system application. A mean difference test was conducted using t-test to identify changes in anemia status.

## RESULTS

Based on the results of the document review, GEMILANG implements four main activities, including validation of stunting data to ensure the accuracy and reliability of data on stunted toddlers; hemoglobin screening, examination, and prescribing iron supplements in the form of syrup with a dose of 7.5 mg elemental iron per day; nutrition education to educate caregivers about proper nutrition to support the health and development of their toddlers; and monitoring and evaluation to continuously monitor the program's progress and evaluate its effectiveness to make necessary adjustments and improvements. The implementation flow of GEMILANG can be seen in **Figure 1**.



**Figure 1.** GEMILANG workflow

Based on interviews with nutrition officers, the difficulties that occurred at the start of the program were toddlers often do not return for follow-up examinations. The reasons for this include forgetfulness, lack of time, or intentionally skipping the check-up because they no longer perceive any health issues. To address this issue, nutritionists frequently seek assistance from health cadres to remind the child's parents to come back for a re-examination. Even since 2021, reminders have been implemented via WhatsApp messages sent to parents so that no more toddlers experience loss to follow up. Toddlers receive supplementation until completion. Furthermore, economic problems exist; while being educated on nutritious food choices, families frequently cannot afford these options, making it difficult to implement the nutritionist's suggestions.

We also spoke with several mothers of toddlers targeted by the GEMILANG program. According to these mothers, their children are willing and even eager to take the iron supplements since they taste good. However, they sometimes experience constipation, although this does not always happen. Other mothers reported that their children consume very little animal protein due to the family's poor economic situation. As a result, despite taking iron supplements daily for up to three months, the toddlers' hemoglobin levels remained unchanged

In early 2022, hemoglobin levels were screened in 121 stunted toddlers, revealing that 30 had low hemoglobin levels. These 30 toddlers received iron supplementation and were monitored by both health workers and health cadres over three months. The characteristics of the toddlers are presented in **Table 1**.

**Table 1.** Population characteristics

Characteristics	Category	N (%)
Age (months)	4-12	9 (30)
	13-24	17 (57)
	25-59	4 (13)
Gender	Male	20 (67)
	Female	10 (33)
Severity of anemia(17)	Moderate (7-9.9 mg/dL)	10 (33)
	Mild (10-10.9 mg/dL)	20 (67)

There was a notable improvement in hemoglobin levels among stunted toddlers following supplementation. The duration required for hemoglobin levels to improve varied: some toddlers achieved normal levels within the first month, others required up to three months, and some showed increased hemoglobin levels after three months but did not yet reach normal levels. By the end of the monitoring period, 23 out of 30 toddlers demonstrated significant improvement, with a notable increase in hemoglobin levels by about 1.8 mg/dL (95% CI, 1.49 to 1.89 mg/dL) (**Table 2**), resulting in a 77% success rate for the supplementation program.

**Table 2.** Intervention effect on hemoglobin

<b>Baseline (N = 30)</b>	<b>After 3-months (N = 30)</b>	<b>Mean difference (95%CI)</b>
		Mean (SD)
Hemoglobin (mg/dL)	9.9 (0.5)	11.7 (0.5)
		1.8 (1.49 to 1.89)*

\*p<.001

All subjects were thereafter followed for one year after the program. Nutritional status measurements were carried out at the beginning before the intervention, 3 months after the iron supplementation, and at the end of the year. It was found that 23 toddlers who were no longer anemic also ceased to be stunted, while the 7 toddlers who remained anemic continued to experience stunting at the end of the year (**Table 3**).

**Table 3.** Intervention effect on stunting status

	<b>Before intervention</b>	<b>After 3-months</b>	<b>End year</b>
	N (%)	N (%)	N (%)
Stunted	30 (100)	30 (100)	7 (23.3)
Normal	0 (0)	0 (0)	23 (76.7)

## DISCUSSION

The prevalence of CAS at Gamping I Health Center in 2022 was 24.7%. Comparatively, the prevalence of CAS among children aged 6-59 months in 43 low- and middle-income countries (LMIC) was estimated at 21.5%, with a range from 2.6% to 46.1%. Specifically, the prevalence rates were 24.4% in Ethiopia, 5.9% in Venezuela, 21.5% in India, and 30.4% in Peru<sup>6,10</sup>. These figures highlight significant variations in CAS prevalence across different regions, underscoring the need for tailored observation to address malnutrition and growth issues in diverse contexts.

Distal factors that elevate the risk of CAS include living in rural areas, poverty, and low caregiver education. Proximal factors contributing to CAS risk include being male, over 12 months of age, a history of low birth weight, a lack of vitamin A supplementation or consumption of foods low in vitamin A, and infrequent eating. Similarly, Sahiledengle identifies several risk factors for CAS, including the child's age, a history of low birth weight, anemic mothers, the short stature of mothers, low maternal education, residing in rural areas, and families practicing open defecation<sup>18</sup>. Children with severe stunting reported considerably lower Hb concentrations ( $110.8 \pm 14.0$  g/L) compared to stunted ( $114.0 \pm 11.4$  g/L) and

normal-height children ( $114.6 \pm 13.2$  g/L)<sup>19</sup>. Stunted children are at a higher risk of iron deficiency, which can lead to anemia and CAS.

Dietary habits, particularly animal protein intake, contribute to increasing hemoglobin levels. At six months, an innovative nutrition-sensitive poultry intervention that allowed children to own hens increased hemoglobin levels by about 0.53 g/dL and decreased the prevalence of anemia, as well as concurrent anemia and stunting<sup>20</sup>. The odds of CAS were 1.55 times higher for those who did not consume meat, and meal frequency was also substantially related to CAS, with the risks of CAS being 1.22 times higher in those who did not meet MMF (minimum meal frequency) versus those who did<sup>21</sup>. Family food security affects the quality of daily food intake. Children from food-insecure households may lack healthy meals with high protein quality, enough micronutrient content and bioavailability, macrominerals, iron, and critical fatty acids, which increases the incidence of childhood anemia<sup>22</sup>.

The duration of iron supplementation in the GEMILANG program aligns with WHO recommendations, which is 3 months. Andersen conducted a systematic review indicating that shorter (1–3 months) and longer (7 or more months) durations of iron supplementation generally showed similar benefits on hemoglobin levels after controlling for baseline anemia status<sup>23</sup>. Additionally, frequent supplementation (3-7 times/week) and intermittent supplementation (1-2 times/week) provide similarly beneficial effects. Frequent supplementation faces challenges such as unwanted gastrointestinal side effects and the burden on caregivers to procure supplements, suggesting that intermittent supplementation could be a viable solution. However, De-Regil noted that weekly supplementation was less effective in reducing anemia rates compared to daily supplementation<sup>24</sup>.

This study's outcomes demonstrate that iron intervention in stunted toddlers with anemia at the Gamping I Health Center positively impacts on their nutritional status. After the intervention period, there was a significant increase in hemoglobin levels and toddler height, which increased gradually until they were no longer stunted. There are few studies that have conducted iron supplement interventions in CAS, so the discussion written will be quite limited, but in 1993, Angeles found that iron supplementation effectively improved hemoglobin status and also contributed to increased height and weight in children with anemia<sup>25</sup>. Iron supplementation improved height-for-age z score (HAZ) by 0.20 (95% CI 0.01, 0.40) in anemic children but based only on n=2 trial arms<sup>23</sup>.

However, it is important to note that the response to iron supplementation may vary depending on many factors. Some toddlers in this study showed slower improvement, which may be due to problems with iron absorption or the presence of undiagnosed chronic infections. Infectious diseases, often linked to poor sanitation, contaminated water, and overcrowding, increase baseline inflammation and hepcidin levels, which hinder iron absorption and leave excess iron in the gut, potentially aiding pathogenic bacteria<sup>26</sup>. It is important to assess the children's health status before the supplementation program.

This study has several limitations, including the limited sample size and relatively short intervention duration. Further research with larger samples and longer monitoring periods is needed to confirm these findings and evaluate the long-term effects of iron supplementation on stunted toddlers with anemia. Overall, the results of this study emphasize the importance of iron intervention as part of a comprehensive strategy to address stunting and anemia in toddlers. Collaborative efforts between health workers, families, and communities, such as health cadres, are needed to ensure the success of this program. With a holistic and sustainable approach, it is hoped that the prevalence of stunting and anemia in toddlers can be significantly reduced, thereby improving the quality of life and development of children in the future.

## CONCLUSION

The GEMILANG program is an effective, innovative approach for addressing stunting at the Gamping I Health Center. The program includes stunting data validation, hemoglobin screening, clinical physical examinations, supplementation, and direct monitoring over a three-month period. It has successfully reduced anemia rates among stunted toddlers. In the long term, this supplementation program also contributes to lowering stunting rates at the Gamping I Health Center, although achieving this outcome requires more time beyond the initial monitoring period.

## ACKNOWLEDGMENTS

We would like to express our gratitude to the Gamping I Health Center in Sleman for providing the opportunity to observe the GEMILANG program. Additionally, we extend our appreciation to the Indonesia Endowment Fund for Education (LPDP) for their funding. We hope this work will improve community health outcomes and provide valuable benefits.

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## Research Article (FF12)

### Factors Influencing Compliance with Weekly Iron-Folic Acid Supplementation among Adolescent Girls in Medan Deli, North Sumatra

Asma Rizkiyani<sup>1\*</sup>, Aulia Rahmadini Saputri<sup>1</sup>, Khairani Fauziah<sup>1</sup>

<sup>1</sup>Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

#### ABSTRACT

Anemia continues to be a pressing public health concern among adolescent girls in Indonesia, with prevalence rates rising from 37.1% in 2013 to 48.9% in 2018. To combat this, the Indonesian Ministry of Health launched the iron-folic acid supplementation program, providing weekly iron-folic acid (Fe-FA) supplements to adolescent girls. However, compliance to the supplementation regimen remains suboptimal among the target demographic. This study aims to evaluate compliance with iron-folic acid supplements and identify barriers to consistent consumption among adolescent girls in the Medan Deli Primary Health Care area. This cross-sectional design involved 187 adolescent girls from six schools selected via purposive sampling. Data collection was conducted using questionnaires designed to assess compliance with iron-folic acid tablet supplementation, reasons for non-compliance, and associated factors. The study found that only 13.9% of adolescent girls consistently consumed the weekly iron-folic acid supplement. The predominant reasons for non-compliance were the unpleasant odor (44.9%) and taste (65.2%) of the tablets, as well as forgetfulness (48.7%). Additionally, a substantial proportion of the participants (72%) were found to be anemic, underscoring the urgent need for enhanced intervention strategies. The low compliance with iron-folic acid supplementation observed in this study underscores a significant challenge in combating anemia among adolescent girls. Targeted health education, including the use of social media platforms is needed to address sensory-related issues like unpleasant taste and odor. Reformulating iron-folic acid supplements into more acceptable forms, such as syrups or effervescent tablets, and implementing enhanced monitoring strategies are crucial to improve compliance and effectively address anemia.

**Key words:** anemia, iron-folic acid compliance, adolescent girls, nutritional intervention.

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\* Correspondence: asmarizkiyani@mail.ugm.ac.id

## INTRODUCTION

Anemia remains a prevalent public health problem, especially among adolescents in developing countries like Indonesia. According to the World Health Organization (WHO), anemia affects approximately 25% of the global population, with the highest prevalence observed among children and women of reproductive age<sup>1</sup>. Anemia in adolescents, particularly iron deficiency anemia, is a major concern because of its adverse effects on growth, cognitive development, and future reproductive health.

The impact of anemia on adolescent health is significant. Adolescence is a critical period of rapid growth and development, leading to an increased demand for nutrients, especially iron. Inadequate iron intake, poor dietary habits, and menstrual blood loss often lead to anemia in adolescent girls<sup>2</sup>. According to research, anemia can result in decreased physical and cognitive performance, increased susceptibility to infections, and impaired academic achievement.

In Indonesia, anemia remains a significant issue among adolescent girls. The prevalence of anemia among adolescents aged 15-24 years is reported to be as high as 32%, with iron deficiency being the most common cause. National data from the Indonesian Ministry of Health indicate a rise in anemia cases, particularly in adolescent girls, due to insufficient iron intake from both dietary sources and supplementation.

To address this, the Ministry of Health launched the iron-folic acid supplementation program in 2014, providing weekly iron-folic acid (Fe-FA) supplements (60 mg iron and 0.4 mg folic acid) to adolescent girls. The program was implemented in schools and community health centers for adolescent, following WHO's recommendation for weekly iron supplementation in areas where the prevalence of anemia exceeds 20%. The iron-folic acid program was first introduced in North Sumatra in 2015, with a national target achievement rate of 10%. However, despite these efforts, compliance rates have remained low, limiting the program's overall effectiveness. Studies suggest that factors such as the unpleasant taste and smell of the supplements, forgetfulness, and lack of awareness about the importance of iron-folic acid intake contribute to low compliance. A study conducted by Fitriana and Pramardika (2019) on the evaluation of iron supplementation programs in adolescent girls revealed that only a small percentage of girls comply with the recommended weekly intake of iron supplements<sup>3</sup>. Similar findings were reported by Hasanah and Bahrin (2018) who highlighted the role of educational interventions in increasing compliance. These studies underscore the need for continuous education and improved monitoring strategies to enhance the effectiveness of iron supplementation program<sup>4</sup>.

In the Medan Deli area, anemia is a pressing issue among adolescent girls. Based on the 2022/2023 screening report from Medan Deli Primary Health Care, 72% of adolescent girls were found to have anemia. Despite the government's efforts to provide iron-folic acid supplements, only 13.9% of girls consistently consumed iron-folic acid supplement weekly. The primary reasons for non-compliance include the unpleasant taste (65.2%), smell (44.9%), and forgetfulness (48.7%).

Given the high prevalence of anemia and persistent low compliance with iron-folic acid supplementation in this area, this study aims to evaluate the factors influencing non-compliance with iron-folic acid supplement consumption among adolescent girls in Medan Deli. By identifying these factors, the study seeks to propose strategies for improving compliance, which could ultimately reduce anemia rates and improve the overall health and well-being of adolescent girls.

## MATERIALS AND METHODS

This cross-sectional study was conducted over a 10-week period in 2024 within the working area of Medan Deli Primary Health Center, targeting adolescent girls from six junior and senior high schools (SMP (Junior High School) Ibnu Halim, SMP Asuhan Jaya, SMP Suci Murni, SMP Bakti II, SMP Asuhan Raya, and SMA (Senior High School) Asuhan Daya), where iron supplements (Tablet Tambah Darah, TTD) had been distributed for one year. A total of 187 adolescent girls participated in the study, selected using purposive sampling.

Data were collected using a self-administered questionnaire designed to assess compliance with weekly iron-folic acid consumption and identify reasons for non-compliance. The questionnaire was adapted from a validated tool developed in a previous study titled "Factors Affecting the Consumption of Blood Supplement Tablets in the School Program for Caring for Anemia Cases in State High School Students in Bantul Regency in 2017" In that study, the questionnaire's validity and reliability were tested, confirming its appropriateness. The attitude questionnaire had 15 valid questions ( $r > 0.334$ ), the school support questionnaire had 12 valid questions from 15, and the knowledge questionnaire had 18 valid items from 25, with all questionnaires showing reliability coefficients of  $> 0.7$ . Therefore, no additional validity tests were performed for this study, although a pre-testing was conducted to ensure clarity of language and understanding of the questions<sup>5</sup>.

Data collection was performed with the assistance of a nutrition program officer and schoolteachers from the participating schools to ensure smooth distribution and completion of the questionnaires during school hours. While ethical approval was not obtained for this study, which is a limitation, an internship letter from the Medan City Health Department Number 440/124.04/IV/2024 and Circular Letter No. HK.03.03/V/0595/2016 issued by the Directorate General of Public Health, Ministry of Health, Republic of Indonesia, regarding iron supplementation for adolescent girls and women of reproductive age were provided. Informed consent was obtained from all participants and their guardians before data collection. To enhance awareness of anemia and the importance of iron-folic acid consumption, educational interventions were implemented, including the use of posters and leaflets during educational sessions at schools and community health centers for adolescent (posyandu).

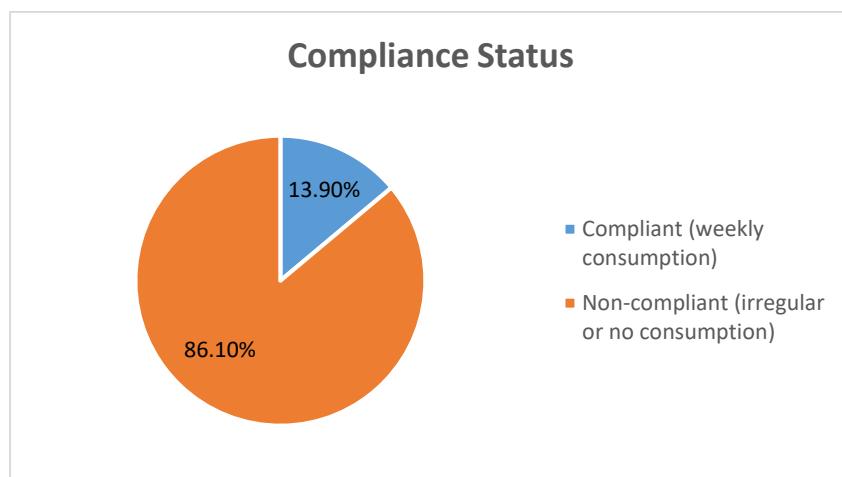
Additionally, a booklet titled "Cantik Berseri Tanpa Anemia" was developed to further support educational efforts, though it was still under development and had not been distributed at the time of the study. The data were analyzed using descriptive statistics, focusing on the frequency of iron supplement consumption and the primary reasons for non-compliance. The findings were used to provide

recommendations for improving compliance with iron-folic acid consumption among adolescent girls in Medan Deli.

## RESULTS

The results of this study provide a detailed overview of the compliance with iron-folic acid supplements (TTD) consumption among 187 adolescent girls in the working area of Medan Deli Primary Health Care. This section presents the key findings regarding the frequency of iron supplements consumption and the reasons for non-compliance.

### 1. Compliance with Iron Supplements Consumption

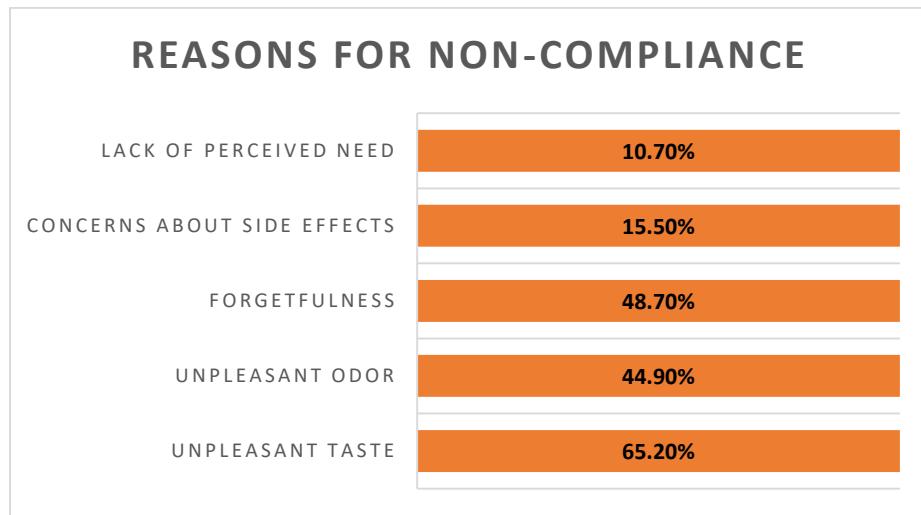


**Figure 1.** Compliance with iron-folic acid supplement consumption

Out of the 187 adolescent girls who had received iron-folic acid supplements from their schools, only 26 (13.9%) reported regular consumption of iron-folic acid supplements as recommended one tablet per week (**Figure 1**). The remaining 161 girls (86.1%) were classified as non-compliant, meaning they either did not consume iron-folic acid supplement at all or consumed it inconsistently. This highlights a significant gap between the distribution of iron-folic acid supplements and their actual consumption among adolescent girls in Medan Deli. Despite access to the supplements, the majority of the participants did not adhere to the recommended regimen, underscoring the need for further investigation into the underlying factors contributing to non-compliance.

When comparing compliance across different schools, it was observed that compliance rates varied slightly depending on the level of educational intervention and school support. Schools that actively collaborated with healthcare providers to reinforce the importance of iron-folic acid supplements consumption showed marginally higher compliance rates. However, these differences were not statistically significant.

## 2. Reasons for Non-Compliance



**Figure 2.** Reasons for non-compliance with iron-folic acid supplement consumption

The survey revealed several reasons why the majority of adolescent girls did not regularly consume iron-folic acid supplements. The most frequently cited reasons were related to the sensory characteristics of the supplements (Figure 2). Specifically:

- Unpleasant taste: 122 girls (65.2%) reported that the taste of the iron-folic acid supplement was unpleasant, which discouraged them from consuming it regularly.
- Unpleasant odor: 84 girls (44.9%) cited the strong odor of the iron-folic acid supplement as a reason for avoiding consumption. This was particularly prevalent among younger participants, who were more sensitive to the smell of the supplements.
- Forgetfulness: 91 girls (48.7%) mentioned that they often forgot to take the supplements, especially because iron-folic acid supplement consumption is recommended only once per week. The lack of a consistent daily routine contributed to this issue.

Additionally, a smaller percentage of participants (15.5%) expressed concerns about potential side effects, such as nausea or stomach discomfort, which were also factors influencing their reluctance to take iron-folic acid supplement. It is important to note that misinformation regarding the side effects of iron-folic acid supplement, particularly among their peers and family members, appeared to amplify these concerns.

Interestingly, the reasons for non-compliance were not solely limited to personal preferences or physical reactions. Some girls (10.7%) also reported that they did not see the immediate need to consume iron-folic acid supplements because they were unaware of the potential health risks of anemia. This group had little understanding of the long-term health impacts of iron deficiency, such as reduced cognitive function, lowered physical performance, and future reproductive health risks.

### 3. Knowledge and Awareness about Anemia

Prior to the educational interventions, the participants' knowledge about anemia and the importance of iron-folic acid supplementation was generally low. Approximately 70% of the respondents were unaware of the causes and consequences of anemia. When asked about their understanding of the role of iron supplement in preventing anemia, only 55 girls (29.4%) could correctly explain its purpose.

## DISCUSSION

The results of this study highlight several key challenges in improving compliance with iron-folic acid supplements consumption among adolescent girls in the Medan Deli area. Despite efforts by the government and healthcare providers to distribute iron-folic acid supplements, the majority of participants (86.1%) did not adhere to the recommended weekly iron-folic acid supplement regimen. This finding is consistent with previous studies in Indonesia, which also reported low compliance rates among adolescent girls, driven primarily by factors related to the supplements' taste and smell, as well as forgetfulness.

### 1. Sensory Barriers to Compliance

One of the most prominent barriers identified in this study was the unpleasant sensory characteristics of iron-folic acid supplement, particularly its taste and odor. Over 65% of the participants mentioned that the taste of the supplements discouraged regular consumption, and 44.9% cited the unpleasant smell as a reason for avoiding iron-folic acid supplements. These findings align with research by Fitriana and Pramardika (2019), who also found that the sensory attributes of iron supplements were a major deterrent to their regular use among adolescent girls<sup>3</sup>. Similarly, a study by Hasanah and Bahrun (2018) revealed that the perceived negative side effects of iron-folic acid supplements, such as gastrointestinal discomfort, were associated with reduced compliance<sup>4</sup>.

Addressing these sensory issues may require the reformulation of iron-folic acid supplements into more palatable forms, such as effervescent tablets or syrups, which could be more acceptable to adolescents. Previous studies have shown that making supplements more enjoyable to consume can significantly improve compliance. For example, in a study conducted by Rahmiati *et al.* (2018), efforts to improve the taste of iron supplements led to higher compliance rates among pregnant women, which could potentially be replicated in adolescent populations<sup>6</sup>.

### 2. Knowledge and Awareness Gaps

The low baseline knowledge about anemia and the importance of iron supplementation among participants also played a critical role in non-compliance. Prior to the educational interventions, only 29.4% of participants understood the function of iron-folic acid supplement in preventing anemia, indicating a significant gap in awareness. Studies have repeatedly shown that knowledge is a key determinant of health behavior. According to research by Permatasari *et al.* (2018), adolescents who

were educated about the risks of anemia and the benefits of iron supplementation were more likely to comply with iron-folic acid supplements consumption<sup>7</sup>.

After the educational sessions, there was a marked improvement in awareness, with 78.6% of participants demonstrating a better understanding of the risks associated with anemia and the benefits of iron-folic acid supplements. However, despite this increase in knowledge, the study found that knowledge alone was insufficient to significantly improve compliance rates. This suggests that while educational interventions are necessary, they must be accompanied by other strategies, such as consistent monitoring and community-based support systems, to reinforce behavior change. These findings are consistent with the conclusions drawn by Hurfiati (2018) who emphasized that a combination of education, monitoring, and stakeholder engagement is needed to ensure the success of public health interventions<sup>8</sup>.

### **3. Behavioral and Logistical Barriers**

The study also identified forgetfulness as a significant behavioral barrier, with 48.7% of participants reporting that they often forgot to take iron-folic acid supplements. This issue of forgetfulness has been well-documented in the literature. A study by Wijayanti (2011) noted that adolescent girls are particularly susceptible to forgetfulness in relation to health interventions that require long-term commitment, such as weekly iron-folic acid supplement consumption<sup>9</sup>.

Implementing tools that facilitate compliance, such as reminder systems or physical tracking tools like the booklet "*Cantik Berseri Tanpa Anemia*," could help address this challenge. Although the booklet was still in the development phase during this study, its potential to serve as both an educational and monitoring tool is promising. Studies have shown that self-monitoring can enhance compliance in health-related behaviors, particularly when combined with regular follow-up by healthcare providers.

### **4. Recommendations for Future Programs**

For future programs, it is recommended to prioritize the reformulation of iron-folic acid supplements into more palatable forms, such as syrups or effervescent tablets, to address sensory barriers that discourage consumption. Continuous education through schools and community health centers should be integrated into the curriculum, as suggested by Permatasari *et al.* (2018), to ensure that adolescent girls consistently receive information about the importance of iron supplementation<sup>7</sup>. Additionally, systemic improvements in collaboration between schools, healthcare providers, and families are necessary to create a supportive environment for iron-folic acid supplements consumption. Rahmiati *et al.* (2018) emphasized the need for community-based interventions that involve key stakeholders, such as parents and local leaders, to ensure the success of public health programs. Strengthening partnerships between schools, healthcare providers, and local governments could ensure better coordination of resources and efforts, leading to higher compliance and a significant reduction in anemia rates among adolescent girls<sup>6</sup>.

## 5. Strengths and limitations

The strengths of this study include its cross-sectional design, which provides a snapshot of iron-folic acid supplementation (IFAS) consumption behaviors and the factors influencing compliance among adolescent girls in a specific region. Additionally, the use of a previously validated questionnaire enhances the reliability of the results. However, the study has several limitations. First, the findings may not be generalizable beyond the Medan Deli area, as the sample size was limited to 187 girls from six schools. Second, the cross-sectional nature of the study only captures data at one point in time, making it impossible to establish causality between the identified barriers and non-compliance. A longitudinal study would be more suitable for assessing the long-term effectiveness of interventions. Lastly, while the educational interventions increased knowledge, the study did not fully explore why this improvement did not lead to higher compliance rates. Future research should investigate the impact of educational interventions and effective program implementation.

## CONCLUSION

This study highlights the multifaceted challenges in addressing anemia among adolescent girls through the iron-folic acid supplementation program in the Medan Deli area. Despite the availability of iron-folic acid supplements, compliance with iron-folic acid supplements remains low, with only 13.9% of the participants adhering to the recommended weekly regimen. Several key factors contributed to this non-compliance, including the unpleasant taste and smell of the supplements, forgetfulness, and a lack of awareness regarding the importance of iron-folic acid supplementation. Based on this study identifies several critical barriers to iron-folic acid supplement compliance, it also provides actionable recommendations for improving the program. While increasing awareness is important, targeted efforts to reduce sensory discomfort and provide consistent reminders are essential to ensure higher compliance. This is critical for reducing anemia rates among adolescent girls in Indonesia.

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## Research Article (FF13)

### Assessing the Impact of the Integrated Child Health Check-up (ICHC) Program on Early Detection of Nutritional and Developmental Issues in Yogyakarta

Dean Salsabila Rihadatulaisi Falahudin<sup>1\*</sup>

<sup>1</sup>Postgraduate Program of Public Health; Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada , Yogyakarta, Indonesia

#### ABSTRACT

Early detection of child growth and development initiatives has arisen in Yogyakarta. In this regard, many programs have been developed, including the Integrated Child Health Check-up (ICHC) program at Mlati 2 Public Health Center. This program aims to enhance early detection and prevention of health issues in children. It focuses on identifying nutritional and health problems at an early stage, providing appropriate interventions, and raising awareness among parents and caregivers about the importance of child health. This study utilized an observational design with a quantitative approach. The subjects were 6-month-old infants who attended Mlati 2 Public Health Center in Sleman District. Interviews and observations were conducted using the ICHC medical examination form, which assesses family caregiving patterns, growth, development, and clinical issues in children. Throughout the ICHC, out of 45 infants who underwent the examination, 35.5% were identified with growth disorders, while 17.7% showed signs of developmental delays and 13.3% with clinical issues. Furthermore, through the ICHC, 60% of infants required educational counseling on nutrition and received guidance on developmental stimulation for the next stage of growth as an early intervention. Additionally, some infants were referred to the hospital for further examination. The Integrated Child Health Check-up (ICHC) program has shown to be a valuable tool for the early detection and prevention of nutritional and developmental issues in children. It identified growth and developmental disorders, provided targeted interventions, and offered counseling on nutrition and developmental stimulation.

**Key words:** early detection, nutritional issues, integrated child health check-up (ICHC)

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\* Correspondence: deansalsabila17@gmail.com

## INTRODUCTION

The Mlati 2 Health Center, as one of the public health service centers in the Yogyakarta area, plays an important role in ensuring the health of children as the next generation of the nation. The first thousand days of life are a key period for a child's health and quality of life, as this period significantly impacts the growth and development of children. In recent years, child development issues have been on the rise. In Indonesia, 13-18% of children experience developmental disorders, which include physical growth, motor skills, language, and behavioral issues<sup>1</sup>. According to the results of an Indonesian health survey, the trend of decreasing stunting prevalence in Indonesia has stagnated nationally, from 21.6% in 2022 to only 21.5% in 2023<sup>2</sup>.

The Mlati 2 Community Health Center, challenges related to health issues, especially nutrition, still persist. The results of monitoring toddler nutrition show that the prevalence of stunting in children aged 0-23 months 4.59% in 2023. The prevalence of wasting stagnated from 3.99% in 2022 to 3.10% in 2023, and the prevalence of underweight stagnated from 10% in 2022 to 9% in 2023<sup>3</sup>. Based on a Mlati 2 community health center survey, the prevalence of nutritional problems at Mlati 2 Health Center has not shown a significant decline and still requires more attention to improve children's health. One important effort that can be made is the early detection of children's nutritional and health problems. Early prevention is essential to reduce issues related to children's growth and development. Additionally, early detection is a crucial aspect of children's health services, aimed at improving their survival and quality of life<sup>4</sup>.

Early detection of child growth and development is crucial because the earlier problems are identified, the sooner treatment can be implemented, leading to more optimal outcomes. The results of early detection indicate issues in several children, as well as developmental delays in social, emotional, and attention-related aspects. If developmental irregularities are found, immediate intervention, such as medical treatment or special education, can help reduce further complications<sup>5</sup>.

Previous efforts to improve early detection of nutrition-related problems in children have been implemented through the *Stimulation, Detection, and Early Intervention of Growth and Development (SDIDTK)* program at the primary healthcare level. However, the program faces several limitations, including a narrow focus on physical development aspects<sup>6</sup>. As a result, issues that are not directly related to physical growth, as well as clinical health problems in children, tend to receive less attention in its implementation.

Thus, this effort can be enhanced through the Integrated Child Health Check-up Program (ICHC), which combines various health service components to identify and address nutritional and developmental issues in children more comprehensively. The ICHC program is a child examination initiative that emphasizes a preventive approach, particularly for infants aged 6 months. At this age, children begin to show signs of sensory development, cognitive skills, language, speech, and social behavior. To prevent developmental issues, early detection should be carried out as soon as possible<sup>7</sup>.

Through the ICHC examination, children undergo assessments of growth and development, nutritional status, immunization, detection of parental concerns, and evaluation of the childcare environment, allowing for the determination of whether a child is in a healthy and normal condition or requires further treatment<sup>8</sup>. This program was launched at the Mlati 2 Community Health Center in late 2023, marking a significant step toward early detection and intervention in child development at the community level. The objective of this study is to examine the results of early detection of growth, development, and clinical issues in infants aged 6 months within the working area of the Mlati 2 Community Health Center. Therefore, this research is expected to provide useful information for the development of better health interventions and to support the well-being of children in the community.

## MATERIALS AND METHODS

This study used an observational design with a quantitative approach. The subjects were 6-month-old infants who visited the Mlati 2 Health Center in Sleman District, along with their parents or caregivers. The sampling technique used was non-probability convenience sampling, involving all infants who underwent integrated child health checks from April to June 2024, with a total of 45 infants as the study subjects. The target population was all 6-month-old infants within the Mlati 2 Health Center's working area. Data collection was carried out through interviews and observations using the ICHC (Integrated Child Health Check-up) medical examination form, which assesses growth, development, and clinical issues. The initial evaluation involved assessing the completeness of basic immunizations at 6 months of age, as well as nutrition and parenting practices through interviews.

In this study, the results categorized as "Follow-up on problems" and "no problem", the term "follow-up on problems" refers to infants who were detected to have growth problems, developmental delays, or clinical health issues that were identified during the Integrated Child Health Check-up (ICHC). Data analysis was performed using descriptive statistical methods to describe the demographic and health characteristics of the subjects. Additionally, descriptive analysis was performed to identify the detection results of issues arising from the ICHC program, including calculating the prevalence of nutritional problems, developmental delays, and other clinical issues observed during the health checks.

### Growth/Anthropometric Measurement

Growth measurements were conducted by nutritionists to assess the nutritional status of children based on the child anthropometric standards regulated by the WHO Child Growth Standards and the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2020. Children's weight is measured using a digital baby scale with an accuracy of up to 10 grams. The height of infants is measured with an infantometer, with results measured to an accuracy of 0.1 cm. The results of weight and height measurements are then calculated using the Weight-for-Age Z-score (WAZ), Height-for-Age Z-score (HAZ), and Weight-for-Height Z-score (WHZ) to determine growth status. Infants are categorized into two groups based on the evaluation results: 1) Follow-up on problems, if the Z-score is between -3

and -2 SD. The Follow-up group includes children identified with nutritional concerns, such as stunting, wasting, or underweight. 2) No problem (no growth issues), if the Z-score is above -2 SD.

**Development Measurement** Child development is evaluated using the Pre-Screening Development Questionnaire (KPSP) which is designed to assess the child's developmental stage according to their age group. For children aged 6 months, there are 10 stages of development that must be evaluated, covering aspects such as sensory, motor, language, and social behavior. The questionnaire is filled out based on interviews with parents and direct observation of the child. The results of the development assessment are categorized as: 1) Follow-up on problems, if the infants have developmental delays that cannot go through 2-3 stages of development. 2) No problem, if the child is able to go through all stages of development according to his/her age. **Clinical Measurement** Evaluation of clinical problems is conducted through direct physical observation, examining various aspects of the infant's health, including general nutritional status, skin, head/neck, eyes, ears, chest, back, abdomen, hands/feet, and reflex and movement functions by a doctor in Mlati 2 Health Center. Each examination aims to detect signs of abnormalities that may require further intervention. The results of the clinical evaluation are categorized as: 1) Follow-up on problems, if abnormalities are found in any of the aspects observed during the clinical evaluation. 2) No problem, if no abnormalities are found in the assessed clinical aspects.

## RESULTS

### Sample Characteristics

The characteristics of this study sample are reported in **Table 1**. Overall, this study involved 45 infants who underwent Integrated Child Health Examination (ICHC) at the Mlati 2 Health Center. The study subjects consisted of 60% female infants. Based on interviews, most infants (86.7%) had received complete basic immunization at the age of 6 months. Regarding breastfeeding practices, 66.7% of infants received exclusive breastfeeding, 24.4% were given a combination of breast milk and formula, and 8.9% were fed with formula milk.

In terms of providing complementary foods for breastfeeding (MPASI), most mothers introduced MPASI right at the age of 6 months (82.2%). As many as 62.2% of mothers expressed concerns regarding the nutritional status of their children. In terms of household and environmental health access, 71.1% of families have access to clean water, and all families have access to healthy toilets, but 26.7% of families do not have access to adequate sanitation.

### ICHC Examination

Out of a total of 45 infants examined through the Integrated Child Health Check-up (ICHC) program, several key findings were identified regarding the detection of growth, developmental, and clinical problems, as reported in **Table 2**.

**Table 1.** Nutritional Information and Background Characteristics of Children Participating in the Integrated Child Health Check-up (ICHC) Program

Childs' Nutritional Information	Observation (n=45) Percentage	
Gender:		
Male	18	40
Female	27	60
Basic Immunization (6 months old):		
Complete	39	86.7
Incomplete	6	13.3
Breastfeeding (ASI):		
Exclusive breastfeeding	30	66.7
Formula milk	4	8.9
Mixed	11	24.4
Introduction of complementary feeding:		
6 months	37	82.2
< 6 months	8	17.8
Mother's concerns regarding the child's nutrition:		
Yes	28	62.2
No	17	37.8
Household Health and Environment:		
Access to clean water:		
Yes	32	71.1
No	13	28.9
Access to a healthy toilet:		
Yes	45	100
No	0	0
Access to proper sanitation:		
Yes	33	73.3
No	12	26.7

**Table 2.** Detection of Growth, Developmental, and Clinical Problems in Infants Participating in the Integrated Child Health Check-up (ICHC) Program

	Observation	Percentage
Growth Problem Detection:		
Follow-up on Problems	16	35.5
No Problems	29	64.5
Developmental Problem Detection:		
Follow-up on Problems	8	17.7
No Problems	37	82.3
Clinical Problem Detection:		
Follow-up on Problems	6	13.33
No Problems	39	86.67

#### Evaluation of Growth Problem Detection

Of the 45 infants examined, 35.5% required follow-up due to the detection of growth problems. Although the majority of infants were within the normal growth range, more than one-third of the total infants showed issues requiring further intervention. Based on the nutritional status evaluation using anthropometric measurements, it was found that four infants experienced stunted based on the Height-for-Age Z-score (HAZ). Meanwhile, 5 infants were detected to have underweight according to the Weight-for-Age Z-score (WAZ), 4 infants were categorized as wasted, and 3 infants were identified as having a possible risk of being overweight based on the Weight-for-Height Z-score (WHZ).

#### Evaluation of Developmental Problems Detection

A total 17.7% show any developmental problems and required follow-up because some developmental milestones were not achieved. Several developmental milestones that the infants were unable to achieve were related to gross motor skills, such as lifting their head while maintaining a stiff neck, being unable to lift their chest with both arms as support when lying face down on a flat surface, and never turning over from prone to supine and vice versa. Among the infants who experienced developmental issues, one infant was unable to pass the assessment across 10 developmental stages, which include gross motor skills, fine motor skills, speech and language, as well as socialization and self-care, that should be reached by the age of 6 months. This infant was referred to the hospital for further examination as part of the intervention.

## Evaluation of Clinical Problem Detection

In the clinical problem evaluation, 86.67% of infants did not have any clinical problems, while 13.3% required follow-up. This shows that most infants involved in the ICHC program are in good clinical condition. However, there are still a small number of infants who require further medical attention to address identified clinical problems, such as skin conditions, reflexes, or abnormal motor functions.

## DISCUSSION

The findings from this study provide valuable insights into the growth, development, and clinical issues among infants participating in the Integrated Child Health Check-up (ICHC) program. Through this ICHC, various aspects of growth, development and clinical problems were found. Most infants do not have problems in these three aspects, but some still require follow-up on problems. This is in line with previous studies that emphasize the importance of early detection in improving children's health. Early detection allows the identification of health problems at an early stage, which allows for faster and more effective intervention, thereby increasing the child's chances of optimal growth and development (7).

Based on the evaluation of child growth using the Weight-for-Age Z-score (WAZ), Height-for-Age Z-score (HAZ), and Weight-for-Height Z-score (WHZ), 35.5% of infants were found to have various growth problems. Some of the detected growth issues included stunting, underweight, malnutrition, and risk of overweight. Similar studies have shown that through early detection efforts, problems related to children's nutritional status, such as obesity, thinness, and underweight have been identified<sup>9</sup>. Growth problems in infants can be attributed to various factors, one of which is the lack of exclusive breastfeeding<sup>10</sup>. Infants who were not given exclusive breastfeeding were at a higher risk of experiencing abnormal growth disorders compared to those who received exclusive breastfeeding<sup>11</sup>.

In the developmental evaluation, 17.7% of infants exhibited developmental delays that required further attention. Some specific developmental milestones that were not achieved included gross motor skills such as lifting their head while maintaining a stiff neck, being unable to lift their chest using both arms for support when lying face down on a flat surface, and not turning over from prone to supine and vice versa. These developmental delays may be influenced by environmental factors, such as inadequate stimulation or suboptimal family health conditions<sup>12</sup>. Children who receive limited stimulation—such as storytelling, interactive play, and singing—are more likely to experience developmental delays<sup>13</sup>. To address these concerns, follow-up actions should include educating mothers, parents, or caregivers on providing appropriate developmental stimulation tailored to the child's age. This stimulation should be delivered in an engaging manner, primarily through play.

The evaluation of clinical problems revealed that 13.3% of infants required follow-up for identified health issues. While this proportion is lower than that for growth and developmental problems, it is crucial to recognize that clinical issues detected at an early age may indicate more serious health conditions if

not addressed promptly. Clinical problems identified during the Integrated Child Health Check-up (ICHC) included eczema and issues related to movement/reflexes, such as the parachute reflex. Eczema, or atopic dermatitis, if not treated promptly, can lead to significant discomfort for infants and potentially affect their quality of life<sup>14</sup>.

Apart from early detection, the ICHC may also include components such as counseling and education for parents regarding the issues identified during the examination. Educating parents is essential because an infant's growth and development are closely linked to parental caregiving practices<sup>15</sup>. Thus, Infants requiring follow-up for growth and development issues highlight the vital role of the family, particularly in providing proper nutrition and adequate developmental stimulation. Nutritional counseling equips parents with the knowledge and skills needed to provide balanced nutrition for their children. Appropriate developmental stimulation can also support children in achieving optimal motor, cognitive, and social development. Counseling on early detection and stimulation of toddler growth and development is essential for parents, families, or caregivers to enhance their understanding of child growth and development examinations and encourage active parental involvement in child care<sup>16</sup>. In addition, the findings in this study indicate that the ICHC (Integrated Child Health Program) also plays a role in enhancing family support, which is essential for improving children's growth and development<sup>17</sup>. This increase in family support is facilitated through the education of parents and caregivers. Consequently, this support contributes to creating an environment that promotes optimal physical and cognitive development.

Overall, the ICHC program at Mlati 2 Health Center has successfully contributed to efforts to improve infant's health through early detection of health problems. However, this program also shows that broader and more sustainable interventions are still needed to reduce the prevalence of growth and development problems. Strengthening collaboration between health workers, families, and the community is expected to increase the scope and effectiveness of this early detection program.

This study has several limitations that need to be considered. First, this study only involved one primary health center, so generalization of the results to the entire Yogyakarta region or Indonesia must be done with caution. Second, the observational approach used in this study does not allow for causality assessment, so the relationship between factors such as parenting patterns, household environment, and nutritional status cannot be determined with certainty. Third, measurements of child growth and development were only conducted at one point in time, so longitudinal changes could not be analyzed. In the future, research involving a wider population and longitudinal study design is needed to further explore the effectiveness of early detection and intervention for children's health problems.

## CONCLUSION

The Integrated Child Health Check-up (ICHC) program at Mlati 2 Health Center has shown to be a valuable tool for the early detection and prevention of nutritional and developmental issues in infants. Through comprehensive assessments, the program identified growth problems, developmental

delays, and clinical issues among the infants examined. Early detection allowed for timely interventions, helping to address potential long-term health concerns. Additionally, the program also raised awareness among parents and caregivers about the importance of proper nutrition and developmental stimulation, further contributing to improvements in child health. This study emphasizes the importance of continued efforts in early detection and preventive healthcare, highlighting the role of the ICHC program in improving child health outcomes at the community level.

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## Research Article (FF14)

# Evaluating the Effectiveness of a Nutrition Program in Reducing Anemia Among Adolescent Girls in Yogyakarta, Indonesia

**Khairani Fauziah<sup>1\*</sup>, Asma Rizkiyani<sup>1</sup>, Aulia Rahmadini Saputri<sup>1</sup>**

*Postgraduate Program in Public Health, Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, Indonesia*

## ABSTRACT

Anemia is a common nutritional health issue in Indonesia, particularly among adolescent girls. The most common cause is iron deficiency, but other factors like poor nutrition, infections, and chronic diseases also contribute. In Yogyakarta, the "nutrition program" program aims to reduce anemia among adolescent girls through iron supplementation, nutritional education, and physical activity interventions. This study aim to evaluate the effectiveness of the nutrition program in Yogyakarta. The evaluation of the "nutrition program" program in the Gedongtengen Health Center area was conducted using qualitative methods, specifically interviews with nutrition health officials. Data collection involved interviews as the main component, supported by program observations and analysis of anemia screening results among adolescent girls. Based on the interview results, significant challenges in program implementation were identified, including low adherence to the consumption of an iron-folic acid supplement.) due to taste and odor issues, and a lack of monitoring of adolescent girls. Despite various efforts, anemia prevalence remains high, indicating the need for more effective intervention strategies. The "nutrition program" program has been implemented in all schools in the Gedongtengen Health Center area, although the activities are carried out separately and adherence to an iron-folic acid supplement. consumption among adolescent girls remains low. This is evidenced by the remaining stock of an iron-folic acid supplement and the continued presence of anemia among adolescent girls after the pre-intervention period.

**Key words:** anemia, adolescent girls, iron supplementation, nutritional education, Yogyakarta, public health intervention

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\* Correspondence: Kfauziah7@gmail.com

## INTRODUCTION

Anemia remains a significant global health issue, particularly among adolescent girls. In 2019, the global prevalence of anemia was 29.9% among women aged 15-49 years, affecting more than half a billion women<sup>1</sup>. Among non-pregnant women, the prevalence was 29.6%, while for pregnant women, it reached 36.5%. In Indonesia, adolescents, especially girls aged 10-19, face multiple burdens of malnutrition, including undernutrition, overnutrition, and micronutrient deficiencies. Reports indicate that one in four adolescent girls suffers from anemia, with the 2018 Basic Health Research (Rskesdas) revealing a 48.9% prevalence among Indonesian adolescent girls<sup>2</sup>.

The impact of anemia in adolescent girls goes beyond their current health status; it also has long-term consequences. Adolescent girls who suffer from anemia are more likely to experience the condition during pregnancy, increasing the risk of delivering babies who are anemic, premature, or have low birth weight (LBW), which in turn raises the likelihood of stunting and cognitive impairment. Addressing anemia in adolescence is crucial not only for the immediate health of these girls but also to break the intergenerational cycle of malnutrition<sup>3</sup>.

In response to this, the Indonesian government has made efforts to reduce anemia rates. Through Presidential Regulation No. 72 of 2021, the government aims to achieve 58% compliance in the consumption of iron and folic acid supplements by 2024 as part of the national stunting reduction program. Despite this, the 2023 Indonesian Health Survey (SKI) reported an anemia prevalence of 16.3% among children aged 5-14 and 15.5% among those aged 15-24, demonstrating that anemia continues to affect various age groups, including adolescents<sup>4</sup>.

In Yogyakarta Special Region (DIY) Province, 89.9% of adolescents received iron-folic acid supplements, primarily from schools, while others obtained them from health facilities or personal sources. However, challenges remain: 38.4% of adolescents who did not receive or purchase the supplements were unaware of how to obtain them, indicating the need for more comprehensive education. Furthermore, among those who did receive the supplements, 38.2% did not consume them due to their unpleasant taste or smell, and 22.5% simply forgot to take them. These findings highlight the need for improved awareness, education, and compliance to tackle anemia effectively<sup>5</sup>.

To address this persistent problem, the Indonesian government, in collaboration with UNICEF and other agencies, has implemented nutrition program since 2018. The Nutrition Action Movement to prevent stunting has been routinely implemented in schools since 2020 in the city of Yogyakarta. This program is implemented by UNICEF in collaboration with the Coordinating Ministry for Human Development and Cultural Affairs of Indonesia. The Aksi Bergizi activities are carried out with three main interventions: (1) Breakfast and weekly iron and folic acid (IFA) tablet consumption at schools/madrasas, (2) Multisectoral nutrition education aimed at promoting healthy eating and physical activity, and (3) Communication for relevant and comprehensive behavior change.

Although the government has intensified nutrition program, in reality, many schools are still not optimizing its implementation. Furthermore, the compliance with consuming iron supplements among adolescent girls remains low. The Yogyakarta City Health Office conducted initial anemia screening in August 2023, followed by interventions beginning in March 2024, creating a significant time gap between identifying the problem and taking action. This delay can impact the effectiveness of the intervention, given the importance of a quick response to screening results. Despite data showing that the program's targets and goals for Iron Folic Acid supplementation have been met, the prevalence of anemia among adolescent girls in Yogyakarta City remains high.

This situation indicates that, despite efforts being made, the impact has not met expectations. It highlights the need for a deeper evaluation of the factors influencing these outcomes. After the intervention was implemented, a lack of updated data hindered an accurate evaluation of the program's effectiveness. Without recent data, it is challenging to assess how successful the program has been and which areas require improvement. Therefore, evaluating the effectiveness of this nutrition program is crucial and must be conducted continuously to reduce the prevalence of anemia among adolescent girls.

## **MATERIALS AND METHODS**

The evaluation of the nutrition program in the Gedongtengen Community Health Center (Puskesmas) area was conducted using a mix-method approach, which combines both quantitative and qualitative methods. This approach is designed to obtain more comprehensive, valid, reliable, and objective data. The research applied a concurrent design strategy, where the quantitative approach was conducted first, followed by the qualitative approach. The quantitative approach was used to analyze data from the 2023 Adolescent Girls Anemia Screening Report in Yogyakarta City. Following this, the qualitative approach gathered information through interviews with the person in charge of the Adolescent Girls Program at the Yogyakarta City Health Office and nutrition officers at Gedongtengen Puskesmas. This approach provided a more in-depth understanding of the program's effectiveness in reducing anemia prevalence among adolescents, as well as identifying the challenges encountered during program implementation in the field.

The selection of healthcare facilities was based on the school with the highest prevalence of anemia, which is SMP Muhammadiyah 6 Yogyakarta, located in the Yogyakarta area. Additionally, due to time constraints, the evaluation only included interviews at one community health center (Puskesmas), namely Puskesmas Gedongtengen, and did not involve school observations as the students were undergoing final exams. The selection of the location and respondents was made according to the direction of the program manager at the Yogyakarta City Health Office.

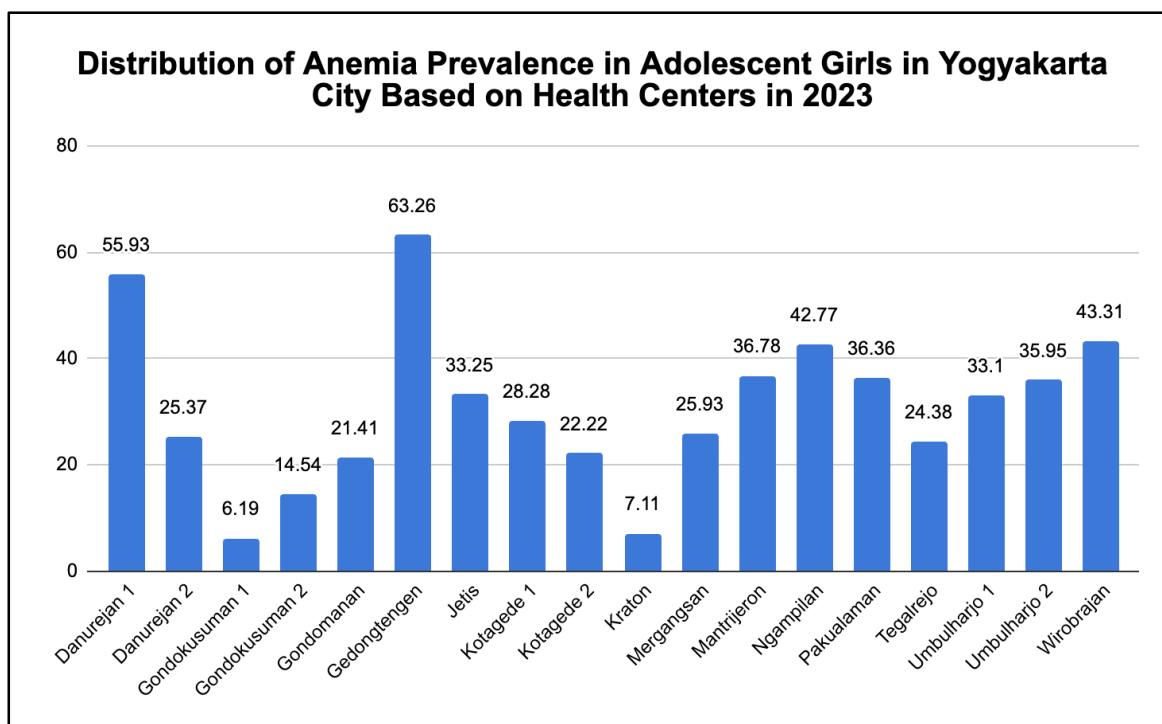
The inclusion criteria for this study encompass all adolescent girls in Yogyakarta City who are attending junior and senior high schools. For the qualitative research, interviews were conducted, with the inclusion criteria consisting of nutrition program officers at Gedongtengen Community Health Center, who are directly responsible for the implementation and supervision of the nutrition program in the area.

In this study, the primary stakeholders involved are the nutrition program officers from the Yogyakarta City Health Office, who provide strategic direction, policy support, and cross-sectoral coordination to ensure the success of the nutrition program.

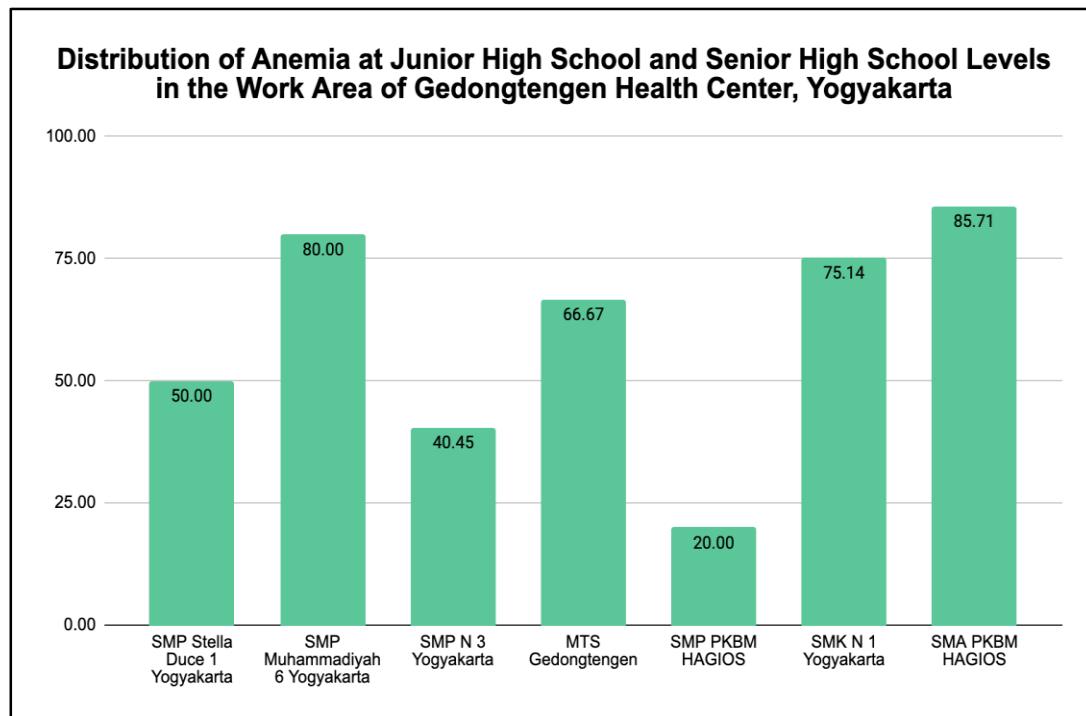
The interview guidelines were adopted from the Monitoring and Evaluation Form for the Nutrition Program in Schools provided by the Nutrition Program of the Yogyakarta City Health Office and were further developed with additional questions resulting from discussions with the adolescent nutrition program officers. These guidelines were also consulted with the Head of the Family Health and Nutrition Section. The interview was conducted for approximately 30 minutes. Qualitative data analysis is conducted by first transcribing the data, ensuring that all interview responses are captured accurately, in detail. After the data is categorized, the researcher interprets the emerging patterns and presented in descriptive analysis

## RESULTS AND DISCUSSION

Based on the results of the anemia screening above, it was found that the distribution of anemia prevalence in adolescent girls in Yogyakarta City was highest in the Gedongtengen Health Center, and the highest distribution of anemia in the Gedongtengen Health Center's working area was SMP Muhammadiyah 6 Yogyakarta (**Figure 1 and Figure 2**).



**Figure 1.** Distribution of Anemia Prevalence in Adolescent Girls in Yogyakarta City Based on Health Centers in 2023



**Figure 2.** Distribution of anemia in the Gedongtengen Health Center work area

#### Implementation of Nutritional Action in Schools

Based on the interviews, the implementation of nutrition program in schools aims to improve the health and nutrition of students through various activities, including communal breakfast, physical activities, and the distribution an iron-folic acid supplement. The results of the informant interview stated that :

“...The method of implementation is organized in such a way as to ensure each activity runs effectively and efficiently. Every student is required to bring breakfast from home, which is then consumed together at school before the start of classes...” (First informant - nutrition section of the Yogyakarta City Health Service)

“...Thus, this program becomes more effective in addressing anemia among adolescents. nutrition program is implemented in three schools: SMP Muhammadiyah 6, SMP Stella Duce 1 Yogyakarta, and MTSN Gedongtengen...” (Second informant - Person in charge of nutrition program at health center”)

“...Each school has a different implementation schedule, but in general, these activities are carried out once a week. With this program, it is expected that students in these schools will achieve better health and nutritional status. Overall, the implementation of nutrition program in these schools is designed to ensure that every student receives the maximum benefit from each activity...”(First informant - nutrition section of the Yogyakarta City Health Service).

This is intended to ensure that each student begins their day with proper nutrition, supporting their concentration and energy throughout the day. In addition to communal breakfast, physical activity is also an important part of nutrition program.

These physical activities are conducted together, either in the form of morning exercises or during Physical Education and Health classes. These activities are designed to improve the students' fitness and health, while also encouraging them to exercise regularly. This not only benefits their physical health but also helps improve their concentration and academic performance.

The distribution an iron-folic acid supplement is a crucial component of nutrition program. However, the distribution of these Iron-folic acid supplement is not carried out simultaneously with breakfast or physical activities. Iron-folic acid supplements are given according to a schedule set by each school to ensure optimal iron absorption and to avoid interference with food or activities that could hinder absorption. By bringing their own breakfast, participating in group physical activities, and receiving Iron-folic acid supplement regularly, this program is expected to help improve the students' nutritional and health status, as well as reduce the prevalence of anemia and other nutritional issues among adolescents.

### **Implementation of Iron Supplement Distribution in Schools**

The implementation of iron supplement distribution in schools plays a crucial role in addressing anemia among adolescents, particularly adolescent girls. The results of the informant interview stated that by Second informant - Person in charge of nutrition program at health center :

“....The distribution of Iron folic acid Supplements in schools is managed by the Health Promotion Department in collaboration with the Nutrition Department under Public Health. The distribution mechanism involves submitting a request to the pharmacy every three months. Once approved, teachers are responsible for distributing the supplements to students. Each student receives 10 tablets for consumption over a 2.5-month period...”

“...At vocational high schools, the tablets are taken every Tuesday, with the class leader acting as the distribution coordinator. However, the distribution of iron supplements in schools does not always run smoothly. Common issues include leftover stock from the previous year, which requires better stock management. Additionally, the distribution schedule often conflicts with other school activities, leading to missed distribution sessions. Lack of cooperation from the school and slow responses from the School Health Unit (UKS) also pose challenges. Many students also face difficulty swallowing the tablets, hindering effective consumption....”

“To ensure the program runs well, monitoring and evaluation (M&E) are conducted for adolescent girls at the school. Initially, M&E was done using manual forms, but now it has been replaced by Google Forms to simplify data collection and analysis...”

This shift is expected to improve efficiency and accuracy in the M&E process. Overall, despite various challenges, efforts continue to ensure the iron supplement distribution program runs effectively. With collaboration between the Health Promotion Department and the Nutrition Department, and the use of technology for M&E, it is hoped that the distribution of iron supplements can be optimized and provide maximum health benefits to adolescent girls in schools.

The Iron folic acid Supplement Program is one of the government initiatives aimed at breaking the stunting cycle, preventing anemia, and increasing iron reserves in the body, preparing a healthy, high-quality, and productive generation. The program's effectiveness is demonstrated by the fact that 76% (152 out of 200) of the female students consistently consumed the supplements weekly. Furthermore, 77.5% (155 students) expressed an awareness of the importance of continuing the consumption of supplements provided by the Merlung Community Health Center staff and agreed that the program should continue at SMA Negeri 4 Tanjung Jabung Barat<sup>6</sup>.

### **Nutrition Education for Adolescent Girls in Schools**

Nutrition education for adolescent girls in schools is essential for promoting healthy dietary habits and addressing issues such as anemia, stunting, and overall malnutrition. The results of Second informant is Person in charge of nutrition program at health center stated that:

“...Health education activities in schools are carried out during the School Orientation Period, which takes place once a year at the beginning of the new academic year. The target of these activities is 7th-grade middle school and 10th-grade high school students in the Gedongtengen community health center area...”

Nutrition education is conducted through counseling sessions using an interactive discussion method, which has garnered significant enthusiasm from the students, as many of them ask questions about examples of healthy food, the impact of anemia, causes of malnutrition, and examples of nutritious food suitable for adolescents. Through these counseling sessions, the students' understanding of the nutritional components in their daily meals and the nutritional needs of their bodies is enhanced<sup>7</sup>

Providing nutrition education to adolescent girls is expected to increase their knowledge, especially about anemia, and is hoped to lead to improved dietary habits, resulting in better nutritional intake. Adolescents, who are still in a learning phase and have open-minded thinking, are indirectly influenced by their habits. Through nutrition education, adolescents will become more familiar with good habits regarding nutritional intake, which they can apply in their daily lives<sup>8</sup>

According to Maghfirah's research, implemented a socialization on the importance of consuming fish protein as one of the key interventions of the "nutrition program Movement." The educational activities of the "nutrition program Movement" successfully sparked adolescents' interest in consuming protein. Most participants expressed a strong curiosity to learn about different fish-based dishes, especially those that are less familiar and rarely available in the market. However, the main challenge

often encountered is the school's busy schedule, which frequently serves as a reason for the inadequate implementation of health education. Despite this, efforts are continuously made to ensure that health education continues and provides benefits to the new students<sup>9</sup>

### **Implementation of Anemia Screening for Adolescent Girls**

The implementation of anemia screening for adolescent girls is a vital initiative in identifying and addressing iron deficiency and other nutritional issues early. Through regular screening programs conducted in schools or health facilities, hemoglobin levels can be monitored to detect cases of anemia among adolescent girls. The results of Second informant is Person in charge of nutrition program at health center stated that:

“... The anemia screening for adolescent girls was conducted in August 2023, with the pre-intervention phase carried out in March 2024. From the hemoglobin (HB) tests conducted at SMP 6 Muhammadiyah Yogyakarta, it was found that 80% of the students were anemic. This finding highlights the high prevalence of anemia among adolescent girls at the school, necessitating effective interventions to address this issue. The pre-intervention process involved several steps. First, coordination with the teachers was carried out to organize the intervention. The schedule for the pre-intervention was requested and adjusted so as not to disrupt teaching and learning activities. HB tests were performed as part of the initial screening, followed by consultations regarding the test results...”

“...Additionally, the students were given an iron-folic acid supplement to consume according to the guidelines. This pre-intervention was implemented simultaneously in March across all participating schools. Meanwhile, the post-intervention was conducted between May and June in two schools, namely SMKN 1 Yogyakarta and SMPN 3 Yogyakarta...”

Despite the intervention, the reduction in anemia prevalence was not significant, as some students continued to experience anemia. This indicates the need for further evaluation and adjustments to the intervention strategy to achieve more effective results in reducing anemia rates among adolescent girls.

Research by Marjan et al. (2023) showed that female adolescents were more likely to experience anemia, while the non-anemic category was dominated by male adolescents. This is consistent with WHO's 2011 theory, which states that female adolescents are at a higher risk of developing anemia compared to males. This is due to the peak iron absorption needs occurring at the ages of 14–15 in female adolescents, while for males, this occurs one or two years later

The selection of respondents involving only program officers from a single health center, Puskesmas Gedongtengen, may result in data that does not reflect the conditions across the entire region or other schools in Yogyakarta. Additionally, the time constraints that only allowed interviews at one health center without direct observation at schools could limit the amount of data collected, leading

to less comprehensive evaluation results. The combination of these two factors risks producing findings that are less representative and may not fully capture the program's effectiveness in various contexts.

## CONCLUSION

**Difficulty Swallowing Iron Supplements:** Many adolescent girls experience difficulty swallowing iron folic acid supplements, leading to reluctance in consuming them. This may be due to the size of the tablets or their unpleasant texture, highlighting the need to explore alternative forms of supplementation that are more easily accepted, such as syrups or smaller tablets.

**Lack of Coordination Between Schools and Health Centers:** There are challenges in coordination between school coordinators and health center staff regarding the monitoring of IFA consumption. Ineffective communication can result in misunderstandings about the responsibilities of each party, causing the program's implementation to falter. Efforts to enhance coordination and communication between both parties are essential for ensuring the success of this initiative.

**Absence of Evaluation by Health Center Staff:** The lack of evaluation of the forms filled out by adolescent girls by health center staff can hinder the monitoring of the program's effectiveness. Systematic and periodic evaluations are crucial to assess whether the adolescent girls have adhered to the recommendations for IFA consumption and to identify any issues that may arise during the program's implementation.

**Limitation of Post-Intervention Implementation:** Post-intervention implementation has only occurred in 2 out of the 7 planned schools. This was due to scheduling conflicts between the schools and health centers. Delays in conducting post-intervention evaluations can diminish the overall effectiveness of the program, making it necessary to establish more flexible scheduling and better coordination among all parties involved to ensure that every school receives the required support.

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## Research Article (FF15)

### The Antioxidant Content of White Mulberry Leaf Extract and Their Potential as Nephroprotective Effects in *In-Vivo* Study

Ahmad Fauzi<sup>1,2</sup>, Nurina Titisari<sup>3</sup>, Mohd. Hezmee Mohd. Noor<sup>4</sup>, Hazilawati Hamzah<sup>1</sup>, Azrina Azlan<sup>5,6\*</sup>

<sup>1</sup> Department of Veterinary Pathology and Microbiology, Faculty of Veterinary Medicine, Universiti Putra Malaysia UPM, Serdang 43400, Selangor, Malaysia; <sup>2</sup> Department of Veterinary Clinical Pathology, Faculty of Veterinary Medicine, University of Brawijaya, Malang East Java 65141, Indonesia; <sup>3</sup> Department of Veterinary Physiology, Faculty of Veterinary Medicine, University of Brawijaya, Malang East Java 65141, Indonesia; <sup>4</sup> Department of Veterinary Preclinical Sciences, Faculty of Veterinary Medicine, Universiti Putra Malaysia UPM, Serdang 43400, Selangor, Malaysia; <sup>5</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia; <sup>6</sup> Laboratory of Halal Science Research, Halal Products Research Institute, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor

#### ABSTRACT

Numerous studies have suggested that mulberry leaves contain bioactive components that exhibit therapeutic activities but still lack evidence demonstrating their therapeutic effects in preventing kidney injury. This study presents the antioxidant properties and preclinical efficacy of an ethanol-extracted white mulberry leaf (WML) in relation to the amelioration of kidney injury. The antioxidant properties were assessed by quantifying the total phenolic content (TPC) through the Folin Ciocalteu method and the total flavonoid content (TFC) through an aluminium chloride colourimetric method. Kidney injury in mice model was induced using unilateral ureteral obstruction (UUO) method, followed by treatment for 14 days according to groups, which received 125 mg/kg of WML (dose was based on previous toxicity study) or 15 mg/kg of enalapril as a control-positive drug. At the end of the study, blood samples were assessed for haematological changes; the urine sample was analysed for urine protein creatinine ratio (UPCr), and the kidney sample was examined for histology. UPCr test was conducted to determine urinary protein levels associated with kidney damage. In WML, TPC (10.93 mg of GAE per g of DW and TFC (256.67 mg of QE per g of DW) indicate high antioxidant properties. Administration of WML demonstrated significantly improved anaemia and leukocytosis ( $p < 0.05$ ) in the UUO-induced mice. The WML treatment improved kidney function by reducing UPCr levels and preventing glomerulonephritis and cellular infiltration in UUO-induced mice. The findings indicate that the WML exhibits significant antioxidant activity, effectively mitigating kidney injury in UUO-induced mice. This offers potential for the development of novel nephroprotective treatments.

**Key words:** White Mulberry Leaf, Haematology, Upcr, Histology

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\* Correspondence: azrinaaz@upm.edu.my

## INTRODUCTION

Obstructive nephropathy is a condition characterised by urinary tract obstruction that affects approximately 10% of adults worldwide<sup>1</sup>. Obstructive nephropathy results from urinary tract obstruction, which diminishes kidney function<sup>2</sup>. Indeed, it is consistent with the previous study, which stated that obstruction could result in renal impairment and a progressive decline in renal function<sup>3</sup>. Additionally, this obstruction will result in various clinical symptoms, including elevated intratubular pressure and reduced intraglomerular filtration, induce renal parenchymal injury, inflammation, and fibrosis, ultimately leading to the development of chronic kidney disease (CKD)<sup>4</sup>.

Moreover, it is well established that patients with CKD require specialised interventions such as haemodialysis and kidney transplantation, both of which are inefficient due to their high cost and the scarcity of available donor organs<sup>5</sup>. By implementing preventative strategies through timely detection and effective treatment, renal impairment can be significantly reduced<sup>6</sup>. The selection of medications for the treatment of CKD is still restricted, mainly due to the concern of drug-induced adverse effects that may exacerbate renal function, such as the use of NSAIDs<sup>7,8</sup>. Thus, exploring treatment to prevent renal disease progression with minimum side effects is essential to inhibit kidney disease progression<sup>9</sup>.

In recent decades, there has been a substantial increase in the focus on using herbal medicine to treat metabolic diseases<sup>10</sup>. White mulberry leaves (*Morus alba*) have been shown to have therapeutic properties for various metabolic disorders, such as diabetic nephropathy<sup>11</sup>. Studies showed that white mulberry leaves have been used for various disease therapies because of their anti-inflammatory and antioxidant properties<sup>12,13</sup>. Several studies have documented the presence of alkaloids and flavonoids in the leaves, which can inhibit oxidative stress and inflammation<sup>14</sup>. Consequently, these compounds can maintain kidney tissue and promote the recovery of kidney damage<sup>15</sup>. Nevertheless, there is a scarcity of studies that specifically investigate the efficacy of white mulberry leaf extract in preventing kidney injury related to obstructive nephropathy. Therefore, additional study is required to enhance the strength of scientific evidence. This study aims to determine the effect of white mulberry leaf extract on kidney injury induced by unilateral ureteral obstruction in mice against haematology, kidney function, and kidney histology.

## MATERIALS AND METHODS

**Ethical approval.** The experiment design and protocol were approved by the Universiti Putra Malaysia Ethics Committee on the use and care of the animals (Approval number AUP-R024\_UPM). All procedures performed were by local institutional guidance and well-established national standards for handling and care of laboratory animals.

**White mulberry extract preparation.** The leaves of white mulberry (*Morus alba*) were collected from the local garden in Selangor, Malaysia. The white mulberry leaves were cleaned from the dust by washing them in tap water and then dried with a conventional oven dryer (Rational CCC 61, Germany)

at  $60\pm1^\circ\text{C}$  for 6-8h. The dried material was ground into powder and sieved. The powdered mulberry leaves were stored in an air-tight container at  $4\pm1^\circ\text{C}$  for further extraction. Ethanolic extract of white mulberry leaves was prepared by Chen et al. (2022)<sup>16</sup>. White mulberry leaf was extracted by dissolving powder and solvent in a ratio of 1:15, where 100 g of powder was dissolved in 1500 mL of 60% ethanol/water (v/v)<sup>17</sup>. Then, the mixed solvent was heated in a water bath (Memmert, Germany) at  $65^\circ\text{C}$  for 4 hours and cooled at  $20^\circ\text{C}$  for 72 hours on a shaker machine (IKA orbital shaker, Staufen, Germany). The white mulberry extract was filtered through Whatman filter paper size no.1. Then, the filtrate was concentrated in a vacuum at  $45^\circ\text{C}$  using a rotary evaporator (Buchi Rotavapor R-200, Switzerland). All crude extracts were stored at  $-20^\circ\text{C}$  for further experimentation.

**The determination of phenolic and flavonoid content.** The total phenolic content of the white mulberry leaf extract was determined using the Folin–Ciocalteau method as described by Do et al. (2014)<sup>18</sup>. The calibration curve was established using gallic acid (0-60  $\mu\text{g}/\text{mL}$ ). Diluted extract or gallic acid was added to 0.2 mL FC reagent and mixed thoroughly for 3 minutes. TPC was depicted as milligram gallic acid equivalent per gram of white mulberry leaf extract (mg GAE/g WML). Meanwhile, the total flavonoid content (TFC) of the white mulberry extract was examined using the aluminium chloride colourimetry method described by Chang et al. (2002)<sup>19</sup>. The calibration curve was prepared by diluting quercetin in methanol (0–100  $\mu\text{g}/\text{mL}$ ). TFC was expressed as milligram quercetin equivalent per gram of white mulberry leaf extract (mg QE/g WML).

**Animals and experimental protocols.** Male Balb/C mice with a body weight (BW) of  $25\pm2$  g was provided by the animal research facility of the Universiti Teknologi MARA, Malaysia. The animals were acclimated and housed in the polycarbonate cage with ad libitum access to food and water. The unilateral ureteral obstruction (UUO) was selected in this study since it was an established animal model of obstructive nephropathy and has been designated as reflecting the progression of human kidney disease in many reports<sup>20</sup>. The mice were randomly divided into four groups: the control group, unilateral ureter obstruction (UUO) group, UUO-induced mice treated with enalapril (enalapril group) as the control medicine group, and UUO-induced mice treated with white mulberry leaves (WML group). 15 mg/kg of enalapril and 125 mg/kg of WML were administered once a day orally for 14 days, starting on the second day after UUO-induced mice. The mice in the control and UUO groups received 0.5 mL of normal saline water orally. In the middle of the experiment, on day 7 of treatment, the urine of mice was collected using metabolic cages for urine analysis. At the end of the study, the mice were sacrificed on day 14 of treatment. Blood samples were collected via retroorbital for haematology assay, and kidney organs were harvested for histological analysis.

**Haematological analysis.** Mice's blood was collected in the EDTA tube and analysed for complete blood count using a veterinary haematology analyser of Celltac Alpha VET® MEK-6550K (Nihon Kohden, Japan). Serial haematology parameters were analysed and compared between the treated and control groups. The haematological parameters are red blood cell (RBC), haemoglobin, packed cell volume

(PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), white blood cell (WBC) and differential leukocyte count.

**Urinalysis.** Collected urine samples in metabolic cages for 12h were immediately measured for urine protein creatinine ratio (UPCr) utilising a biochemical analyser (Bolis 24i Premium® chemistry analyser, Tokyo, Japan).

**Histopathological analysis.** The kidney organs of mice were fixed in buffered formalin 10% for 24 h. The kidney samples were embedded in paraffin blocks, and serial sections of 5-6 $\mu$ m thickness were cut using a rotary microtome (Leica RM2125, Nussloch, Germany). The sections were routinely stained with haematoxylin and eosin (H&E) and were observed and scored under a light microscope (Nikon Eclipse 80i, Japan). A semiquantitative comparison of the structural kidney changes was graded following the Gibson-Corley et al. method<sup>21</sup>.

**Statistical analysis.** The data from haematology and urinalysis were analysed by one-way ANOVA, followed by the Tukey test. The histopathological scoring of the kidney organs was analysed by Kruskal-Wallis, followed by Dunn's test. Quantitative data were expressed as mean+SEM, and  $p < 0.05$  was considered statistically significant. GraphPad Prism software version 6 (GraphPad Inc., Boston, USA) was used for statistical analysis.

## RESULTS

### The total phenolic and flavonoid content of white mulberry leaf extract

The results of the total phenolic and flavonoid content of WML are presented in **Table 1**. The TPC of WML  $10.93 \pm 0.61$  mg GAE/g DW is similar to the previous finding of He et al., and it was higher than another result of Polumackanycz et al. (2021). While the TFC of WML  $256.67 \pm 63.51$  mg QE/g DW is higher than the prior studies<sup>22,23</sup>.

**Table 1.** The total phenolic content (TPC) and total flavonoid content (TFC) of white mulberry leaf extract

Antioxidant content	Value (Mean $\pm$ SD)	References
TPC (mg GAE/g DW)	10.93 $\pm$ 0.61	11.49-30.03 (He et al., 2020) <sup>22</sup>
		0.31 $\pm$ 0.03 (Polumackanycz et al., 2021) <sup>24</sup>
TFC (mg QE/g DW)	256.67 $\pm$ 63.51	24.34-58.42 (He et al., 2020) <sup>22</sup>
		22.12 (Kim et al., 2022) <sup>23</sup>

**Effect of white mulberry leaf extract treatment in kidney injury-induced mice on haematology parameter**

A complete blood count result of kidney injury-induced mice treated with WML for 14 days is presented in **Table 2**. In the UUO group, kidney injury-induced mice presented significantly lower red blood cells, haemoglobin, and haematocrit ( $p < 0.05$ ) than the control group, indicating mild normocytic normochromic anaemia. On the other hand, enalapril and WML groups could significantly increase the red blood cells, haemoglobin, and haematocrit values ( $p < 0.05$ ) than the UUO group, indicating its potential for inhibiting anaemia due to kidney disorders. Furthermore, the WML treatment group also significantly lowered the leukocyte value in the blood compared to the UUO group. This indicates its ability to prevent inflammation in kidney injury-induced mice. In addition, the differential leukocytes of the WML group, which included neutrophils, lymphocytes, monocytes, and eosinophils, depicted a lower trend than the UUO group. Thus, it is suggested that WML is anti-inflammatory in preventing kidney injury-induced mice.

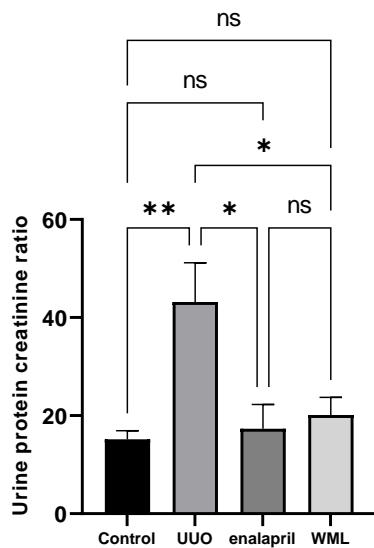
**Table 2.** Complete blood count of kidney injury-induced mice treated with WML

Parameters	Control	UUO	enalapril	WML
RBC ( $\times 10^{12}/\text{L}$ )	8.99 $\pm$ 0.11 <sup>a</sup>	7.42 $\pm$ 0.28 <sup>b</sup>	8.68 $\pm$ 0.38 <sup>a</sup>	8.63 $\pm$ 0.04 <sup>a</sup>
Hb (g/L)	13.86 $\pm$ 0.29 <sup>a</sup>	11.68 $\pm$ 0.36 <sup>b</sup>	13.72 $\pm$ 0.51 <sup>a</sup>	13.56 $\pm$ 0.70 <sup>a</sup>
HCT (%)	39.20 $\pm$ 0.64 <sup>a</sup>	33.70 $\pm$ 1.13 <sup>b</sup>	38.32 $\pm$ 1.37 <sup>a</sup>	38.86 $\pm$ 2.06 <sup>a</sup>
MCV (fL)	43.62 $\pm$ 0.65 <sup>a</sup>	45.44 $\pm$ 0.57 <sup>a</sup>	44.22 $\pm$ 0.51 <sup>a</sup>	45.00 $\pm$ 0.82 <sup>a</sup>
MCH (pg)	15.42 $\pm$ 0.35 <sup>a</sup>	15.84 $\pm$ 0.31 <sup>a</sup>	15.84 $\pm$ 0.22 <sup>a</sup>	15.70 $\pm$ 0.23 <sup>a</sup>
MCHC (g/L)	353.4 $\pm$ 3.20 <sup>a</sup>	348.6 $\pm$ 4.59 <sup>a</sup>	358 $\pm$ 3.42 <sup>a</sup>	349.4 $\pm$ 4.97 <sup>a</sup>
Platelets ( $10^3/\mu\text{L}$ )	604 $\pm$ 99.93 <sup>a</sup>	698 $\pm$ 52.75 <sup>a</sup>	753.8 $\pm$ 49.96 <sup>a</sup>	846 $\pm$ 61.22 <sup>a</sup>
Leucocytes ( $\times 10^9/\text{L}$ )	4.74 $\pm$ 0.61 <sup>b</sup>	6.68 $\pm$ 0.48 <sup>a</sup>	5.60 $\pm$ 0.89 <sup>ab</sup>	4.48 $\pm$ 0.09 <sup>b</sup>
Neutrophil ( $\times 10^9/\text{L}$ )	1.53 $\pm$ 0.28 <sup>a</sup>	2.28 $\pm$ 0.29 <sup>a</sup>	1.39 $\pm$ 0.24 <sup>a</sup>	1.58 $\pm$ 0.32 <sup>a</sup>
Lymphocyte ( $\times 10^9/\text{L}$ )	2.84 $\pm$ 0.46 <sup>a</sup>	4.01 $\pm$ 0.50 <sup>a</sup>	3.70 $\pm$ 0.57 <sup>a</sup>	2.51 $\pm$ 0.57 <sup>a</sup>
Monocyte ( $\times 10^9/\text{L}$ )	0.26 $\pm$ 0.07 <sup>a</sup>	0.21 $\pm$ 0.06 <sup>a</sup>	0.26 $\pm$ 0.07 <sup>a</sup>	0.20 $\pm$ 0.05 <sup>a</sup>
Eosinophil ( $\times 10^9/\text{L}$ )	0.10 $\pm$ 0.03 <sup>a</sup>	0.19 $\pm$ 0.04 <sup>a</sup>	0.22 $\pm$ 0.11 <sup>a</sup>	0.18 $\pm$ 0.10 <sup>a</sup>
Basophil ( $\times 10^9/\text{L}$ )	0.01 $\pm$ 0.01 <sup>a</sup>	0.00 $\pm$ 0.00 <sup>a</sup>	0.00 $\pm$ 0.00 <sup>a</sup>	0.00 $\pm$ 0.00 <sup>a</sup>

Data are presented as mean  $\pm$  SEM; values with different superscripts <sup>a</sup> and <sup>b</sup> in the column differed significantly at  $p < 0.05$ . Key: RBC= red blood cell; Hb= haemoglobin; HCT= Haematocrit; MCV= mean corpuscular volume; MCH= mean corpuscular haemoglobin; and MCHC= mean corpuscular haemoglobin concentration.

### Effect of white mulberry leaf extract treatment in kidney injury-induced mice on urine protein creatinine ratio

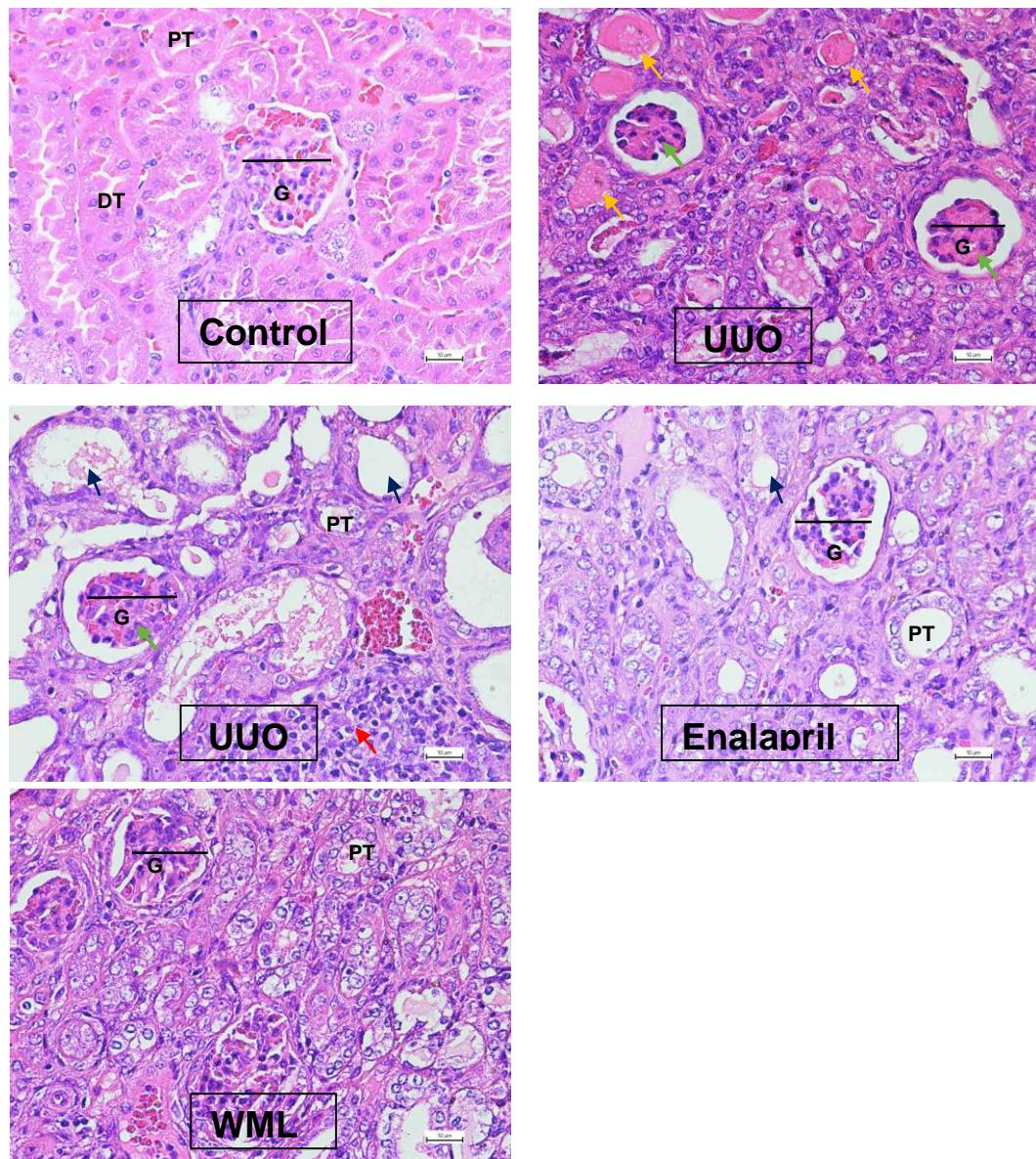
The urine protein creatinine ratio of kidney injury-induced mice treated with white mulberry leaf extract is presented in **Figure 1**. The kidney injury-induced mice in the UUO group showed significantly higher UPCr levels ( $p < 0.01$ ) than the control group. Meanwhile, the WML group indicated a significantly lower UPCr level ( $p < 0.05$ ) than the UUO group. It was not significantly different from the enalapril group, which played as a positive control medicine group, demonstrating its capacity to improve the kidney physiological function of kidney injury-induced mice.



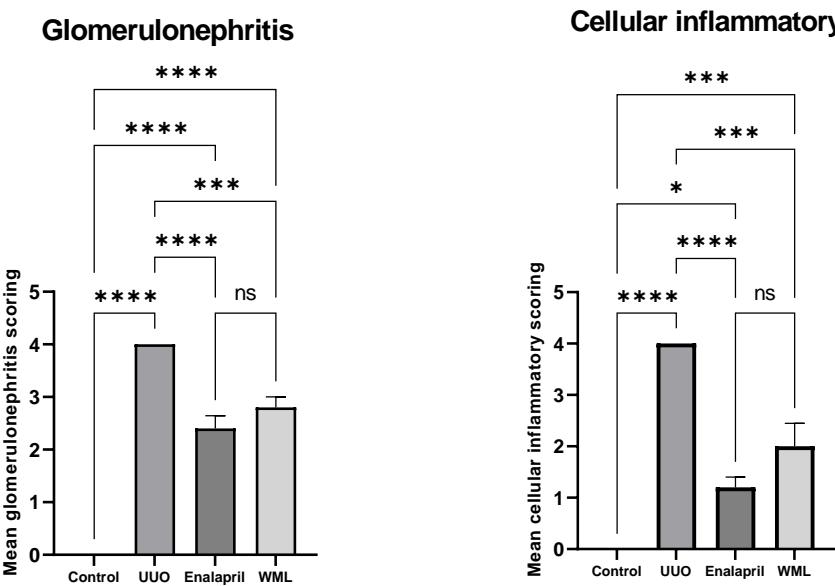
**Figure 1.** Urine protein creatinine ratio of kidney injury-induced mice treated with white mulberry leaf extract. Significance: ns=  $p > 0.05$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ .

#### **Effect of white mulberry leaf extract treatment in kidney injury-induced mice on kidney histology.**

Histology of kidney injury-induced mice treated with white mulberry leaf extract is exhibited in **Figure 2**. Kidney histology of the UUO group showed structural damage of the mice kidney as represented by glomerulonephritis, dilatation of Bowman's space, interstitial fibrosis with infiltration of inflammatory cells, tubular epithelial cells loss, and intralobular eosinophilic cast. Meanwhile, treating mulberry leaf extract improved the kidney histological structure by inhibiting severe kidney damage, as presented in histological scoring (**Figure 3.**). The administration of white mulberry leaf extract in the UUO-induced mice significantly decreased glomerulonephritis and cellular inflammation scoring ( $p < 0.001$ ) compared to the UUO group, which indicates the white mulberry leaf extract capability to prevent kidney damage in obstructed nephropathy animal model.



**Figure 2.** Histology of kidney injury-induced mice treated with white mulberry leaf extract. The control group shows the normal structure of the glomerulus and tubules. Meanwhile, the UUO group depicts several histological changes, including interstitial fibrosis, glomerulonephritis with Bowman's space dilatation, tubular epithelial cell loss with intralobular eosinophilic cast; interstitial fibrosis, dilatation of tubules and infiltration of inflammatory cell. However, administering enalapril or white mulberry leaf extract in mice with UUO-induced kidney injury indicates improved kidney histological structure. (H&E staining; 400x magnification, 10 $\mu$ m scale bar). Key: G: glomerulus; PT: proximal tubule; DT: distal tubule; yellow arrow: intralobular cast; green arrow: glomerulonephritis; red arrow: cellular inflammatory; black arrow: tubular dilation.



**Figure 3.** Kidney histological scoring of glomerulonephritis and cellular inflammatory response in WML treatment on kidney injury-induced mice. Significance: ns=  $p > 0.05$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; \*\*\*\* $p < 0.0001$ .

## DISCUSSION

In this study, WML effectively prevented kidney damage in kidney injury-induced mice by alleviating anaemia, lowering the urinary protein-to-creatinine ratio (UPCr), and preventing kidney histological abnormalities. Based on the haematology results of this current study found that renal injury generated by UUO caused mild normocytic normochromic anaemia and increased white blood cell count. Studies revealed that normocytic normochromic anaemia is a typical occurrence in kidney disorders, specifically acute kidney injury or chronic kidney disease<sup>25,26</sup>. Inflammation state, iron metabolism disorders, oxidative stress during renal injury or chronic renal disease may impact the production of erythropoietin (EPO) hormone, resulting in reduced red blood cell (RBC) synthesis and subsequent development of anaemia<sup>27</sup>. Interestingly, the current study showed that WML therapy in UUO-induced mice significantly prevented the occurrence of mild normocytic normochromic anaemia, which aligns with the findings of a prior study<sup>28</sup>. It is well known that mulberry leaves have the highest iron mineral concentration, ranging from 4-10 mg/100g<sup>29,30</sup>. This concentration may alleviate anaemia, which is essential for preventing anaemia<sup>31</sup>. Furthermore, the treatment of WML also successfully inhibited the elevation of inflammatory leukocyte cells in UUO-induced mice. Indeed, elevated levels of inflammatory cells are frequently observed in kidney disease problems as a reaction to inflammation resulting from kidney nephropathy<sup>32</sup>. Leukocytosis, a condition characterised by an elevated white blood cell count, commonly occurs in kidney disorders and is typically accompanied by an upsurge in several types of white blood cells, such as neutrophils, monocytes, and lymphocytes<sup>33</sup>. The efficacy of white mulberry leaf extract in preventing leukocytosis may be influenced by the abundant presence of phenolic and

flavonoid compounds in the extract, which act as an anti-inflammatory agent<sup>34</sup>. Based on the analysis of TPC and TFC, this current study demonstrated that WML contains significant quantities of phenolic compounds and flavonoids. Thus, it may effectively ameliorate haematological alteration.

Furthermore, a UPCr examination was carried out to evaluate kidney function. The study found that the treatment of WML effectively suppressed renal function problems, as seen by a reduction in UPCr levels. A study demonstrated that proteinuria or albuminuria rises in kidney disorders due to damage to the glomerular filtration barrier, which impairs renal filtration and elicits overload proteinuria<sup>35</sup>. Another study revealed that kidney injury caused an elevation in urinary protein-to-creatinine ratio (UPCr) levels among patients with CKD<sup>36</sup>. The finding of renal histology further supported the abnormalities in kidney function in the UUO-induced kidney injury animal model. The UUO group without treatment exhibited kidney structural damage, which was characterised by glomerulonephritis, dilatation of Bowman's space, interstitial fibrosis with infiltration of inflammatory cells, loss of tubular epithelial cells, and the presence of intralobular eosinophilic cast, which was aligned with the previous investigation<sup>37</sup>. On the contrary, administration of WML in kidney injury-induced mice demonstrated a preventive effect on kidney damage, as represented by amelioration of kidney histological damage, which reduced glomerulonephritis and inflammatory cell infiltration. The potential to enhance kidney function and structure may be attributed to the anti-inflammatory and antioxidant properties of white mulberry leaf<sup>12,38</sup>. The presence of flavonoid and phenolic content in mulberry leaves has been shown to considerably alleviate oxidative stress and inflammation in renal disease, as indicated by numerous studies<sup>39-41</sup>. Phytochemical substances found in mulberry leaves, such as DNJ-1, actively inhibit NFkB and Akt-1 in kidney disease<sup>42,43</sup>. Additionally, the current study revealed that WML administration in UUO-induced mice had a similar inhibitory effect on kidney function as enalapril, as a controlled drug. The observed improvements in haematology, urine, and histology data serve as evidence and suggest the potential of WML to enhance renal function and mitigate kidney injury comparably to the effects of enalapril medication.

## CONCLUSION

In conclusion, white mulberry leaf extract exhibited high antioxidant content that could ameliorate kidney alteration in UUO-induced mice. Further research is needed to identify the specific phytochemical substances in white mulberry leaves, such as rutin, chlorogenic acid, and quercetin, and discover which chemicals have a significant influence in improving kidney injury.

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## Research Article (FF16)

### Postoperative Nutritional Changes and Anthropometric Measures in Cancer Patients: A Prospective Study in Vietnam

Tran Chau Quyen<sup>1,2</sup>, Bui Thi Kim Hue<sup>1\*</sup>, Nguyen Thi Loan<sup>1</sup>, Tran Thi Nam<sup>1</sup>, Ha Thi Kim Hao<sup>1</sup>, Le Van Thanh<sup>1</sup>, Vo Quoc Hoan<sup>1</sup>, Dam Trong Nghia<sup>1</sup>, Vu Kien<sup>1</sup>, Phan Le Thang<sup>1</sup>, Bui Vinh Quang<sup>1</sup>

<sup>1</sup>Hanoi Oncology hospital, Vietnam

<sup>2</sup>Vietnam National Institute of Nutrition, Vietnam

#### ABSTRACT

Early recovery following surgery is crucial for cancer patients as it allows them to undergo subsequent treatments. Malnutrition is a prevalent issue among cancer patients and adversely impacts treatment outcomes. However, data on nutrition continuous monitoring postoperative in Vietnam is still limited. This study aimed to identify the anthropometric and dietary changes in postoperative cancer patients. This prospective, observational study collected patients  $\geq 18$  years old, indicated surgery and waiting for operation from May to July 2020. Their weight, height, mid arm circumference (MAC) and calf circumference (CC) were measured according to standard procedures. The 24 hours dietary recalls were collected from preoperative day (D0) until the 7th day (POD7), using food images. The Patient generated subjective global assessment (PG-SGA) also performed preoperatively based on hospital records, clinical examination and personal interview. A total of 145 patients (102 females), mean aged  $50 \pm 13.7$  were included. Gastrointestinal cancer patients were at highest risk of malnutrition according to PG-SGA classification. The BMI and CC decreased significantly at POD3. Dietary intake covers  $> 80\%$  of the energy and  $> 75\%$  of the protein requirement, but gradually decreased from the POD1 to POD7. Muscle preserved in cancer patients undergoing surgery did not only depend on protein and energy intake. Dietary intakes before and after surgery should be monitored in order to intervene immediately to reduce malnutrition rates postoperatively.

**Key words:** operation, malnutrition, dietary intake, muscle loss, calf circumference.

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\* Correspondence: buithikimhue010695@gmail.com

## INTRODUCTION

Cancer patients often face with metabolic disorders <sup>1</sup> and nutritional challenges <sup>2</sup>, both due to the disease itself and the effects of treatment. In Vietnam, according to GLOBOCAN 2022, there were nearly two hundred thousand new cancer cases and the risk and dying from cancer before the age of 75 was 16.0% and 10.9% respectively <sup>3</sup>.

Surgical intervention is frequently employed in the management of various cancer types; however, it induces stress and a metabolic response, classically identified from the first to over a week depending on the recovery process <sup>4</sup>. This gold period has an important impact on whether the body gets recovered or changes to chronically ill after that. At the first three days, there is the ebb phase, patient get hemodynamic instability and hypo-metabolism. From the 3<sup>rd</sup> day to 7<sup>th</sup> day or more, patient changes to flow phase with catabolism and hyper-metabolism. So anthropometric changes were significant during the first week after surgery. Moreover, surgical also lead to alterations in dietary intake due to a range of postoperative challenges, including pain, difficulty swallowing, reduced appetite, and changes in digestive function.

Early recovery following surgery is crucial for cancer patients as it allows them to undergo subsequent treatments, such as chemotherapy, radiotherapy, and immunotherapy. Body weight, BMI and calf circumference were well-known references to evaluate nutritional status <sup>5</sup>. Calf circumference was considered as an alternative, non-invasive, easy-to-perform method to assess skeletal muscle in cancer patients <sup>6</sup>. However, postoperative dietary changes can cause substantial shifts in these measures, which may influence recovery rates.

Despite the growing awareness of the role of nutrition in cancer care, there is limited research specifically addressing the connection between postoperative dietary changes and their connection to anthropometric measures in cancer patients, particularly in Vietnam. This study seeks to explore this relationship, providing insight into the magnitude of dietary shifts after surgery and their implications for anthropometric outcomes. By gaining a deeper understanding of postoperative nutritional shifts, healthcare professionals can better tailor interventions to mitigate malnutrition, promote recovery, and improve the overall prognosis for cancer patients.

## MATERIALS AND METHODS

This is a prospective, observational study, conducted from May to July 2020 that included patients  $\geq 18$  years old who were indicated surgery and waiting for operation in Hanoi Oncology hospital. Hanoi Oncology Hospital is one of three last stream oncology hospital in Vietnam, received cancer patients from Northern and North Central provinces of Vietnam. Exclusion criteria were state of hemodynamic instability; serious chronic co-morbidities (heart failure in exacerbation phase, severe COPD, asthmatic state); cognitive dysfunction; situations made weigh and/or height measurement impossible such as edema, amputation, kyphosis and scoliosis.

Applied the formula for estimating sample size for a proportion:

$$n = Z_{1-\alpha/2}^2 \frac{p(1-p)}{(p\varepsilon)^2}$$

In which:

n: Required sample size

$\alpha$ : Significance level, with  $\alpha = 0.05$

$Z_{1-\alpha/2}^2 = 1.96$  (for  $\alpha = 0.05$  at 95% confidence level)

p: prevalence of malnutrition patients according to previous study ( $p = 0.541$ )<sup>7</sup>

$\varepsilon$ : relative level of accuracy (choose  $\varepsilon = 0.15$ )

The sample size was calculated to include 144 patients.

### Data collection

Sociodemographic and clinical data were collected from medical records. Anthropometric measurements were performed for each patient. Height measurement was performed once preoperatively (D0). Weight, mid- arm circumference and calf measurement were performed preoperatively and at the 3<sup>rd</sup> day after operation in the early morning. Weight was measured in supine position with 100kg standard scale (Tanita BC-541N, made in China) with a precision of 0.1kg and with shoe removal and minimal clothes. Actual height was measured in standing position using sliding head SECA 217 height scale (SECA Germany, made in China). The subjects were wearing no shoes, hair coverings or hair bands and with hair smoothed down; stand erect on the floor or horizontal platform, with back against the vertical Stadiometer, heels against the wall, and feet or knees together whichever come together first. The participant looked straight ahead, with head in the Frankfort horizontal plane. Measurements were recorded to the nearest 1 mm. The 60 centimeters non-elastic measuring tape (The Abbott Laboratories Purchase Order) was used to measure circumference of the non-dominant mid-upper arm (mid-arm circumference – MAC) and calf circumference (CC), in centimeters, with a precision of 1 mm. MAC was measured with participants' standing positions and their non-dominant arm that was bent to 90 degrees. The midpoint between the accordion and the colcannon was marked with a pen. With the arm hanging straight down, a MAC tape was wrapped around the arm at the midpoint mark. Sitting calf was measured while the participant sat on a chair and held his/her bare foot down, holding the leg folded to 90 degrees. The circumference of the calf in this position was at its widest point that helped two professional dietitians laying the tape on the skin without tightening.

Patients were assessed nutritional status using Patient Generated Subjective Global Assessment (PG-SGA) preoperatively based on interview and clinical examination. PG-SGA was applied to each patient and completed by a dietitian. Each item of the PG-SGA was scored. Total higher scores (the numerical PG-SGA score) representing a poorer nutritional status. The first part was patient generated. Box 1 (Weight history) and Box 3 (Symptoms) scores were additive, whereas scores of Box 2 (Food

intake) and Box 4 (Activities and Function) were not. In these boxes, the highest point score was recorded. The remaining portions of the PG-SGA form were completed by the dietitian. The scores were calculated based on the disease and its stages, components of metabolic stress or use of corticosteroids and physical components (loss of subcutaneous fat, muscle wasting, and edema or ascites). The PG-SGA category score also applied with stage A (well nourished), stage B (moderate or suspect of malnutrition) or stage C (severe malnourished).

The 24 hours dietary recalls were collected from preoperative day (D0) until the 7<sup>th</sup> day (D7) from operation wards using cup/bowl/spoon models and food images by registered dietitian. Protein and energy intake were calculated and assessed for changes each day, from the first to 7<sup>th</sup> day.

All patients were informed about the purpose and content of this study with explained that they could withdraw at any time. Patients also had tailored nutrition counseling by a registered dietitian after first data collection, and nutrition follow up by nurses during hospitalization. The study has been approved by the Ethics Committee of Hanoi Oncology hospital. The study protocol was carried out in accordance with the tenets of the Declaration of Helsinki and Good clinical practice guidelines.

### **Statistical analysis**

Epidata (Version 3.1) software was used to develop datasets on social and anthropometric characteristic. Dietary intake data was input in National Institute of Nutrition dietary analysis software, which developed by Microsoft access, using Vietnam food composition data. All data then convert to Microsoft excel and convert into Statistical Package for the Social Sciences (IBM SPSS Statistics version 20.0 for Windows) for statistical analysis. Continuous variables were presented as the mean  $\pm$  standard deviation (SD); whereas categorical variables were presented as the number and percentage values (n; %). Inter-group differences were assessed by paired sample t test and were significant at  $p < 0.05$ . Postoperative anthropometric changes were determined by subtracting the measurements on the preoperative day (D0) from those on the third postoperative day (POD3).

## **RESULTS**

### **1. Patients' characteristics**

In the final analysis, there was a total of 145 records, including 102 females. Their mean aged was  $50 \pm 13.7$ . Age group and sex were significant different between the two groups PG-SGA A and PG-SGA B&C, but not with types of surgery (**Table 1**).

**Table 1.** Patients' characteristics

Characteristic	PG-SGA A (n; %)	PG-SGA B &C (n; %)	p*
Age group			0.01
18 to 45	42 (40.4)	11 (27.5)	
46 to 60	50 (47.6)	14 (35.0)	
Over 60	13 (12.4)	15 (37.5)	
Sex			0.00
Male	20 (19.0)	23 (57.5)	
Female	85 (81.0)	17 (42.5)	
Types of surgery			0.64
Head &neck	62 (59.0)	11 (27.5)	
Gastrointestinal tract	5 (4.8)	26 (65.0)	
Abdominal surgery	4 (3.8)	3 (7.5)	
Breast	21 (20.0)		
Uterine adnexa	11 (10.5)		
Others	2 (1.9)		

\* p value of independent sample t test

## 2. Anthropometric changes postoperative

At the 3<sup>rd</sup> post-operative day (POD3), patients lost weight and reduced calf circumference significantly compared to the pre-operative day (D0). Averagely, their BMI reduced  $-0.2 \pm 0.4 \text{ kg/m}^2$  and calf circumference decreased  $6.1 \pm 2.2 \text{ cm}$  (**Table 2**) and the difference significantly ( $p < 0.05$ ).

**Table 2.** Anthropometric changes postoperative

<b>Characteristic</b>	<b>Pre-operative</b>	<b>n</b>	<b>Post-operative</b>	<b>n</b>	<b>Difference</b>	<b>p*</b>
	<b>(D0)</b>		<b>(POD3)</b>			
BMI (kg/m <sup>2</sup> )	20.9 ± 2.8	145	20.2 ± 2.6	63	-0.2 ± 0.4	0.00
Male	20.3 ± 3.1	43	19.2 ± 2.3	23	-0.3 ± 0.4	0.00
Female	21.2 ± 2.7	102	20.9 ± 2.6	40	-0.2 ± 0.4	0.01
MAC (cm)	25.0 ± 2.8	145	25.1 ± 2.7	62	-0.1 ± 0.5	0.17
Male	25.1 ± 3.2	43	25.1 ± 3.1	23	-0.2 ± 0.6	0.14
Female	25.0 ± 2.6	102	25.1 ± 2.4	39	-0.0 ± 0.5	0.67
CC (cm)	31.4 ± 3.3	145	25.1 ± 2.6	62	-6.1 ± 2.2	0.00
Male	31.3 ± 3.9	43	25.1 ± 3.2	23	-6.5 ± 1.8	0.00
Female	31.5 ± 3.0	102	25.1 ± 2.3	39	-6.0 ± 2.4	0.00

\* p value of paired sample t-test

### 3. Nutrition status classified by PG-SGA

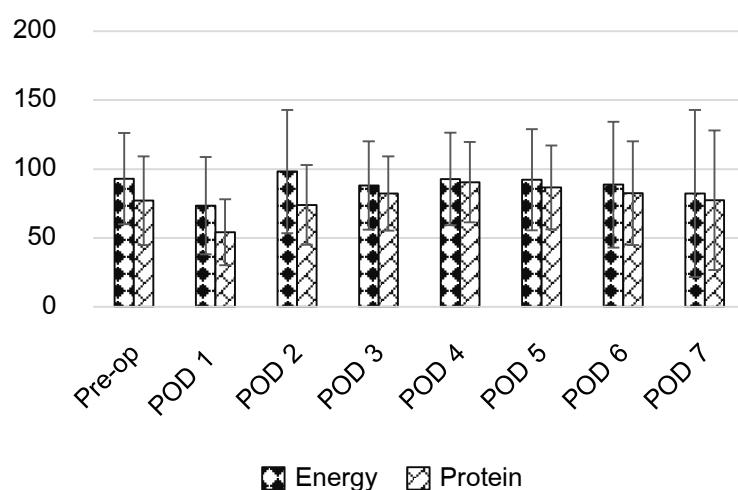
According to PG-SGA classification, gastrointestinal cancer patients had highest rate of malnutrition prior surgery. Patients with breast, uterine adnexal, and other non-gastrointestinal tract cancers were generally well-nourished (**Table 3**).

**Table 3.** PG-SGA classification by cancer sites

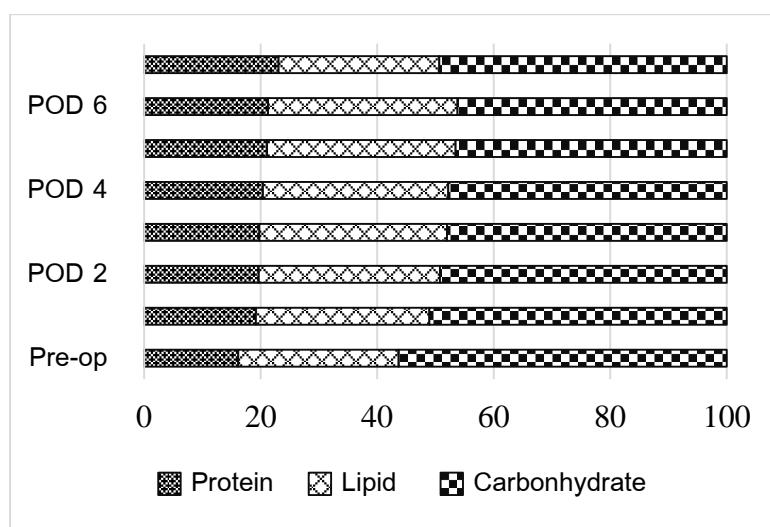
<b>Cancer site</b>	<b>PGSGA classification</b>			<b>Total</b>
	<b>A</b>	<b>B</b>	<b>C</b>	
Oropharyngeal	1	0	2	3
Thyroid	37	2	0	39
Esophageal	0	0	0	2
Gastric and colon	3	7	16	26
Liver	1	0	0	1
Lung	1	1	0	2
Breast	19	0	0	19
uterine adnexa	6	0	1	7
Others	37	6	3	46
<b>Total</b>	105	18	22	145

#### 4. Dietary intake

Overall, dietary intake covered more than 80% of the energy requirement and more than 75% of the protein requirement. This figure illustrates the variation of energy and protein intakes from pre-operative day to the 7<sup>th</sup> post-operative day. The energy intake decreased on the first day after operation, but increased on the 2<sup>nd</sup> day and decreased again on the 3<sup>rd</sup> day, then increased on the 4<sup>th</sup> and 5<sup>th</sup> day, then decreased again from the 6<sup>th</sup> to the 7<sup>th</sup> day. The similar trend occurred with protein intake. The 3<sup>rd</sup> postoperative day was the day that 42% patients were discharged and the 7<sup>th</sup> day was the day that 85% remained patient discharged from the operation wards. So the intake appeared to be decreased on the day the patients were discharged (**Figure 1**).



**Figure 1.** Percentage of intake compared to requirement



**Figure 2.** Protein : Lipid : Carbohydrate ratio

The **Figure 2** showed the ratio of protein: lipid: carbohydrate on the preoperative day, it appeared the same as that of normal Vietnamese people's diet, but the proportion of protein intake tended to increase after surgery. This finding is consistent with the traditional Vietnamese concept that protein-rich foods are good for sick people.

## DISCUSSION

In the final analysis, the dataset comprised 145 records, with a notable majority of 102 females. The mean age was calculated at 50 years with a standard deviation of 13.7 years. This indicates a middle-aged population with a relatively wide age range. When examining age group and sex, significant differences were observed between the two groups: PG-SGA A and PG-SGA B&C. This suggests that age and sex may influence classification within these nutritional assessment categories. However, no significant variation was noted between types of surgery, implying that surgical procedure type does not significantly impact the PG-SGA classification. These insights could be informative for tailoring nutritional interventions based on demographic factors.

By the third postoperative day (POD3), patients exhibited a significant reduction in both weight and calf circumference compared to the preoperative day (D0). On average, BMI decreased by  $-0.2 \pm 0.4$  kg/m<sup>2</sup>, and calf circumference reduced by  $6.1 \pm 2.2$  cm, both changes being statistically significant ( $p<0.05$ ). However, the mid-arm circumference (MAC) did not show a significant difference ( $p>0.05$ ) in either gender. In the initial three days after surgery, postoperative patients often receive intravenous fluids through the elbow veins, which can obscure the changes in MAC reflecting muscle mass reduction. Nevertheless, these observations are crucial for refining nutritional and rehabilitation strategies in postoperative care.

According to the PG-SGA classification, gastrointestinal cancer patients exhibited the highest rate of malnutrition prior to surgery. This contrasts with those suffering from breast, uterine adnexal, and other non-gastrointestinal cancers, who were generally well-nourished. These findings highlight the need for targeted nutritional interventions, particularly for patients with gastrointestinal malignancies, who may face increased risk due to disease-related factors affecting nutritional status. Understanding these differences is crucial for optimizing preoperative care and improving overall patient outcomes.

The results of this study also indicated that patients' food intake slightly decreased on the first day post-surgery but gradually increased, meeting their needs within four days. However, a tendency to decrease in both energy and protein levels was observed. This initial decrease can be attributed to the consumption of high-energy liquids (hospital soup or commercial preparations with an energy level of 1 kcal/ml) in the immediate postoperative period. By the fourth day, patients reverted to their usual dietary habits, leading to a reduction in energy and protein intake. These findings suggest that dietary guidance five days post-surgery is crucial to help patients achieve the necessary energy and protein levels from

regular foods. Moreover, for patients diagnosed with cancer, maintaining an adequate postoperative diet is essential to prepare for subsequent chemotherapy or radiation treatments.

Interestingly, we observed that the patients' muscle mass had lost even though the protein intake after operation was high. It was well known that calf circumference is positively correlated with Bio-electrical Impedance Analysis<sup>8</sup>, computed tomography<sup>9</sup> and dual-energy x-ray absorptiometry<sup>6</sup> measured muscle mass, so the calf circumference reduced in this study reflected the loss of muscle mass after surgery. In addition, there are published studies showing that loss of muscle mass is associated with worse outcomes in cancer patients<sup>10</sup>. Furthermore, following surgery, muscles and soft tissues will undergo a period of healing. Cachexia is the involuntary loss of muscle and adipose tissue that strongly affects mortality and treatment efficacy of cancer patients. So preserving muscles after surgery in cancer patients is challenging because currently, no specific treatments or interventions are available for patients with this disorder. And our study showed that the muscle preserved in cancer patients undergoing surgery did not only depend on protein and energy intake.

Although this report has limitations, such as missing details on clinical factors affecting nutritional status, length of stay, surgical procedures, postoperative infections, timing of first feeding, types of food provided, and patient tolerance, data collected at a specific cancer setting (Hanoi Oncology Hospital), future research could adopt this protocol across broader or specific populations, or in similar settings, to strengthen the evidence base for nutrition policies in Vietnam.

## CONCLUSION

In conclusion, our study found that patients with malnutrition prior to surgery had higher and longer need of parenteral nutrition support. Optimize nutrition status prior surgery and dietary intakes after surgery should be monitored and multidiscipline should be applied in order to reduce postoperative malnutrition and preserve the muscle mass. Special attention should be taken in GI cancer patients.

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## Research Article (FF17)

### Effects of Inulin on Metabolic Parameters in Sprague Dawley Rats Fed with High-Fat Diets

Thanyaporn Musan <sup>1</sup>, Nathamon Kosoltanapiwat <sup>2</sup>, Amornrat Aroonnual <sup>1</sup>, Kansuda Wunjuntuk <sup>3</sup>,  
Pattaneeya Prangthip <sup>2\*</sup>

<sup>1</sup> Department of Tropical Nutrition and Food Science, Faculty of Tropical Medicine, Mahidol University, Thailand

<sup>2</sup> Department of Microbiology and Immunology, Faculty of Tropical Medicine, Mahidol University, Thailand

<sup>3</sup> Department of Home Economics, Faculty of Agriculture, Kasetsart University, Thailand

#### ABSTRACT

Obesity, defined as a BMI  $\geq 25$  kg/m<sup>2</sup>, is a major public health issue that raises the risk of hypertension and cardiovascular diseases. Globally, obesity affects approximately 650 million adults and 340 million children, with notable increases in Thailand from 2012 to 2018. The researcher is interested in fiber to help reduce fat in the blood, helps the digestive system to function normally. This study investigates the effects of inulin, a fermentable fiber, on metabolic health parameters in rats fed a high-fat diet. Inulin, made up of fructosyl units, supports digestive health and may impact lipid metabolism and glucose regulation. Rats were divided into three groups: a control group (N), a high-fat diet group (HF), and a high-fat diet group supplemented with inulin (HF-IN). The experimental design included three phases: adaptation, induction, and treatment. Key parameters measured were blood glucose levels, liver function, renal function, lipid profiles, antioxidant activity, and cytokine levels. The HF-IN group exhibited a weight gain of 24%, slightly better than the HF group's 25%, though this difference was not statistically significant. Inulin supplementation reduced liver enzyme levels, suggesting potential liver protection. High-fat diet rats showed decreased creatinine clearance, indicating renal impairment. While inulin lowered blood glucose in some conditions, its overall impact on antioxidant capacity and cytokine levels was inconsistent. In conclusion, inulin demonstrates potential health benefits related to obesity, particularly in liver function and glucose level, but further research is warranted to clarify its effects on metabolic health.

**Key words:** obesity, high-fat diet, fiber, inulin, prebiotic, probiotic

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\* Correspondence: pattaneeya.pra@mahidol.edu

## INTRODUCTION

Obesity, defined as a body mass index (BMI)  $\geq 25 \text{ kg/m}^2$ , is a significant public health concern that increases the risk of various diseases, including hypertension and cardiovascular disorders. The global prevalence of obesity has reached epidemic proportions, affecting approximately 650 million adults and 340 million children<sup>1</sup>. In Thailand, obesity rates increased notably between 2012 and 2018<sup>2</sup>. The researcher is interested in fiber to help reduce fat in the blood, helps the digestive system to function normally, stimulate bowel movements, accelerate the excretion of waste from the body and some dietary fiber also helps to control sugar and cholesterol levels as well. Fiber is a type of carbohydrate that the body cannot digest. Though most carbohydrates are broken down into sugar molecules called glucose, fiber cannot be broken down into sugar molecules, and instead it passes through the body undigested. Fiber helps regulate the body's use of sugars, helping to keep hunger and blood sugar in check. Dietary fiber intake provides many health benefits. However, average fiber intakes for adults and US children are less than half of the recommended levels. Individuals with high intakes of dietary fiber appear to be at significantly lower risk for developing coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases. Increasing fiber intake lowers blood pressure and serum cholesterol levels. Increased intake of soluble fiber improves glycemia and insulin sensitivity in non-diabetic and diabetic individuals. Fiber supplementation in obese individuals significantly enhances weight loss. Increased fiber intake benefits a few gastrointestinal disorders including the following: gastroesophageal reflux disease, duodenal ulcer, diverticulitis, constipation, and hemorrhoids. Prebiotic fibers appear to enhance immune function<sup>3</sup>. The fibers that we are interested in is inulin. Inulin, composed of fructosyl units, is known to support digestive health and may play a role in lipid metabolism and glucose regulation. This study investigates the effects of inulin, a fermentable fiber, on metabolic health parameters in rats subjected to a high-fat diet. The hypothesis derived from previous research on inulin is that inulin will help manage obesity, reduce liver function levels<sup>4</sup>, and lower blood sugar levels<sup>5</sup>. The objective of this study is to evaluate the health benefits of inulin in rats subjected to a high-fat diet.

## MATERIALS AND METHODS

The study was approved by the Animal Care Ethical Committee of the Laboratory Animal Science Center, Faculty of Tropical Medicine, Mahidol University (Approval No FTM-ACUC 006/2021). All procedures were conducted according to the Guide for the Care and Use of Laboratory Animals published by the US National Institutes of Health.

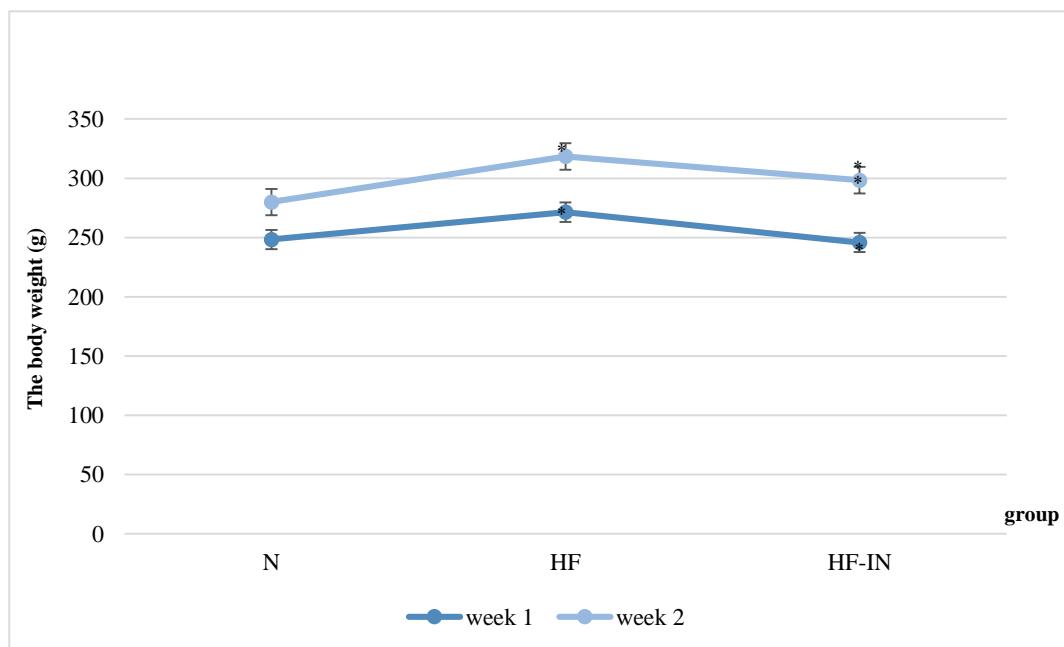
In this study, male Sprague-Dawley rats, aged 6 weeks and weighing between 210 and 235 grams, were utilized. These rats were procured from the National Laboratory Animal Center at Salaya

Campus, Mahidol University. The rats were raised with free access (ad libitum) to water and their respective diets, either ND or HFD, at the Faculty of Tropical Medicine, Mahidol University, in accordance with the rules and regulations of the Animal Care Ethical Committee of the Laboratory Animal Science Center, Faculty of Tropical Medicine, Mahidol University. The subjects were divided into three distinct groups: the control group (N), the high-fat diet group (HF), and the high-fat diet supplemented with inulin group (HF-IN). The experimental design comprised three phases: an adaptation phase, an induction phase, and a treatment phase. Our experimental plan involved adapting the rats for a period of two weeks. We divided the rats into three groups, with five rats in each group: a normal diet group, a high-fat diet group, and a high-fat diet group supplemented with inulin. During the induction phase, we fed the designated diets to each group. The normal diet consisted of 65% carbohydrates, 19% protein, and 16% fat, while the high-fat diet contained 43% carbohydrates, 17% protein, and 40% fat. The energy intake per rat was 88 Kcal for the normal diet and 102.73 Kcal for the high-fat diet. After two weeks of induction on the normal and high-fat diets, the rats in the third group were gavaged with inulin. The dosage of inulin is 0.5 g/kg based on dietary fiber intake recommendations<sup>6</sup>, calculated using the formula: dose = group dose/1000 x average weight. This treatment was administered weekly for four weeks. Following the treatment period, the rats underwent sacrifice procedures to collect organs and blood samples. Various parameters were meticulously measured, including blood glucose levels, liver function, kidney function, lipid profiles, antioxidant activity, and the levels of pro-inflammatory.

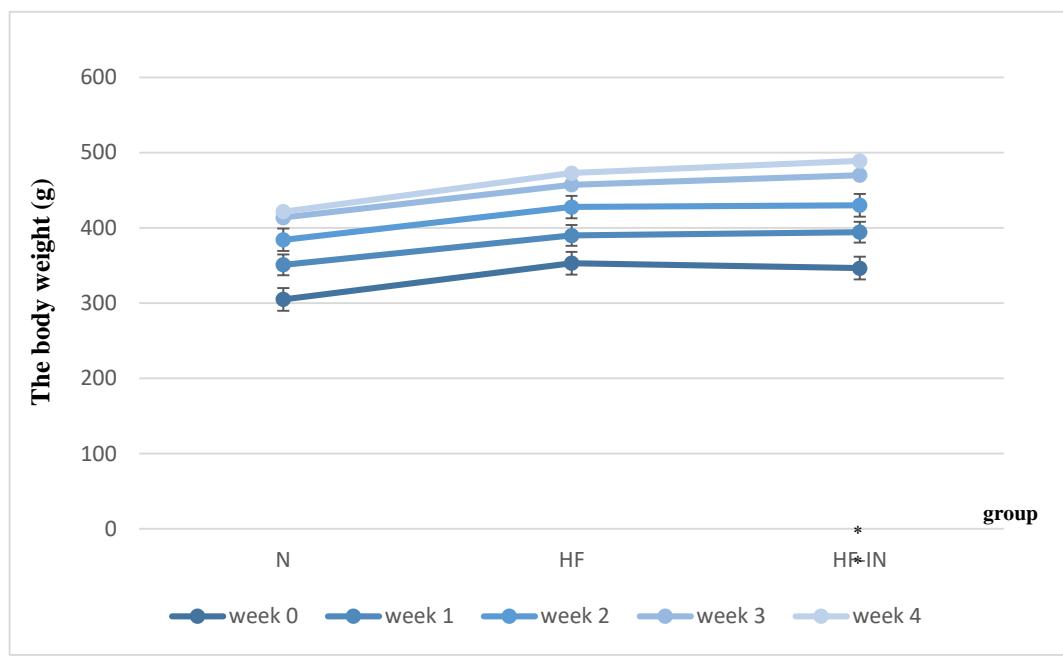
## RESULTS

The Sprague Dawley (SD) rats had similar mean initial body weight (221 - 230 g). After feeding with different types of diets for 4 weeks, the body weight of rat fed either a normal diet (ND) or a high-fat diet (HFD) was observed. All animals survived throughout the preliminary period. In the adaptation phase, rats acclimated to normal pellet food and a new environment, allowing them to adjust to the experimental setting. During the first and second weeks of this phase, the rats' weights ranged from 221-230 g and 244-271 g, respectively. After two weeks, the rats entered the induction phase. The first group was fed a normal diet (ND), while the second through sixth groups were fed a high-fat diet (HFD) to induce obesity according to the protocol for two weeks. During the third and fourth weeks, the weight of rats in the ND group ranged from 280-305 g, while the HFD group ranged from 298-353 g. The higher weight range of the rats in the HFD group compared to the ND group indicates that the HFD successfully induced obesity, (shown in **Figure 1**). Following the induction phase, the rats entered the treatment phase. Rats in group 3 were treated with inulin. The weight gains in the normal (non-disease) group was 19%, which was less than the 25% gain observed in the high-fat (disease) group. Rats in group 3 (HF-IN) gained 24% (**Figure 2**). Inulin demonstrates potential in mitigating liver cell damage associated with high-fat diet consumption,

as evidenced by decreased levels of ALT and AST in the group receiving inulin. However, further studies are warranted to confirm these findings and to investigate the specific mechanisms underlying inulin's effects, as well as to determine the appropriate dosage for effective application (**Figure 3**). Additionally, inulin may enhance kidney function, as indicated by reduced creatinine levels in the group supplemented with inulin. Nonetheless, further research is essential to validate these results and to elucidate the precise mechanisms through which inulin contributes to improved renal function (**Figure 4**). Inulin also shows promise in lowering blood sugar levels, particularly in individuals consuming a high-fat diet. However, additional studies are required to confirm these outcomes and to better understand the mechanisms by which inulin regulates blood glucose levels (**Figure 5**). The experimental findings suggest that a high-fat diet negatively impacts blood lipid profiles, and the administration of inulin in this context may not lead to significant improvements in lipid profiles. Moreover, inulin supplementation (HF-IN) did not enhance the body's antioxidant activity compared to the high-fat diet group (HF). In fact, the HF-IN group exhibited lower antioxidant activity than several other groups, potentially due to various factors, including the dosage and type of inulin utilized or interactions between inulin and other nutrients within the body. The antioxidant activity is no significant. Inulin administration in the high-fat diet group affected levels of the cytokine IL-6 but did not significantly alter TNF- $\alpha$  levels. These results suggest that inulin may play a role in modulating inflammation.

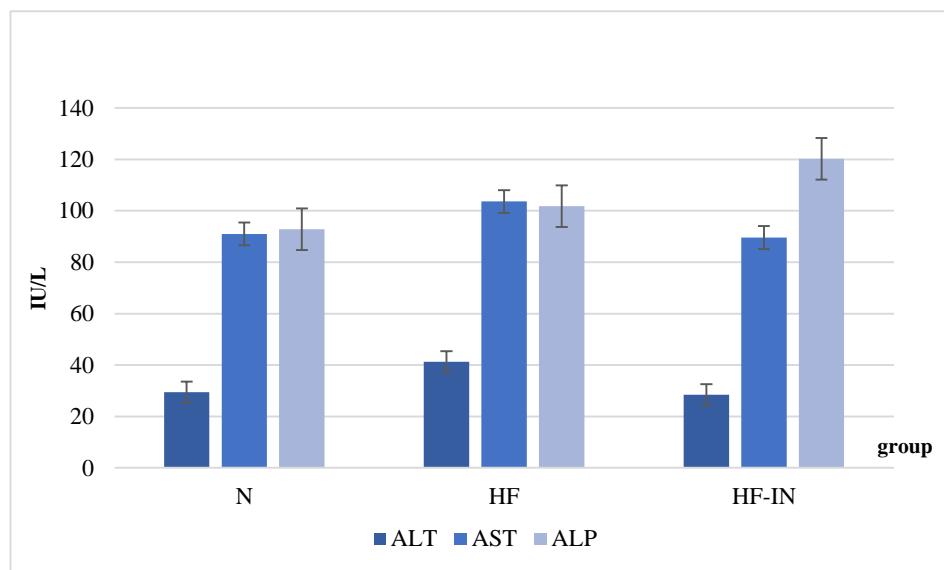


**Figure 1.** The body weight (g) of each group in induction phase

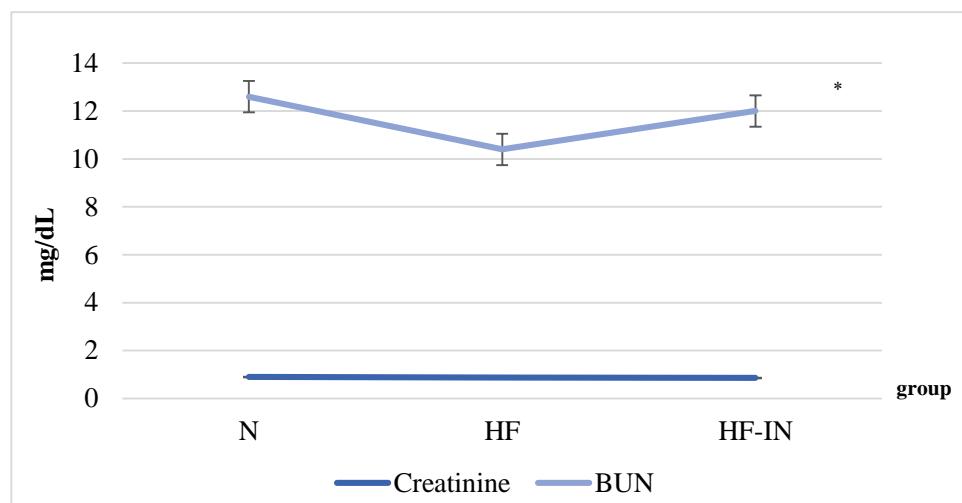


**Figure 2.** The body weight (g) of each group in treatment phase. \* $p < 0.05$

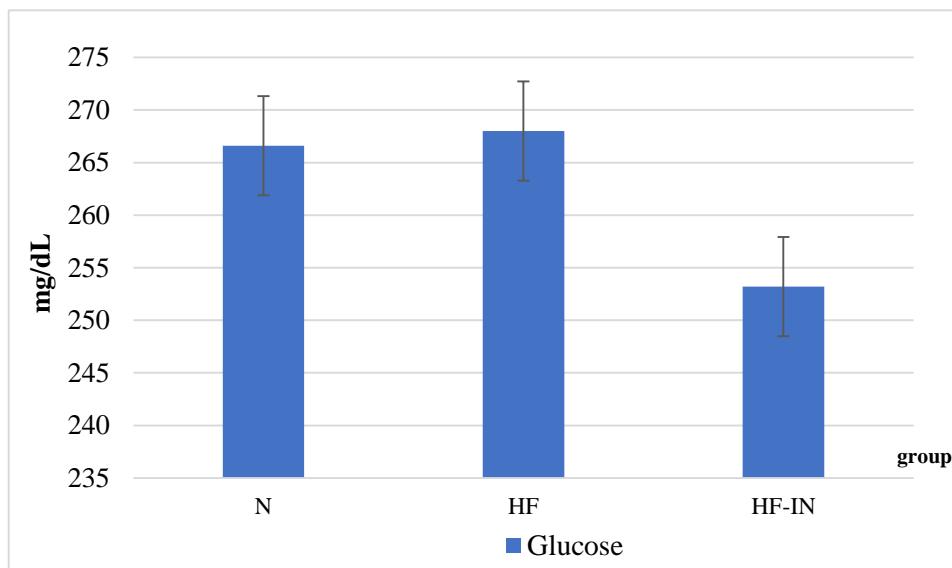
represent significant difference compared with the normal group (N)



**Figure 3.** The level of liver function in rat for each group



**Figure 4.** The level of renal function in rat for each group



**Figure 5.** The level of glucose in rat for each group

## DISCUSSION

The findings of this study highlight the impact of inulin on metabolic health in Sprague Dawley rats fed high-fat diets. Initially, the successful induction of obesity through high-fat diets was evidenced by the weight gains of the HFD group, which significantly exceeded those of the normal diet (ND) group. This aligns with previous studies demonstrating that high-fat diets can lead to increased body weight and obesity in rodent models<sup>7</sup>. Inulin supplementation showed promise in mitigating liver cell damage, indicated by decreased levels of liver enzymes ALT and AST in the inulin-treated group. These results are consistent with earlier research that supports the hepatoprotective effects of inulin and other dietary fibers in reducing liver inflammation and damage<sup>4</sup>. However, further studies are necessary to elucidate the mechanisms through which inulin exerts these protective effects and to establish optimal dosages for clinical relevance. Additionally, the study found that inulin might enhance kidney function, as suggested by reduced creatinine levels in the supplemented group. This finding is significant given the known associations between obesity, high-fat diets, and renal impairment<sup>8</sup>. Moreover, the potential of inulin to lower blood sugar levels, particularly in high-fat diet consumers, is noteworthy. Previous studies have reported that inulin can modulate glycemic responses, potentially through mechanisms involving increased insulin sensitivity and improved gut microbiota composition<sup>9</sup>. Despite these promising results, additional research was needed to confirm these findings and to explore the specific biochemical pathways involved. While inulin supplementation did not lead to significant improvements in blood lipid profiles, it was essential to consider that dietary interventions could have varied effects on lipid metabolism. The level of antioxidant activity indicated how effectively the product we were interested in, specifically Inulin, could counteract free radicals. It was observed that the antioxidant levels in the HF-IN group were not significantly different from those in other samples, which may have been due to the short duration of the experiment. In future studies, it might have been necessary to extend the duration or adjust the concentration of the substances to achieve clearer results for lipid profile and antioxidant activity<sup>10</sup>. Inulin supplementation did not significantly reduce TNF- $\alpha$  levels compared to the high-fat group (HF), suggesting that the inflammatory effects of a high-fat diet may outweigh the potential anti-inflammatory benefits of inulin in this context. Additionally, IL-6 levels remained consistent across all groups, indicating that the dietary interventions selectively influenced TNF- $\alpha$  production. These findings highlight the complexity of dietary influences on inflammation and underscore the need for further investigation into the underlying mechanisms<sup>11</sup>.

## CONCLUSION

In conclusion, the study conducted on Sprague Dawley rats indicates that a high-fat diet effectively induces obesity, as evidenced by the significant weight gain observed in the high-fat diet (HFD)

group compared to the normal diet (ND) group. Inulin supplementation appears to offer potential benefits in mitigating liver cell damage, enhancing kidney function, and reducing blood sugar levels among rats on a high-fat diet. However, the effects of inulin on blood lipid profiles and antioxidant activity were not significant, highlighting the necessity for further research to clarify its role in these areas. Additionally, inulin's impact on inflammatory cytokines suggests its potential as an anti-inflammatory agent, although the underlying mechanisms require further investigation. Overall, it was evident that Inulin had an impact on weight loss, reduced liver damage levels, improved kidney function levels, and lowered blood sugar levels compared to the high-fat (HF) group. The findings from this study could be applied to consumption practices or serve as an additional option for preventing obesity.

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## Research Article (FF18)

### Correlation Between Dietary Diversity, Fermented Food Intake, and Blood Glucose Control in Patients with Type 2 Diabetes

Annisa Rizky Maulidiana<sup>1\*</sup>, Anisa Wahyuni<sup>1</sup>, Annisa Mayang Soliha<sup>1</sup>, Olivia Anggraeny<sup>1</sup>,

Catur Saptaning Wilujeng<sup>1</sup>

<sup>1</sup>Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia

#### ABSTRACT

Fermented foods are widely recognized for their health benefits and have become an integral part of diets across many cultures, including Indonesia. Incorporating a diverse range of foods into the daily diet can help control blood glucose levels, which may be beneficial for diabetes management. This study aimed to investigate the relationship between local fermented food consumption, dietary diversity, and blood glucose control in diabetic patients. A cross-sectional survey was conducted with thirty outpatients with type 2 diabetes mellitus from private clinics in Lampung, Indonesia. Body mass index was performed to evaluate nutritional status. Dietary intake was assessed using a 24-hour recall and a semi-quantitative food frequency questionnaire to determine patterns of fermented food consumption and individual dietary diversity scores (IDDS). Fasting blood glucose (FBG) levels were measured monthly over a three-month period and averaged. The majority of respondents were classified as obese class 1 (66.7%) and had uncontrolled FBG (63.3%). The mean IDDS was moderate,  $5.23 \pm 2.83$ . The most frequently consumed food groups included starchy staples, other fruits and vegetables, legumes, nuts and seeds, and fish and seafood. On average, respondents consumed 5 to 6 types of fermented foods over the past three months, with soybean tempeh being the most commonly consumed. Significant positive correlations were observed between fermented food consumption ( $r = 0.696$ ;  $p < 0.001$ ), food diversity ( $r = 0.649$ ;  $p < 0.001$ ), and FBG control. This study suggests that a diverse diet, including adequate consumption of fermented foods, may benefit diabetes management. Incorporating a variety of foods could improve blood glucose control in diabetic patients.

**Keywords:** blood glucose control, diabetes, dietary diversity, fasting blood glucose, fermented food

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\* Correspondence: annisarizky@ub.ac.id

## INTRODUCTION

Diabetes mellitus type 2 (T2DM) is a chronic metabolic disorder characterized by insulin resistance and elevated blood glucose levels. Its prevalence is rapidly increasing both globally and in Indonesia, where it now affects a significant portion of the population, reflecting a growing public health challenge. The International Diabetes Federation (IDF) Diabetes Atlas (2021) indicates that 10.5% of adults aged 20-79 years are affected by diabetes and this prevalence is projected to rise to 19.9% by 2045 <sup>1</sup>. Within the Southeast Asia region, Indonesia is ranked third, with a prevalence of 11.3% <sup>2</sup>. Nationally, data from the Indonesia Basic Health Research reveal a significant increase in diabetes prevalence, rising from 6.9% in 2013 to 8.5% in 2018 <sup>3</sup>.

Current dietary guidelines for individuals with diabetes in Indonesia was using the Balanced Nutrition Guide that emphasizes whole grains, fruits, vegetables, and lean proteins, while restricting the intake of refined sugars and saturated fats. Diabetics are encouraged to monitor their dietary pattern (time, type, and portion) especially carbohydrate intake to maintain optimal glycemic control <sup>4</sup>. Dietary diversity, which encompasses a range of different food types consumed regularly, has been associated with better health outcomes, including lower risks of chronic diseases. The diversity of food consumed plays an important role in T2DM management <sup>5</sup>. Prior studies have indicated that individuals who reported consuming diets with only two or fewer food groups per week face a higher risk of mortality. Conversely, those who adhered to dietary guidelines by including items from all five food groups experienced a reduced risk of developing T2DM <sup>5-7</sup>. Furthermore, individuals who regularly consumed a diverse food group within the fruit and vegetable categories also demonstrated a lower risk of T2DM <sup>8,9</sup>. Despite the recognized importance of diet in managing T2DM, adherence to dietary recommendations remains a significant challenge.

Consumption of fermented foods is one of the potential dietary strategies that may contribute to better management of diabetes. Fermentation process enhances the nutritional value and digestibility of foods, which helps reduce the risk of T2DM complications. Incorporating fermented foods in daily diet can significantly reduce diabetes-related health complications by increasing the antioxidant capacity and improving inflammatory response <sup>10-12</sup>. Fermented foods also have demonstrated the potential to improve various metabolic parameters, including fasting blood glucose and homeostasis model assessment of insulin resistance (HOMA-IR) in individuals with prediabetes and diabetes <sup>12</sup>.

In Indonesian cuisine, and specifically within Lampung culture, fermented foods play a central role. Traditional fermented products from Lampung include cassava tapai, glutinous rice tapai, pickled vegetables, pickled fruits, soybean tempeh, and tempoyak or bekasam (fermented durian), all of which reflect the region's rich culinary heritage. By understanding how dietary diversity and fermented food consumption interact with diabetes risk is vital for developing targeted dietary recommendations and public health strategies in Indonesia. Therefore, the aim of this study was to investigate the relationship between dietary diversity, fermented foods intake, and blood glucose control in type 2 diabetic patients.

## METHODS

### Study design and participants

This was an observational analytic study using cross-sectional approach conducted between July and November 2021. The participants involved thirty adult patients diagnosed with diabetes mellitus in private clinics in Bandar Lampung, Lampung Province, Indonesia. Participants were selected through total sampling and met all inclusion criteria. All patients above 18 years of age with type 2 diabetes mellitus and had a regular blood glucose check within the last three months were approached for potential enrollment in the study. After given important information about the study and signed a written informed consent to participate, the patient was interviewed. Excluded were patients below 18 years of age, current usage of probiotic or prebiotic supplements, were on certain diets such as strict vegetarian or vegan diets, had food allergies or intolerances, had chronic gastrointestinal conditions, and recent antibiotic use. This study was approved by the Health Research Ethics Committee of the Tanjungkarang Health Polytechnic, Indonesia (No. 242/KEPK-TJK/X/2021).

### Data collection

All study participants underwent comprehensive assessments including anthropometric measurements, laboratory data collection, and dietary intake evaluation. Anthropometric variables were measured by recording body weight and height using standardized procedures. Weight was measured to the nearest 0.1 kg with a digital scale (GEA-EB9360, China), and height was measured to the nearest 0.1 cm using a stature meter (GEA Medical SH-2A, China). Each measurement was performed in duplicate by trained enumerators to ensure accuracy. Body Mass Index (BMI) was calculated as weight (kg) divided by the square of height (m), and classified according to the BMI category in Asia-Pacific <sup>13</sup>.

Fasting blood glucose (FBG) level was determined using digital glucometer regularly each month (Accu-Chek, Roche Diabetes Care, Inc., USA). The average value of FBG levels in the three months then categorized as "controlled" if <126 mg/dL and "uncontrolled" if >126 mg/dL. A 1 x 24-hour recall and semi-quantitative food frequency questionnaire (SQ-FFQ) was used to assess dietary data. The SQ-FFQ concerns the total types and amounts of food consumed by respondents in the last 3 months. The food list in the SQ-FFQ was previously pilot-tested within the diabetic patient community in Lampung City and was compared to a 24-hour dietary recall method to ensure its validity. The dietary diversity was measured using the Individual Dietary Diversity Score (IDDS) based on the dietary recall, which involves categorizing the participants' intake into nine food groups. A score of 1 was assigned if the participants consumed one or more types of food from each group in an amount of >15 grams; and a score of 0 was given if the amount consumed was <15 grams or if the food group was not consumed at all. The food consumption diversity scores were then summed and assessed: a total score of <3 food groups were classified as "low DDS", 4-5 food groups as "medium DDS", and >6 food groups as "high DDS" <sup>14</sup>.

The types of fermented foods included in this study were selected based on those recognized and commonly consumed by the Lampung community, as determined during the preliminary study. Fermented foods were identified in five groups out of nine food groups, including seeds and tubers, animal proteins, plant proteins, vegetables and fruit, as well beverages. Data was analyzed to determine the types of fermented foods frequently consumed. Frequency of fermented foods was the classified as often, if consumed <1x/day; rarely, if 4-6x/week, 1-3x/week, or 1-3x/month; and never<sup>15</sup>. Then, the number of portions per day is known based on the conversion in grams presented in the average daily consumption.

### **Data analysis**

All analyses were conducted using Statistical Package for the Social Sciences (SPSS) 25. Data are presented as mean $\pm$ SD or n (%). Association between the DDS and the sociodemographic characteristics of the participants was tested using Pearson chi-square and Fisher's exact test. Significant mean difference of DDS across the characteristics was assessed using Least Significant Difference (LSD). Spearman's rank correlation test was used to evaluated the bivariate association between studied variables. Statistical significance was set at p-value less than 0.05.

## **RESULTS**

A total of 30 participants were included in the study, with 50% male (**Table 1**). The mean age was  $65.85\pm9.99$  years, with 72% aged 60 years or older. Majority of participants had completed tertiary education, were not currently employed (70.0 %), and had a family history of diabetes (83.3%). The mean duration of diabetes among participants was  $6.75\pm3.88$  years, with 63.3% classified as having uncontrolled fasting blood glucose level. The average body mass index was  $26.08 \text{ kg/m}^2$ , with most participants (66.7%) were classified as obese class I.

**Table 1.** Characteristics of the study participants

Characteristics	n (%)	Mean±SD
Gender		
Male	15 (50.0)	
Female	15 (50.0)	
Age, years		65.85±9.99
<60	14 (28.0)	
>60	16 (72.0)	
Educational Level		
None/Primary	4 (13.3)	
Secondary	5 (16.7)	
Tertiary	21 (70.0)	
Working status		
Working	9 (30.0)	
Not working	21 (70.0)	
Monthly income		
< RMW <sup>1</sup>	16 (53.3)	
> RMW	14 (46.7)	
Duration of diabetes, years		6.75±3.88
<5	9 (30.0)	
5 – 9.9	13 (43.3)	
>10	8 (26.7)	
Family history of diabetes		
Yes	25 (83.3)	
No	5 (16.7)	
Fasting blood glucose, mg/dl		146.06±27.21
Controlled <sup>2</sup>	11 (36.7)	
Uncontrolled	19 (63.3)	
Weight, kg		65.85±9.99
Height, cm		159.01±7.80
Body mass index, kg/m <sup>2</sup>		26.08±3.69
Normal <sup>3</sup>	7 (23.3)	
Overweight	2 (6.7)	
Obese I	20 (66.7)	
Obese II	1 (3.3)	

<sup>1</sup> RMW: Regional Minimum Wage of Lampung City 2021, IDR 2,700,000; <sup>2</sup> Controlled if <126 mg/dL and uncontrolled if >126 mg/dL;<sup>3</sup> Normal, 18.0 – 22.99 kg/m<sup>2</sup>, Overweight, 23 - 24.9 kg/m<sup>2</sup>, Obese I, 25 – 29.9 kg/m<sup>2</sup>, Obese 2, >29.9 kg/m<sup>2</sup>

**Table 2** reveals the distribution of study participants by their dietary diversity score (DDS). All participants (100%) reported the daily consumption of starchy staples as well as legumes, nuts, and seeds food groups. Second most consumed was the other fruits and vegetables (43.3%). One-third of the participants consumed dark green leafy vegetables, vitamin A-rich fruits and vegetables, meat and fish, and milk food groups. Less commonly consumed food groups were eggs (26.7%) and organ meat (3.3%).

**Table 2.** Distribution of participants according to the dietary diversity score

Food Group	n(%)
Starchy staples <sup>1</sup>	30 (100.0)
Dark green leafy vegetables	10 (33.3)
Other vitamin A rich fruits and vegetables <sup>2</sup>	9 (30.0)
Other fruits and vegetables	13 (43.3)
Organ meat	4 (13.3)
Meat and fish	11 (36.7)
Eggs	8 (26.7)
Legumes, nuts and seeds	30 (100.0)
Milk and milk products	9 (30.0)

<sup>1</sup> The starchy staples food group is a combination of cereals and white roots and tubers; <sup>2</sup> The other vitamin A rich fruits and vegetables group is a combination of vitamin A rich vegetables and tubers and vitamin A rich fruit (FAO, 2011)

The average food groups consumption was  $5.23 \pm 2.83$ , indicating a moderate dietary diversity. The minimum number of food groups consumed daily was 2, while the maximum was 11. Almost half of participants had low DDS (43.3%), followed by high DDS (40.0%) and medium DDS (16.7%). The study participants' DDS distribution across their characteristics was displayed in **Table 3**.

**Table 3.** Distribution of IDDS according to the participants' characteristics

Variables	IDDS category			p	IDDS (Mean±SD)
	Low	Medium	High		
<b>Gender</b>					
Male	6 (20.0)	3 (10.0)	6 (20.0)	0.871	5.40±2.82
Female	7 (23.3)	2 (6.7)	6 (20.0)		5.07±2.91
<b>Age, years</b>					
<60	4 (13.3)	4 (13.3)	6 (20.0)	0.165	5.50±2.50
≥60	9 (30.0)	1 (3.3)	6 (20.0)		5.00±3.14
<b>Educational level</b>					
None/Primary	4 (13.3)	0 (0.0)	0 (0.0)		2.75±0.50 <sup>a</sup>
Secondary	3 (10.0)	1 (3.3)	1 (3.3)	0.037	3.80±1.30 <sup>b</sup>
Tertiary	6 (20.0)	4 (13.3)	11 (36.7)		5.53±2.95 <sup>c</sup>
<b>Working status</b>					
Employed	1 (3.3)	4 (13.3)	4 (13.3)	0.051	5.89±2.26
Non-employed	12 (40.0)	1 (3.3)	8 (26.7)		5.02±3.32
<b>Monthly income</b>					
< RMW <sup>1</sup>	12 (40.0)	1 (3.3)	3 (10.0)	0.001	3.88±2.60 <sup>a</sup>
> RMW	1 (3.3)	4 (13.3)	9 (30.0)		6.79±2.26 <sup>b</sup>
<b>Duration of diabetes, years</b>					
<5	3 (10.0)	3 (10.0)	3 (10.0)		5.33±2.69
5 – 9.9	5 (16.7)	2 (6.7)	6 (20.0)	0.401	5.38±2.96
>10	5 (16.7)	0 (0.0)	3 (10.0)		4.88±3.09
<b>Blood glucose control, mg/dL</b>					
Controlled	0 (0.0)	0 (0.0)	11 (36.7)	<0.001	8.27±1.55 <sup>a</sup>
Uncontrolled	13 (43.3)	5 (16.7)	1 (3.3)		3.47±1.61 <sup>b</sup>
<b>Body mass index</b>					
Normal	3 (10.0)	1 (3.3)	3 (10.0)		5.57±2.94
Overweight	0 (0.0)	1 (3.3)	1 (3.3)	0.656	8.00±4.24
Obese I	10 (33.3)	3 (10.0)	7 (23.3)		4.65±2.56
Obese II	0 (0.0)	0 (0.0)	1 (3.3)		9.00±0.00

Chi-square and fisher's exact test were used to determine the p-values; <sup>1</sup> RMW: Regional Minimum Wage of Lampung City 2021, IDR 2,700,000; <sup>abc</sup> Different superscripts between rows within each variable indicate significant mean±SD IDDS difference

Dietary diversity score was found significantly different within educational level, monthly income, and blood glucose control. Educational attainment had a notable impact, with participants having tertiary education achieving the highest IDDS mean (5.53±2.95), while those with no formal education had the lowest (2.75±0.50). Working status showed borderline statistical significance in the distribution between

employed and non-employed individuals across the groups, suggesting that those who were employed had a higher average IDDS. Participants with higher income had better dietary diversity ( $6.79 \pm 2.26$ ) than lower ones ( $3.88 \pm 2.60$ ). Notably, participants with controlled fasting glucose levels had a significantly higher mean IDDS ( $8.27 \pm 1.55$ ) compared to those with uncontrolled levels ( $3.47 \pm 1.61$ ). Body mass index did not show a significant relationship with IDDS, although variations were observed across different weight categories.

**Table 4** presents the distribution of fermented food consumption among participants. The results indicate that tempeh was consumed by all respondents, making it the most commonly and most consumed reported fermented food. Other frequently consumed items included shrimp paste (80%), oncom (70%), and cassava tapai (66.7%). In contrast, glutinous rice tapai was the least consumed, with only 26.7% of respondents reporting its intake. The findings indicate that the most frequently consumed fermented foods included those derived from both animal and plant protein sources, as well as carbohydrate sources such as tubers.

**Table 4.** Distribution of participants according to the fermented foods intake

Food Group	n (%)	Mean $\pm$ SD (g/day)
Soybean tempeh	30 (100.0)	203.36 $\pm$ 170.55
Shrimp paste	24 (80.0)	4.4 $\pm$ 5.12
Oncom	21 (70.0)	20.9 $\pm$ 41.89
Cassava tapai	20 (66.7)	8.19 $\pm$ 11.3
Pickled vegetables	19 (63.3)	8.84 $\pm$ 15.69
Salted egg	15 (50.0)	7.5 $\pm$ 19.41
Tempoyak/bekasam	12 (40.0)	2.69 $\pm$ 4.95
Cheese	11 (36.7)	2.29 $\pm$ 3.52
Yogurt	9 (30.0)	6.88 $\pm$ 2.29
Glutinous rice tapai	8 (26.7)	3.24 $\pm$ 6.38

On average, respondents consumed 5 to 6 types of fermented foods daily, with the highest consumption was 8 types and the lowest was 4 types. Compared to the average daily consumption of all food groups, the majority of participants (66.7%) reported rarely consuming fermented foods, whereas 33.3% of participants indicated that they frequently consumed with more than one portion daily.

**Table 5.** Spearman's correlation coefficients between dietary diversity, fermented foods intake, and blood glucose control

	<b>p</b>	<b>p</b>
Dietary diversity	0.665	<0.001
Fermented foods intake	0.695	<0.001

The correlation test results between dietary diversity, fermented food consumption, and blood glucose control are shown in **Table 5**. A strong positive correlation was found between dietary diversity and blood glucose control ( $p=0.649$ ,  $p<0.001$ ) and between fermented food consumption and blood glucose control ( $p=0.695$ ,  $p<0.001$ ). These findings indicate a significant correlation between both dietary diversity and fermented food intake with improved blood glucose regulation in T2DM patients.

## DISCUSSION

The current study investigated the correlation between dietary diversity, fermented food intake, and blood glucose control in patients with T2DM in Lampung, Indonesia. The participants in this study were predominantly elderly, had a family history of diabetes, and fell into the category of obesity class I. As individuals age, the risk of developing T2DM increases, particularly among those over 45. Aging resulted in gradual decline of the glucose homeostasis regulation, eventually lead to impaired glucose tolerance and T2DM <sup>16</sup>. Individuals with a family history of diabetes are at greater risk than those without<sup>17,18</sup>. Being overweight deteriorates these disruptions, contributing to the mechanisms of insulin resistance observed in individuals with T2DM <sup>17</sup>. This risk is further exacerbated by lifestyle factors such as physical inactivity, poor diet, decreased muscle mass, and increased body weight <sup>16,19</sup>. While this study includes elderly individuals with obesity, it is important to note that participants had a long history of diabetes. This indicates that lifestyle factors likely influence their metabolic outcomes more than age.

The mean IDDS obtained in this study was 5.23 out of 9 food groups, indicating a moderate diverse dietary pattern. Similar with previous study in Côte d'Ivoire <sup>20</sup> and Bangladesh <sup>21</sup>, most of diabetic patients had a moderate IDDS. The IDDS is particularly useful in dietary assessments as it helps identify populations at risk of poor nutrition due to a lack of dietary variety <sup>14</sup>. Most participants in this study had diabetes for over five years, leading to established dietary habits that prioritize staple foods and legumes while often avoiding animal-based protein sources, which refer as "diabetic diet" <sup>8</sup>. According to the participants, they perceived that adequate protein can be obtained from plant-based foods and concerns over the high sugar content in dairy products, which could exacerbate diabetes and contribute to obesity. This is in accordance with previous studies showing that diabetic adults prefer vegetables, staple foods, and fish while limiting their intake of meats, poultry, processed products, and dairy due to fears of weight gain and increased blood glucose levels <sup>8, 21, 22</sup>.

This study reveals that IDDS was significantly differ by educational level, monthly income, and fasting blood glucose control categories. Previous studies have demonstrated that a high proportion of individuals with T2DM do not adhere to national dietary guidelines<sup>8, 20, 21</sup>. Most participants in this study with tertiary education exhibited the highest IDDS, suggesting a correlation between higher education and improved dietary practices. Additionally, the data indicate that those with higher monthly incomes tend to maintain a more diverse diet, underscoring the influence of socioeconomic status on dietary choices in diabetic patients<sup>8, 21</sup>. A strong, positive correlation between fasting blood glucose control and IDDS was evident, with those maintaining controlled glucose levels exhibiting substantially higher diversity in their diets. This finding aligns with previous studies showed that higher IDDS is associated with better glycemic control in diabetic patients and lower incident of T2DM<sup>6, 21, 24</sup>. Enhanced dietary diversity may provide a broader range of essential nutrients and phytochemicals, which can positively impact metabolic health and glucose regulation<sup>7, 8, 24</sup>.

The average daily consumption of fermented foods in this study was highest for tempeh, indicating it is the most frequently consumed fermented item among participants. Tempeh offers excellent nutritional benefits, including increased digestibility and a significant rise in arginine, which is beneficial for diabetes management. Aglycones produced during fermentation help regulate blood sugar by affecting the beta-glucosidase enzyme<sup>25, 27</sup>. The second most consumed was oncom, a fermented by-product of soymilk, also known to benefit diabetic patients. Oncom possess significant antioxidant activity due to presence of isoflavones and carotenoids<sup>27</sup>. Tapai, and pickled vegetables were consumed as side dishes or snacks, while shrimp paste and tempoyak served primarily as condiments. Yogurt and cheese were consumed the least, likely reflecting their limited integration into the diets of the elderly participants. Even though consumed in small portions, these fermented foods have shown beneficial effects in maintaining blood glucose levels<sup>28</sup>.

Understanding the recommended consumption of fermented foods is crucial for health, particularly regarding T2DM. Prior study suggested the daily intake guidelines for various fermented foods, including cereals (129 g), grains (143 g), fermented milk (171 g), yogurt (176 g), cheese (0.1 g), and buttermilk (41.9 g)<sup>28</sup>. Consuming 48-89 g of fermented cereals daily (equivalent to 3-5 servings) can reduce the risk of T2DM by 26%. This effect is attributed to improvements in blood glucose control and reduced peripheral insulin resistance, emphasizing that a diet rich in grains and cereals can enhance insulin sensitivity and help manage blood sugar levels<sup>29</sup>. In accordance with this, our present study also showed that there were strong and positive correlation between fasting blood glucose control and fermented foods intake. Indonesians have a longstanding appreciation for fermented foods, yet awareness of their health benefits remains limited. Studies have also shown a significant relationship between fermented food intake and reduced insulin resistance, highlighting benefits such as weight loss and improvements in body mass index and blood pressure<sup>11, 30, 31</sup>. Despite the promising findings, further research is needed to develop specific dietary guidelines for fermented food consumption in relation to glucose control.

This study has several limitations. First, the small sample size may limit the generalizability of the findings. The cross-sectional design further restricts our ability to establish causal relationships. While all relevant confounding variables, such as age, sex, duration of diabetes, and lifestyle factors, were collected, the predominance of elderly participants with obesity may influence dietary patterns and health outcomes differently than in younger or non-obese populations. This demographic characteristic could limit the applicability of the results to a broader population. Additionally, the participants, all with T2DM, had regular check-ups, indicating that their dietary patterns might have been influenced by these interactions. The impact of anti-diabetic medications on dietary patterns was not evaluated, which represents a significant oversight, as these medications can alter nutritional needs and behaviors. The dietary assessment methods employed, including the 24-hour recall and FFQ, are susceptible to recall bias, particularly among participants with less diverse diets who may struggle to accurately report their food intake.

Acknowledging the limitations, to the best of our knowledge, this is the first study to evaluate the relationship between dietary diversity, fermented food intake, and blood glucose control among diabetic patients in Lampung City, Indonesia. The participant selection process was clearly outlined, and to reduce the potential for recall bias, standardized data collection methods were implemented. Future research should aim to include larger, more diverse samples and consider longitudinal designs to better account for these limitations and further investigate the relationships between dietary patterns and health outcomes.

## CONCLUSION

In conclusion, this study emphasizes the significant correlation between dietary diversity, fermented food consumption, and blood glucose control in patients with type 2 diabetes mellitus. The higher diversity of diet, characterized by the intake of multiple food groups, is positively correlated with improved blood glucose regulation. Similarly, the consumption of fermented foods is associated with better glucose control. These findings suggest that promoting a diverse diet, particularly one that includes fermented foods, may be serve as beneficial strategies by improving glycemic control and other metabolic outcomes in diabetic patients.

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## Research Article (FF19)

### The Relationship between Macronutrient Intake, Metabolic Profiles, and Wound Severity in Diabetic Foot Ulcer Patients

Anggun Rindang Cempaka<sup>1\*</sup>, Kanthi Permaningtyas Tritisari<sup>1</sup>, Ayuningtyas Dian Arestiningsih<sup>1</sup>,  
Rowan Laili Dwi Puspita Rini<sup>1</sup>, Armavia Nisrina<sup>1</sup>, Sheila Sabina Fadiyatus Zahroh<sup>1</sup>

<sup>1</sup>Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, East Java, Indonesia

#### ABSTRACT

Nutrition and metabolic management play a critical role in treating diabetic foot ulcers (DFU). However, the relationship between these factors and wound severity is not fully understood. This study aimed to explore the relationship between macronutrient intake, metabolic profiles, and wound severity in DFU patients in the Malang Raya area. This cross-sectional study involved 34 DFU patients from the Malang Raya area. The Wagner classification was used to assess wound severity. Macronutrient intake was recorded using a validated Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) based on dietary patterns over the past 3 months. Metabolic profile data, including blood glucose, HbA1C, and serum albumin, were obtained from venous blood vessels, while blood pressure measurements were collected using a digital sphygmomanometer. Spearman correlation analysis was performed to evaluate the relationship between macronutrient intake, metabolic profile, and wound severity. The Kruskal-Wallis test analyzes the differences in dietary intake and metabolic profiles across varying wound severities. Higher carbohydrate intake was found to be positively correlated with greater wound severity ( $r=0.469$ ,  $p=0.005$ ), whereas serum albumin levels were negatively correlated with wound severity ( $r=-0.640$ ,  $p<0.001$ ). The Kruskal-Wallis test confirmed significant differences in energy intake ( $p=0.048$ ), carbohydrate intake ( $p=0.044$ ), and serum albumin ( $p=0.006$ ) across different levels of wound severity. Patients with more severe wounds tended to have higher carbohydrate intake and lower serum albumin levels. The study highlights significant correlations between macronutrient intake, metabolic profiles, and wound severity in DFU patients. These findings underscore the importance of tailored nutritional and metabolic management in improving wound outcomes and managing diabetic foot ulcers effectively.

**Key words:** Diabetic Foot Ulcer, Macronutrient Intake, Metabolic Profile, Wound Severity

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\* Correspondence: cempakaanggun@ub.ac.id.

## INTRODUCTION

Diabetes Mellitus (DM) is one of the chronic metabolic diseases that impacts global health. The prevalence of DM continues to rise each year, especially in developing countries. In 2016, World Health Organization reported that a total of 422 million people were suffering from DM <sup>1</sup>. According to International Diabetes Federation data, Indonesia ranked 5th among countries with the highest number of DM cases in 2021, with 19.5 million people aged 20 to 79 affected by the condition <sup>2</sup>. DM is characterized by chronic hyperglycemia due to pancreas's inability to produce sufficient insulin which then affecting insulin secretion, insulin action, or both <sup>3, 4</sup>.

Diabetic Foot Ulcer (DFU) is one of conditions arising from various chronic microvascular complications of DM, characterized by the formation of deep tissue lesions in the lower limbs <sup>5</sup>. DFU is a prevalent and serious condition that threatens limb health and significantly contributes to illness and hospitalization for diabetic patients <sup>6</sup>. Around 15 – 25% of those with diabetes will develop diabetic foot at some point in their lives <sup>7</sup>. Long-term uncontrolled hyperglycemia is suspected to be the underlying cause of this condition. Persistent high blood glucose levels can lead to peripheral neuropathy and vascular insufficiency, which are associated with sensory loss, tissue damage, ulcer formation, increased susceptibility to infection, delayed wound healing, and potentially amputation <sup>8, 9</sup>. In addition, recurrent infection and increased pressure while walking can further delay the wound healing process.

The severity of the wound in DFU patients is determined by a variety of factors, including nutrition. Macronutrient intake, particularly protein, is critical for wound healing because it is transformed into amino acids, transported into the bloodstream, and used by the body to build and maintain tissues. Protein deficiency can have a serious impact on the entire immune system because wound healing cells require proteins for production and activation <sup>10</sup>. According to Cheng et al. (2021), albumin is a type of protein that is intricately related to wound healing and is engaged in blood coagulation, antioxidation, inflammation, wound healing, endothelial cell stabilization, and immune system modulation <sup>11</sup>. Del Core et al. (2018) discovered that albumin can accelerate the healing process of DFU by supplying energy to tissues <sup>12</sup>. Apart from proteins, lipids and carbohydrates provide the increased energy required during the proliferative phase of healing, promoting angiogenesis, cellular activity, inflammatory reactions, and collagen synthesis <sup>10</sup>. In addition to macronutrient consumption, micronutrient intake (particularly vitamin C, vitamin A, zinc, and iron) is also important to support wound healing process. Vitamin A and zinc stimulate the immune response by producing antibodies during the inflammatory phase. Furthermore, vitamin A and zinc are essential nutrients for collagen formation, fibroblast proliferation, and epithelialization during the proliferation and remodeling phases of wound healing. Besides vitamin A and zinc, vitamin C contributes to collagen production, antioxidant protection, and the formation of new blood vessels. Meanwhile, iron is vital for oxygen delivery to tissues, collagen formation, and tissue perfusion <sup>10</sup>.

Along with diet, metabolic control is crucial to wound healing. According to Dworzański et al. (2020), hyperglycemia may have an impact on wound healing by leading to free radical damage, resulting

from reduced activity of the antioxidant enzymes glutathione peroxidase and superoxide dismutase <sup>13</sup>. Furthermore, persistent high blood glucose levels increase the skin's susceptibility to injury and infection, which further hampers the healing process <sup>14</sup>. In addition, Irawan et al. (2018) found that increasing serum albumin levels in DFU patients receiving hyperbaric oxygen therapy significantly improved tissue oxygen levels, which affects growth factors and lowering pro-inflammatory cytokine levels <sup>15</sup>. Tissues containing high levels of pro-inflammatory cytokines will take longer to recover. Therefore, to enhance the wound healing process, it is essential to boost macronutrient intake (particularly protein) and other nutrients that may potentially inflammation in the body.

Besides dietary management and metabolic control, nutritional status plays a crucial role in the outcomes of wound healing <sup>16, 17</sup>. In patients with diabetic foot ulcers, it serves as a significant independent predictor of both infections and overall wound healing. A poor nutritional status was significantly linked to more severe wounds, as indicated by nutritional assessments and the Wagner grading system, which evaluates the severity of diabetic ulcers. As the severity of DFUs increased, nutritional status worsened, and malnutrition was correlated with unfavorable outcomes <sup>18</sup>.

Currently, there is limited study on the relationship between macronutrient intake, metabolic profiles, and wound severity in patients with DFU. An imbalance nutrients intake will impair wound healing, potentially leading to complications. Thus, nutritional intake must be taken into account in order to improve the quality of life for DFU patients. Based on this, we aimed to investigate the relationship between macronutrient intake, metabolic profiles, and wound severity in DFU patients in the Malang Raya area.

## MATERIALS AND METHODS

### Study design and participants

This cross-sectional study was carried out in the Malang Raya area of Indonesia, from January to July 2024. Participants are DFU outpatients who treat their wounds at wound care clinics such as Pediscare Clinic, RUMAT Sukun, RUMAT Blimbing, RUMAT Lawang, and Griya Luka Malang. The inclusion criteria were DFU patients between the ages of 21 and 75 and having an ulcer grade 0 until 5 who agreed to participate in this trial. Participants were excluded from this study if they have diabetes with complications such as chronic kidney diseases, hypertension and cardiovascular diseases, liver diseases, cancer, and other metabolic diseases, have diabetic wounds other than those on the foot, suffering from mental health concerns, pregnancy or breastfed for women, uncooperative, unable to read and write. Purposive sampling was used to select the participants thus we collect all the DFU patients who meet our inclusion criteria between January to July 2024. A number of 34 Indonesian adults with DFU were eligible to participate in this study, and all of them signed written informed permission. All the study protocols were reviewed, evaluated, and approved by the Ethical Committee of the Faculty of Health Sciences, Universitas Brawijaya, Indonesia with the protocol number 23F171211320 (No. 8930/UN10.F17.10.4/TU/2023).

## **Wound severity determination**

Diabetic patients with foot ulcers must be monitored and evaluated based on numerous aspects of the ulcer or wound, including size, depth, appearance, and location. In this study, we used the Wagner classification to determine wound severity, which was evaluated by a professional nurse. The wound degrees are classified based on the severity of the injury, which are as follows <sup>19, 20</sup>:

Grade 0: indicating no skin lesions, the foot's skin is intact, however cellulitis may be deformed.

Grade 1: indicating the presence of a superficial ulcer of the skin and subcutaneous tissue.

Grade 2: indicating the presence of a deeper ulcer, ulcer spreads to ligaments, tendons, joint capsules, or deep fascia without an abscess or osteomyelitis.

Grade 3: indicating the presence of a deep ulcer with osteomyelitis or an abscess

Grade 4: indicating gangrene on the forefoot or heel.

Grade 5: indicating extensive gangrene that has spread throughout the entire foot

## **Basic questionnaires and food intake assessment**

A basic questionnaire was utilized to collect the participants' basic demographic data, which included their name, address, age, gender, birth date, nutritional status, education level, occupation, comorbidities, physical activity, duration of illness, and medications used. A validated semi-quantitative food frequency questionnaire (SQFFQ) was used by trained enumerators to record the dietary pattern over the previous three months. A total of 196 food items were collected during the food intake assessment interview. Food intake data were analyzed using Nutrisurvey for Windows (SEAMEO TROPMED RCCN-University of Indonesia, 2007) to assess participants' daily energy and macronutrient intake such as protein, fat, PUFA, carbohydrate, and dietary fiber.

## **Anthropometric and metabolic profiles measurement**

Trained enumerators directly measured anthropometric characteristics such as ulna length and mid-upper-arm-circumference (MUAC) by using retractable measuring tape (0.1 cm precision, SECA 201, Germany). Patients' nutritional status was assessed by utilizing %MUAC method because they are unable to stand due to a foot wound. In this study, systolic and diastolic blood pressures were evaluated immediately using a digital sphygmomanometer (Omron HEM-8712, Japan). Additionally, blood samples were collected to provide metabolic profile data such as blood glucose, HbA1C, and serum albumin. A trained nurse drew 5 ml of blood from each participant's veins for laboratory testing, particularly HbA1C and serum albumin. The blood sample was then collected into EDTA tubes. Then, HbA1C was quantified using the Ion Exchange HPLC method, and serum albumin levels were determined using Bromcresol Green (BCG) methods. Blood glucose levels were obtained by drawing blood from the fingertip and analyzing it using a glucometer (AutoCheck, General Life Biotechnology Co., Taiwan and Contour TS, Bayer Healthcare, USA).

## Statistical analysis

All data were analyzed using SPSS version 25 (IBM Statistics, USA). Continuous data with normal distribution is shown as mean  $\pm$  SD (all the baseline data except for food intake and metabolic profiles), while non-normal distribution is shown as median and interquartile range (for food intake and metabolic profiles data). All categorical data are presented as number and percentage (N, %). The normality test was carried out using Shapiro-Wilk analysis. The Spearman correlation analysis was used to investigate the relationship between macronutrient intake, metabolic profile, and wound severity, while the Kruskal-Wallis test was used to evaluate the variations in dietary intake and metabolic profiles across wound severity levels.

## RESULTS

The baseline sociodemographic characteristics of the study participants are provided in **Table 1**. The average age of the 34 participants which enrolled in this study is  $58.29 \pm 10.31$  years. The majority of DFU patients (47.1%) are between the ages of 51 and 60 years. There are approximately similar numbers of men (52.9%) and women (47.1%) patients, with half having a normal nutritional status (47.1%). The mean duration of diabetes was  $8.82 \pm 7.05$  years, with 50% of individuals reporting a familial history of the condition. The mean duration of weekly physical activity was  $192.18 \pm 249.70$  minutes, with men having longer duration than women. In general, men and women have similar average levels of metabolic profile data. However, men tend to have a higher food intake than women, particularly in terms of energy and fat intake ( $p=0.025$  and  $p=0.042$ , respectively).

**Table 1.** Sociodemographic Characteristics of Participants

Characteristics	All (N=34)	Women (N=16)	Men (N=18)	p-value
<b>Age (years)</b>	$58.29 \pm 10.31$	$57.06 \pm 12.77$	$59.39 \pm 7.72$	0.458
<b>Age group (N, %)</b>				
31 - 40 tahun	3 (8.8)	2 (12.5)	1 (5.6)	0.614
41 - 50 tahun	3 (8.8)	2 (12.5)	1 (5.6)	
51 - 60 tahun	16 (47.1)	6 (37.5)	10 (55.6)	
61 - 70 tahun	10 (29.4)	5 (31.3)	5 (27.8)	
71 - 80 tahun	1 (2.9)	0 (0.0)	1 (5.6)	
>80 tahun	1 (2.9)	1 (6.3)	0 (0.0)	
<b>Nutritional status (N, %)</b>				
Underweight	14 (41.2)	5 (31.3)	9 (50.0)	0.386
Normal	16 (47.1)	8 (50.0)	8 (44.4)	
Overweight	2 (5.9)	1 (6.3)	1 (5.6)	
Obese	2 (5.9)	2 (12.5)	0 (0.0)	
<b>Educational level (N, %)</b>				
No school/not graduate	4 (11.8)	4 (25.0)	0 (0.0)	0.213

Characteristics	All (N=34)	Women (N=16)	Men (N=18)	p-value
Elementary School	9 (26.5)	5 (31.3)	4 (22.2)	
Junior High School	6 (17.6)	1 (6.3)	5 (27.8)	
Senior High School	6 (17.6)	2 (12.5)	4 (22.2)	
Bachelor Degree	8 (23.5)	4 (25.0)	4 (22.2)	
Master Degree	1 (2.9)	0 (0.0)	1 (5.6)	
<b>Duration of Diabetes (years)</b>	$8.82 \pm 7.05$	$6.75 \pm 5.85$	$10.67 \pm 7.66$	0.072
<b>Family history of Diabetes (N, %)</b>				
Yes	17 (50.0%)	8 (47.1%)	9 (52.9%)	1.000
No	17 (50.0%)	8 (47.1%)	9 (52.9%)	
<b>Physical Activity duration</b> (minutes/week)	$192.18 \pm 249.70$	$111.19 \pm 133.87$	$264.17 \pm 305.88$	0.345
<b>Metabolic Profiles</b>				
Systolic Blood Pressure (mmHg)	$131.91 \pm 18.16$	$133.56 \pm 21.82$	$130.44 \pm 14.68$	0.889
Diastolic Blood Pressure (mmHg)	$80.97 \pm 9.73$	$82.56 \pm 11.61$	$79.56 \pm 7.77$	0.772
Blood glucose (mg/dl)	$173.50 \pm 91.94$	$172.50 \pm 111.42$	$174.39 \pm 73.84$	0.581
HbA1C (%)	$7.89 \pm 3.50$	$7.06 \pm 3.93$	$8.62 \pm 2.95$	0.208
Albumin serum (g/dl)	$3.38 \pm 1.41$	$3.20 \pm 1.66$	$3.53 \pm 1.17$	0.580
<b>Food Intake</b>				
Energy (kcal)	$1674.07 \pm 805.45$	$1324.33 \pm 437.09$	$1984.96 \pm 934.51$	<b>0.025</b>
Protein (g)	$71.87 \pm 42.06$	$59.90 \pm 38.50$	$82.51 \pm 43.25$	0.112
Carbohydrate (g)	$201.13 \pm 102.54$	$160.67 \pm 57.11$	$237.09 \pm 120.94$	0.053
Fat (g)	$70.46 \pm 38.01$	$56.16 \pm 24.46$	$83.17 \pm 43.74$	<b>0.042</b>
PUFA (g)	$14.82 \pm 10.38$	$11.64 \pm 7.85$	$17.65 \pm 11.70$	0.125
Dietary fiber (g)	$18.74 \pm 11.57$	$15.63 \pm 9.08$	$21.51 \pm 13.03$	0.120

**Table 2** show the variables associated to wound severity in DFU patients according to the Spearman correlation test. Among the food intake and metabolic profiles data, only carbohydrate intake and serum albumin associated with wound severity. Higher carbohydrate intake was found to be positively correlated with greater wound severity ( $r=0.469$ ,  $p=0.005$ ), whereas serum albumin levels were negatively correlated with wound severity ( $r=-0.640$ ,  $p<0.001$ ).

**Table 2.** Spearman Correlation of Variables related to Wound Severity

Variables	N	r	p-value
<b>Food Intake:</b>			
Energy (kcal)	34	0.324	0.062
Protein (g)	34	0.174	0.326
Carbohydrate (g)	34	0.469	<b>0.005</b>
Fat (g)	34	0.095	0.591
PUFA (g)	34	0.090	0.612
Dietary fiber (g)	34	0.127	0.473
<b>Metabolic Profiles:</b>			
Systolic Blood Pressure (mmHg)	34	-0.143	0.421
Diastolic Blood Pressure (mmHg)	34	-0.212	0.229
Blood glucose (mg/dl)	34	0.182	0.303
HbA1C (%)	34	0.102	0.567
Albumin serum (g/dl)	34	-0.640	<b>&lt;0.001</b>

**Table 3.** The differences of macronutrient intake and metabolic profiles across wound severity

Variables	Wound Severity Grade based on Wagner's Classification					p-value*
	Grade 0 (N=1)	Grade 1 (N=12)	Grade 2 (N=12)	Grade 3 (N=7)	Grade 4 (N=2)	
<b>Food Intake:</b>						
Energy (kcal)	3197.10	1252.80 ± 5.17	1563.2 ± 280.75	2197.40 ± 350.64	1919.3 ± 293.2	<b>0.048</b>
Protein (g)	110.90	41.90 ± 11.92	78.85 ± 12.36	70.00 ± 17.00	80.95 ± 16.25	0.157
Carbohydrate (g)	218.10	158.65 ± 9.10	196.60 ± 35.10	266.60 ± 49.16	231.30 ± 41.20	<b>0.044</b>
Fat (g)	193.30	52.75 ± 3.77	63.40 ± 12.18	61.50 ± 13.55	80.00 ± 8.20	0.216
PUFA (g)	42.60	8.85 ± 1.20	13.90 ± 3.19	11.60 ± 4.31	18.60 ± 5.10	0.180
Dietary fiber (g)	33.40	15.00 ± 2.41	15.35 ± 3.93	22.60 ± 5.30	17.10 ± 1.90	0.565
<b>Metabolic Profiles:</b>						
Systolic Blood Pressure (mmHg)	130.00	130.00 ± 5.13	134.00 ± 4.34	129.00 ± 10.34	120.50 ± 0.50	0.759
Diastolic Blood Pressure	80.00	80.00 ± 2.23	80.00 ± 2.13	71.00 ± 6.40	81.00 ± 1.00	0.500
Blood glucose (mg/dl)	160.00	138.50 ± 15.47	162.50 ± 22.22	237.00 ± 55.95	134.50 ± 35.50	0.549
HbA1C (%)	11.10	7.85 ± 0.52	8.85 ± 1.19	8.00 ± 1.76	11.10 ± 1.20	0.269
Albumin serum (g/dl)	4.40	4.25 ± 0.17	3.80 ± 0.45	2.60 ± 0.57	3.15 ± 0.25	<b>0.006</b>

\*Kruskall Wallis test, median ± SEM.

The median intake of macronutrients and metabolic profiles across different grades of wound severity based on Wagner's classification are shown in **Table 3**. We found that individuals with more

severe wounds tend to consume more energy ( $p=0.048$ ) and carbohydrates ( $p=0.044$ ), and have lower serum albumin levels ( $p=0.006$ ) compared to those with milder grade of wounds.

## DISCUSSION

To our knowledge, there were limited study that evaluate the relationship between macronutrient intake, metabolic profiles, and wound severity in DFU patients. In this study, we found that men consume more calories and fat than women ( $p=0.025$  and  $p=0.042$ , respectively), while having similar metabolic profiles. This outcome could be attributed to the disparities in body size between men and women. Further analysis demonstrated that higher carbohydrate intake was positively correlated with greater wound severity ( $r=0.469$ ,  $p=0.005$ ), whereas serum albumin levels were negatively correlated with wound severity ( $r=-0.640$ ,  $p<0.001$ ). Additionally, we discovered that individuals with more serious wounds consume more energy ( $p=0.048$ ) and carbs ( $p=0.044$ ) and have lower serum albumin levels ( $p=0.006$ ) than those with milder wounds.

Wound healing is an energy-intensive process thus carbohydrates, lipids, and proteins are essential macronutrients that meet the increased energy demands and play distinct roles in the wound-healing process<sup>18, 19</sup>. Carbohydrates play a crucial role in wound healing by promoting insulin production, a hormone involved in anabolic activities, particularly during the proliferative stage of wound healing. Insulin stimulates glucose absorption into cells, supplying the energy required for tissue repair<sup>10</sup>. In addition, adequate carbohydrate intake is particularly important for fibroblast formation and mobility, as well as leukocyte activity<sup>10</sup>. Carbohydrates also increase the secretion of hormones and growth factors, including insulin, which aids in anabolic processes during the proliferative period<sup>20</sup>. However, it is important to control glucose level as hyperglycemia impairs granulocyte function, raise the risk of infection, and aggravated wound development<sup>10, 21</sup>.

In addition to fats, carbohydrates play a crucial role in wound healing by promoting insulin production, a hormone involved in anabolic activities, particularly during the proliferative stage of wound healing. Insulin stimulates glucose absorption into cells, supplying the energy required for tissue repair<sup>10, 25</sup>. In addition, adequate carbohydrate intake is particularly important for fibroblast formation and mobility, as well as leukocyte activity<sup>10</sup>. However, it is important to control glucose level as hyperglycemia impairs granulocyte function, raise the risk of infection, and aggravated wound development<sup>10, 23</sup>. In this study, higher carbohydrate intake was positively correlated with greater wound severity. Moreover, individuals with severe wounds tend to consume more energy and carbohydrates. High energy and carbohydrate intake is linked to hyperglycemia in diabetic patients.

Hyperglycemia can affect wound closure and the formation of DFU by causing atherosclerosis, decreased skin cell activity, and peripheral neuropathy<sup>14</sup>. Hyperglycemia promotes the formation of atherosclerosis, which reduces nutrient delivery to wounds and delays healing. Furthermore, hyperglycemia has been recognized as a potential source of endothelial cell dysfunction, which is crucial for DFU healing through mechanisms like pressure-induced vasodilation, a typically protective response

in the skin<sup>14</sup>. Hyperglycemia also inhibits wound healing through free radical damage caused by diminished activity of the antioxidant enzymes glutathione peroxidase and superoxide dismutase<sup>13</sup>. This could explain why previous research have discovered that long-term uncontrolled hyperglycemia is related with higher levels of skin age markers, notably advanced glycation end products (AGEs) and their receptors<sup>26</sup>. Hyperglycemia can also trigger the generation of reactive oxygen species (ROS) through the polyol, hexosamine, protein kinase C, and AGE pathways<sup>27</sup>. Although ROS are essential for the early stages of wound healing, an imbalance in their production can negatively impact the later phases<sup>28, 29</sup>. Elevated levels of ROS can particularly disrupt peripheral neurons' blood flow, metabolism, and structural integrity. Damaged nerves may lead to sensory, motor, and autonomic dysfunction, each increasing the risk of developing a DFU<sup>30</sup>. These alterations, driven by uncontrolled high blood glucose, render the skin more susceptible to injury and infection, thereby hindering the healing process. In addition, the type of carbs consumed has an impact on hyperglycemia; for example, a lower glycemic index can help to control blood glucose levels, although this is reliant on how they are distributed throughout the day, meal combinations, and other factors<sup>31</sup>. In this study, the majority of participants consumed items with a moderate to high glycemic index, including white rice, corn rice, potatoes, donuts, biscuits, wafers, crackers, rice flour pudding, sticky rice cake topped with shredded coconut and palm sugar (a popular Indonesian traditional snack), watermelon, and mango.

Our study indicated that serum albumin levels were inversely associated with wound severity. Those with more severe wounds had lower serum albumin levels compared to individuals with milder wounds. In line with this result, Shi et al (2021) reported that low serum albumin is a major risk factor for the severity of DFU, with patients experiencing severe DFUs showing significantly reduced serum albumin levels<sup>32</sup>. Protein deficiency, indicated by hypoalbuminemia, led to decreased collagen formation and wound dehiscence, ultimately resulting in impaired wound healing. Hypoalbuminemia, caused by a protein deficiency, may impairs wound healing by reducing collagen production and causing wound dehiscence<sup>33</sup>. Malnutrition or diabetic nephropathy can cause hypoproteinemia in patients with diabetic foot ulcers (DFUs). This disorder can cause skin edema, which makes the skin more sensitive to injury and hinders wound healing. Additionally, hypoproteinemia raises the incidence of methicillin-resistant *Staphylococcus aureus* infections in DFU patients<sup>34</sup>. A comprehensive assessment of the patient is crucial to identify and address the underlying causes of tissue damage, including ensuring adequate nutrition to provide sufficient protein for granulation tissue growth<sup>35</sup>. Overall, this study indicated that patients with severe DFUs have notably lower serum albumin levels, and enhancing these levels may promote wound healing, prevent disease progression, and reduce the likelihood of amputation.

There are certain limitations to our investigation. First, the sample size was limited (n=34). Second, the patients' nutritional status was assessed using the %MUAC method due to their wound condition. Third, the body weight used to calculate energy requirements was based on body weight estimation from MUAC, rather than actual body weight. Fourth, the blood glucose level was measured

using a glucometer that collects blood from the fingertip instead of from a vein. Fifth, dietary intake was evaluated through an interview using the SQFFQ, which may be prone to underreporting and recall bias.

## CONCLUSION

The study reveals important connections between macronutrient intake, metabolic profiles, and wound severity in patients with diabetic foot ulcers (DFUs). These findings emphasize the importance of good dietary and metabolic control for each DFU patient in order to effectively enhance wound healing. Future research with a larger sample size and adequate amount of food intakes is necessary to confirm these findings.

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## Research Article (FF20)

### Association Between Burnout and Eating Behaviors Among Thai Nutrition and Dietetics Practitioners

Tithita Chinthanakorn<sup>1</sup>, Thanit Vinitchagoon<sup>2</sup>, Phenphop Phansuea<sup>2, \*</sup>

<sup>1</sup>Master of Science Program in Nutrition and Dietetics (International Program), Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand

<sup>2</sup>Food and Nutrition Academic and Research Cluster, Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand

#### ABSTRACT

Burnout can trigger coping mechanisms like emotional eating, potentially affecting weight status. Among healthcare professionals, nutritionists and dietitians face a heightened risk of burnout. Given the limited research in Thailand, this study aims to explore the prevalence of burnout and overweight/obesity among Thai nutrition and dietetics practitioners and examine whether eating behavior patterns vary with different levels of burnout and weight status. An online cross-sectional study, conducted from July to August 2024, involved 483 participants stratified by geographical region and recruited via snowball sampling. Data were collected through questionnaires assessing demographic characteristics, burnout levels (using the Thai version of the Maslach Burnout Inventory – General Survey), eating behaviors (using the Thai Eating Style Scale), and self-reported weight and height. Descriptive statistics and Pearson's chi-squared test were used for statistical analysis. Among the 483 nutrition and dietetics practitioners, 42% experienced burnout, while 52% were classified as overweight or obese. The most common burnout type was low professional efficacy (71%), followed by cynicism (60%) and emotional exhaustion (54%). Regardless of weight status, participants experiencing burnout exhibited higher rates of external eating and emotional eating but lower rates of restrained eating ( $p < .001$ ). These results highlight the impact of burnout on coping-related eating behaviors across weight categories. Burnout and overweight/obesity are prevalent among Thai nutrition and dietetics practitioners and are linked to various coping-related eating behaviors. These findings underscore the need for mental health support to address burnout, promote healthier eating behaviors, and improve weight management in this essential healthcare workforce.

**Key words:** burnout, dietitians, eating behaviors, health, obesity

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\* Correspondence: phenphop.ph@gmail.com

## INTRODUCTION

In recent years, burnout has been increasingly prevalent among working-age populations<sup>1</sup>. Burnout defines as a state of physical and mental fatigue resulting from prolonged exposure to job-related stress<sup>2</sup> and is typically characterized by emotional exhaustion, cynicism, and depersonalization, which likely negatively impact both professional efficacy and personal accomplishment<sup>3</sup>. As the fatigue may occurs both physically and mentally, the consequences of burnout may include issues such as psychological distress, sleep disturbances, weight gain, pain disorders, depressive symptoms, risk of chronic diseases, and premature mortality<sup>4, 5</sup>.

The impact of burnout is particularly pronounced among healthcare practitioners, not only affecting on their personal health but also departmental performance and broader implications for the functioning of the entire healthcare system<sup>6, 7</sup>. Experiencing burnout is associated with unhealthful eating behaviors, emotional eating, and overweight/obesity among healthcare professionals<sup>8-12</sup>. Healthcare practitioners with overweight/obesity, and potentially burnout, may experience negative interactions with patients, potentially leading to experiences of stigma, decreased professional confidence, and negative impacts on their own well-being and job performance<sup>13, 14</sup>. Previous studies found that positive self-perception and confidence in professional role, often diminished when experiencing burnout, are crucial for effective patient care<sup>14, 15</sup>.

Despite the substantial body of research focusing on physicians and nurses<sup>16-19</sup>, there remains a significant gap in the understanding regarding burnout among other healthcare professionals, including nutritionists and dietitians. Nutritionists and dietitians are trained to provide recommendations for patients on healthy eating and lifestyle behaviors. However, their work often involves significant desk time, consultations, administrative tasks and daytime shifts on weekends or holidays, which may limit their time for self-care and healthful eating behaviors. Additionally, the emotional demands of dealing with patients can lead to emotional eating as a coping mechanism, contributing to weight gain. Previous studies have shown the association between negative emotions, emotional eating, and unhealthy dietary patterns (high intake of high-fat foods), that may contribute to the development of overweight and obesity<sup>11, 20</sup>. Like other health professionals, nutritionists and dietitians might prioritize their patients' health over their own, resulting in neglected self-care practices. These unique challenges suggest a need to explore the burden of burnout and associated consequences related to eating behaviors and weight status among nutritionists and dietitians, in which the current research is relatively limited. Therefore, this preliminary study aims to explore the prevalence of burnout and overweight/obesity among Thai nutrition and dietetics practitioners and examine whether eating behavior patterns vary with different levels of burnout and weight status.

## MATERIALS AND METHODS

### Study Design

A cross-sectional study was employed to investigate the relationship between burnout, eating behaviors, and weight status among Thai nutrition and dietetics practitioners. Online self-administered questionnaires were distributed targeting nutrition and dietetics practitioners in Thailand from July to August 2024. Stratified sampling by geographical region of the workplace was done to ensure generalizability of the data, in which approximately 35% should come from Bangkok and Central region, 18% should come from the Northern region, 33% should come from the Northeastern region, and 14% should come from the Southern region, representing the approximate percentage of the Thai population<sup>21</sup>. Using the Cochran's formula<sup>22</sup>, the target sample size for this study is 420 participants, accounting for approximately 10% attrition, to ensure adequate statistical power.

Participants were included in the study if they met the following criteria: 1) 18 years of age or older 2) Thai nationality 3) able to communicate effectively in Thai 4) currently live in Thailand 5) holds registered dietitian (RD) or Certified Dietitian of Thailand (CDT) status and 6) currently working as a dietitian/nutritionist with a minimum experience of at least one year (full-time or part-time) in any position involving nutrition and dietetics knowledge and practice. Participants were excluded from the study if they met the following criteria: 1) currently pregnant or lactating 2) unwilling to provide informed consent 3) experiencing psychiatric disorders (e.g., major depressive disorder, anxiety disorder, schizophrenia, etc.) that prevented the ability to fully participate in the study. This study was approved by the Central Institutional Review Board at Mahidol University (MU-CIRB 2024/215.1605).

### Data Collection

A demographic questionnaire was used to collect information about the demographic characteristics of participants, including sex, age, education level, marital status, geographic location, self-report measures of weight, and height and history of mental health disorders. Age was recorded as a continuous variable (in years) while other variables were recorded as categorical variables. Additionally, participants self-reported their weight in kilograms and height in centimeters. Body mass index (BMI) were calculated and categorized according to the Asian-Pacific cutoff points<sup>23</sup> including: underweight (BMI < 18.5 kg/m<sup>2</sup>), normal weight (BMI 18.5 - 22.9 kg/m<sup>2</sup>), overweight (BMI 23 - 27.4 kg/m<sup>2</sup>), and obesity (BMI > 27.5 kg/m<sup>2</sup>).

Regarding burnout, a Thai version of Maslach Burnout Inventory – General Survey (MBI-GS) was used to assess burnout experience among participants. MBI-GS is a 16-item questionnaire used to assess three dimensions of burnout: emotion exhaustion, cynicism, and professional efficacy. It has been validated in Thai adults and shown good consistency (Cronbach's alpha = 0.832, 0.901, and 0.839 for emotional exhaustion, cynicism, and professional efficacy, respectively<sup>24</sup>. Participants used a Likert

scale ranging from 0 (never) to 6 (always) to indicate the frequency of their burnout experience. Scores for each subscale, along with the total score, were recorded as continuous variables. The degrees of burnout of each subscale were classified into three levels: low, moderate, and high. Participants are classified as experiencing burnout if they had high degrees of emotional exhaustion and cynicism, and high degree of low professional efficacy <sup>3, 17</sup>.

The Thai-Eating Style Scale (T-ESS) was used to evaluate eating behaviors that may be the result of coping mechanisms to burnout in this study. T-ESS consists of 3 eating behavior domains: emotional eating, external eating, and restrained eating. It is a 31-item questionnaire in which 12 items are used to measure emotional eating as described the tendency to overeat in response to emotional states, 8 items for external eating as evaluated eating in response to external food-related, and 11 items for restrained eating style to determine the intention to restrict food intake in order to control body weight. Participants rated each item on a five-point Likert scale from 1 (never) to 5 always. The T-ESS has relatively good internal consistencies for all three domains with the overall Cronbach's alpha coefficient of .87 <sup>25</sup>. Participants were classified according to the domain with highest scores (emotional eating, external eating, and restrained eating), and classified as mixed if there were two or more domains with equal scores <sup>26</sup>.

### Statistical Analysis

Descriptive statistics were used to report the demographic characteristics of the participants. The Kolmogorov-Smirnov test was performed for continuous variables to assess normality. Means and standard deviations (SD) were reported for continuous variables while counts and percentages were reported for categorical variables. Pearson's chi-squared test were used to explore association between eating behavior patterns and difference burnout group by weight status among participants. SPSS version 27.0 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses.

## RESULTS

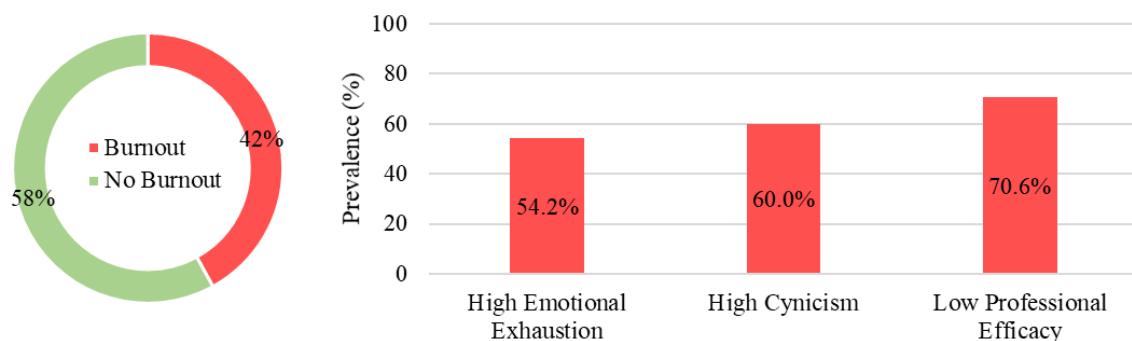
A total of 483 nutrition and dietetics practitioners participated in this study. Most participants identified as females, consistent with the sex distribution among nutrition and dietetics practitioners globally <sup>27-30</sup>. The geographical region distribution of participants was also consistent with the expected distribution, reflecting the generalizability of the results across regions in Thailand (**Table 1**).

Regarding the prevalence of burnout, 42% of participants reported experiencing burnout; categorized by high emotional exhaustion, high cynicism and low professional efficacy. Moreover, among the 483 participants included in this study, low professional efficacy was the most prevalent type of burnout (71%) followed by high cynicism (60%) and high emotional exhaustion (54%) (**Figure 1**).

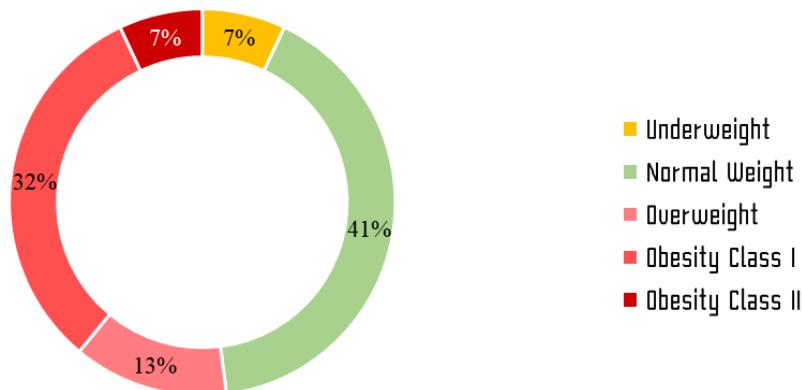
**Table 1.** Demographic Characteristics of Participants (n = 483).

Characteristics	Participants (n = 483)
Age, years, mean ± SD	37.22 ± 9.68
Sex, n (%)	
Male	36 (7.5)
Female	447 (92.5)
Educational level, n (%)	
Lower than Bachelor's degree	17 (3.5)
Bachelor's degree	422 (87.4)
Higher than Bachelor's degree	44 (9.1)
Marital status, n (%)	
Single	229 (47.4)
Married	245 (50.7)
Divorced/widowed	9 (1.9)
Geographical region, n (%)	
Central	188 (38.9)
North	76 (15.7)
Northeast	150 (31.1)
South	69 (14.3)
Work experience, years, mean ± SD	8.9 ± 7.0
Height, cm, mean ± SD	160.8 ± 5.8
Weight, kg, mean ± SD	61.9 ± 12.2
Body mass index, kg/m <sup>2</sup> , mean ± SD	23.9 ± 4.3

Abbreviations: centimeter (cm), kilometer (kg), kilometer per square meter (kg/m<sup>2</sup>).

**Figure 1.** Prevalence and Types of Burnout among Participants (n=483).

In terms of overweight and obesity prevalence, 52% of participants were classified as overweight or obesity with 39% categorized specifically as obesity (BMI greater than  $25 \text{ kg/m}^2$ ). This proportion is comparable to the percentage of participants with normal weight, which was 41% (**Figure 2**).



**Figure 2.** Prevalence of Overweight/obesity among Participants (n=483).

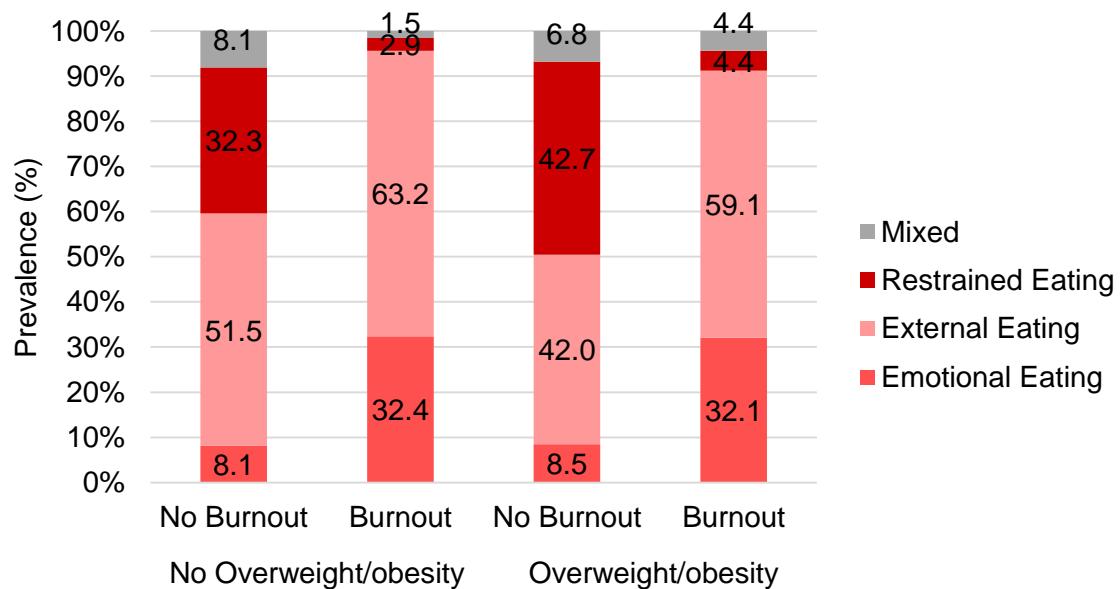
**Table 2** demonstrates a statistically significant association between eating behavior patterns and burnout across different weight categories ( $p<0.001$ ). In the no overweight/obesity group, external eating was the most common eating behavior, observed in 55% of participants. When further examined by burnout status, 63% of those with burnout engaged in external eating compared to 52% of those without burnout. Emotional eating was present in 15% of the no overweight/obesity group, with a significant difference between participants with (32%) and without burnout (8%). Conversely, restrained eating was substantially lower among those with burnout (3%) compared to those without burnout (32%).

In the overweight/obesity group, external eating was also the most prevalent behavior, at 51%. Further analysis showed 59% of participants with burnout exhibited external eating, compared to 42% without burnout. Emotional eating was reported in 21% of the group, with a significantly higher prevalence in those with burnout (32%) compared to those without burnout (9%). As observed in the no overweight/obesity group, restrained eating was markedly lower in those with burnout (4%) compared to those without burnout (43%). Overall, a higher proportion of participants with emotional eating and lower proportion with restrained eating were observed in burnout groups when compared to no burnout groups regardless of weight status (**Figure 3**).

**Table 2.** Association between Eating Behavior Patterns and Burnout by Weight Status (n=483).

Weight Status	Eating Behavior	Total	Burnout		p-value
			No	Yes	
No overweight/ obesity	Emotional eating	35 (15.3)	13 (8.1)	22(32.4)	<0.001
	External eating	126 (55.0)	83(51.5)	43(63.2)	
	Restrained eating	54 (23.6)	52(32.3)	2 (2.9)	
	Mixed	14 (6.1)	13 (8.1)	1 (1.5)	
Overweight/ obesity	Emotional eating	54 (21.3)	10 (8.5)	44 (32.1)	<0.001
	External eating	130 (51.2)	49 (42.0)	81 (59.1)	
	Restrained eating	56 (22.0)	50(42.7)	6 (4.4)	
	Mixed	14 (5.5)	8 (6.8)	6 (4.4)	

Data expressed as a count (%). Pearson's  $\chi^2$  test was used with statistical significance at p-value <0.05.

**Figure 3.** Proportions of Eating Behavior Patterns by Burnout and Weight Status (n=483).

## DISCUSSION

### Burnout Among Thai Nutrition and Dietetics Practitioners

This study reports the high prevalence of burnout (42%) among Thai nutrition and dietetics practitioners, a population often underrepresented in burnout research. Compared to a previous Canadian study, which reported over 57% of dietitians facing moderate to high levels of burnout<sup>28</sup>, our findings suggest a comparable, if not higher, prevalence, as participants with moderate levels of burnout were not categorized as experiencing burnout in this study. This discrepancy may be attributed to differences in professional roles and workload of dietitians across countries, although more evidence is needed.

Furthermore, Thai nutrition and dietetics practitioners reported higher burnout rates than other healthcare professionals in Thailand<sup>17, 31</sup>. This may be attributed to the multifaceted nature of their roles, which often encompass clinical nutrition, food service management, and community nutrition. In contrast, other healthcare professionals may specialize in specific areas within wards or clinics. As previous studies have shown that job-related stress including shift works, high work pressure, and low salary satisfaction is often related to job burnout<sup>32, 33</sup>, it is likely that these factors may also contribute to burnout among nutrition and dietetics practitioners.

### Eating Behaviors and Weight Status among Thai Nutrition and Dietetics Practitioners

Our findings reveal that participants with burnout exhibited higher rates of emotional eating compared to those without burnout, regardless of weight status. Conversely, restrained eating was less prevalent among individuals with burnout. These results align with previous research indicating that negative emotions can lead to increased emotional eating and decreased restrained eating, potentially contributing to excessive caloric intake due to increased preference for unhealthy, calorie-dense foods<sup>16, 34, 35</sup>.

The prevalence of overweight and obesity among participants in this study was 52%, slightly exceeding the national rate of 47.8% reported in the 2022 Thai Population Health Survey<sup>36</sup>. When compared to other healthcare professionals, the prevalence of overweight and obesity among our participants aligns with estimates of 41-55%<sup>37</sup>. These findings challenge the assumption that healthcare professionals, including nutritionists and dietitians, are inherently protected from obesity. The prevalence of obesity among this group may further highlight the significant impact of stress and burnout on healthy lifestyle behaviors and weight management in this population<sup>11, 12, 38</sup>.

### Association Between Burnout and Eating Behaviors by Weight Status

This study reveals a significant association between burnout and coping-related eating behaviors among participants, regardless of weight status. While our cross-sectional design precludes causal inferences, it's plausible that individuals with burnout may experience weight gain over time. Those already overweight or obese might be at an even higher risk, given the established link between high stress, emotional eating, and increased BMI<sup>20, 39</sup>. Longitudinal studies further support the connection

between elevated stress, emotional eating, and weight gain<sup>40</sup>. Given the potential long- term consequences of burnout on weight management, interventions aimed at reducing burnout among healthcare professionals, along with organizational support<sup>41</sup> could be crucial in promoting healthier lifestyles and preventing obesity-related health issues.

### **Strengths and Limitations**

One of the main strengths of this study is its focus on a population that has not been extensively studied in Thailand. Given the critical role of nutritionists and dietitians in public health, the lack of research in this area may have resulted in the limited awareness of the impact of burnout on health outcomes and professional performance in this profession. Moreover, stratified sampling approach based on geographical region may result in a more generalizability of the results to practitioners across different geographical regions in Thailand.

However, there are several limitations for this study. First, the cross-sectional design limits the ability to infer causality between burnout and eating behaviors. Second, response bias may occur due to the self- reported nature of the data collection in this study. Third, this study did not explore specific workplace factors contributing to burnout, which could provide a more comprehensive understanding of the issue. Future research should consider longitudinal studies with actual measurements, and include an examination of workplace environment, job satisfaction, and support systems to better address burnout and its impact on eating behaviors.

## **CONCLUSION**

Burnout is prevalent among Thai nutrition and dietetics practitioners and is associated with various coping-related eating behaviors (i.e., emotional eating) that may negatively impact weight status. These findings underscore the need for mental health support to address burnout, promote healthier eating behaviors, and improve weight status in this essential healthcare workforce.

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## Research Article (FF21)

### Factors Influencing Street Food Selection Among Groups with Different Weight Statuses

Sontaya Boonlaun<sup>1</sup>, Rewadee Chongsuwat<sup>1</sup>, Chanchira Phosat<sup>1\*</sup>

<sup>1</sup>Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand

#### ABSTRACT

Street food has become increasingly popular and may serve as a primary food source in contemporary society. Identifying the factors that affect street food selection, especially among high-risk health groups, is crucial for creating effective nutritional health promotion strategies. This study aims to investigate the determinants of street food selection among individuals with varying health statuses. A cross-sectional study involving 404 consumers was conducted to explore the relationship between body mass index, sociodemographic factors, and street food consumption. Comparisons were made among underweight, normal weight, overweight, and obese groups. Significant differences were found across these groups regarding gender, age, waist circumference, marital status, type of accommodation, monthly income, dietary expenses, and frequency of street food consumption ( $p<0.05$ ). Over half of the overweight and obese participants did not express nutritional concerns regarding selected street food ( $p<0.05$ ). The study also identified significant positive correlations between the frequency of street food consumption and factors such as ease of access, and perceived food prices ( $p<0.05$ ). However, no positive correlation was found between consumption frequency and factors related to proper nutrition, nor were significant associations observed with gender, weight, or education. These findings suggest that street food selection, influenced more by accessibility and economic factors than by nutritional considerations, could contribute to the rising prevalence of obesity and related health issues. The results emphasize the need for public health strategies focused on modifying food environments and encouraging healthier dietary practices to combat the growing obesity epidemic.

**Key words:** street food, street food consumption, food selection, weight, obese

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\* Correspondence: chanchira.pho@mahidol.ac.th

## INTRODUCTION

Obesity has emerged as a significant global public health challenge, largely due to its association with a range of chronic diseases. According to the World Health Organization (WHO), approximately 2.5 billion adults aged over 18 years were classified as overweight in 2022, with 890 million individuals living with obesity<sup>1</sup>. Furthermore, the prevalence of obesity among children and adolescents has also escalated markedly<sup>1</sup>. Various factors contribute to obesity, including dietary habits and the surrounding food environment. A previous study indicates that the availability of unhealthy food options within an individual's environment is a contributing factor to elevated obesity rates<sup>2</sup>. Street food, often characterized by high caloric content and low nutritional value, plays a crucial role in the dietary practices of numerous cultures. It provides a convenient and economical food choice while also reflecting the diverse culinary traditions of specific regions<sup>3-4</sup>. Its widespread availability, both in urban and rural environments, ensures it caters to a broad spectrum of tastes and preferences. However, the appeal of street food extends beyond its immediate sensory satisfaction; it often embodies cultural significance, fosters social interaction, and serves as a practical solution for individuals with busy lifestyles. Despite its popularity and deep integration into daily life, the decision-making processes behind street food consumption are complex, particularly when considering how weight status influences dietary choices<sup>5-6</sup>. Individuals with different weight statuses may exhibit distinct behaviors and preferences related to street food consumption, influenced by a variety of internal and external factors<sup>7</sup>. Additionally, the perception of street food as either a guilty pleasure or a convenient meal can significantly impact how individuals with different weight statuses approach their food choices<sup>8</sup>. Understanding these nuanced differences in street food selection provides critical insights for developing targeted nutritional education and interventions. By examining factors such as nutritional awareness, taste preferences, cultural norms, socioeconomic status, and health perceptions, this study aims to address a notable gap in the existing literature. The outcomes of this research will contribute to a deeper understanding of dietary patterns across different weight status groups and offer practical recommendations for policymakers and health practitioners striving to enhance public health. Ultimately, this study will shed light on the intersection between street food consumption and weight status, laying the groundwork for effective strategies to promote healthier eating habits and improve the nutritional quality of street food options.

## MATERIALS AND METHODS

### Study design and participants

The study employed a cross-sectional design and included 404 street food consumers aged 18 years and older who were fluent in Thai, had previously consumed street food in Bangkok, Thailand, and voluntarily consented to participate. The selection of samples by used simple random sampling. Participants who were unable to complete the self-administered questionnaire were excluded from the analysis. The study protocol was reviewed and approved by the Ethics Committee of the Faculty of

Public Health, Mahidol University (Certificate of Approval No. MUPH 2021-072). Written informed consent was obtained from all participants prior to the initiation of the study.

### **Data collection**

Data were collected using a self-administered questionnaire on street food consumption behaviors among eligible street food consumers. Participants were selected randomly by sending “the street food consumption behaviors questionnaire” online, targeting groups such as employees, students, and staff. To significantly enhance the response rate, a rolling ball method was implemented. Before implementation, the questionnaire was reviewed and evaluated by three food and nutrition experts, achieving a content validity of 0.99 and a reliability value (Cronbach Alpha Coefficient) of 0.97. The questionnaire is divided into two main sections: general information and factors related to street food selection. The general information section includes questions on sex, age, underlying health conditions, weight, body mass index, waist circumference, educational level, occupation, marital status, and type of accommodation. The factors related to street food selection section encompasses questions on knowledge of nutrition and food safety (answered as yes-or-no), monthly income, monthly expenditure on food, frequency of street food purchases, and reasons for buying street food (also answered as yes-or-no). Each correct answer to the knowledge questions is awarded 1 point. Knowledge levels were categorized using Bloom's cut-off points<sup>9</sup>.

### **Statistical analysis**

All data analyses were performed using the statistical package for the social sciences (SPSS) version 18. Participants were categorized into different groups based on body mass index (BMI) criteria<sup>10</sup>: underweight (BMI < 18.5 kg/m<sup>2</sup>), normal weight (BMI = 18.5-22.9 kg/m<sup>2</sup>), overweight (BMI = 23.0-24.9 kg/m<sup>2</sup>), and obese (BMI > 25 kg/m<sup>2</sup>). Descriptive statistics were summarized using percentages, means, and standard deviations (SD). Comparisons between study groups were performed using chi-square tests and ANOVA, with post-hoc tests applied as necessary. Pearson correlations were used to evaluate the relationships between study parameters. A p-value of less than 0.05 was considered statistically significant.

## **RESULTS**

### **Participants' characteristics**

A total of 404 participants were recruited and classified into four BMI categories: underweight (n=29), normal weight (n=197), overweight (n=60), and obese (n=118). **Table 1** presents the participants' characteristics, revealing significant differences across various variables. Notably, sex distribution varied significantly ( $p=0.000$ ), with more males in the overweight and obese groups. Age distribution also differed significantly ( $p=0.024$ ), with individuals over 40 years more prevalent in the obese group. The obese group had the highest average waist circumference ( $p=0.000$ ). Additionally, abdominal obesity

was present in 88.1% of obese individuals ( $p=0.000$ ). Educational levels showed a trend toward significance ( $p=0.065$ ), while occupational distribution remained consistent across BMI categories ( $p=0.387$ ). Marital status differed significantly ( $p=0.003$ ), with a higher percentage of single individuals in the underweight group (93.1%) compared to the obese group (64.4%). Significant differences in accommodation type were also observed ( $p=0.000$ ), with underweight individuals more likely to reside in houses, whereas obese individuals tended to live in condominiums. Monthly income varied significantly by BMI category ( $p=0.019$ ), with obese individuals reporting the highest average income (22,352.0 ± 6,685.0 baht). Food expenditure also varied significantly ( $p=0.001$ ), with the overweight group most frequently spending between 15,001-20,000 baht. The average knowledge score differed significantly by BMI category ( $p=0.020$ ), with obese individuals having the highest score (8.9 ± 2.2) and underweight individuals the lowest (7.9 ± 2.5). Knowledge levels did not vary significantly ( $p=0.070$ ), with most individuals having moderate knowledge.

**Table 1** Participants' characteristics (n=404)

Parameters	Underweight (n=29)	Normal (n=197)	Overweight (n=60)	Obese (n=118)	p-value
Gender					
Male	1 (3.4%)	28 (14.2%)	23 (38.3%)	20 (16.9%)	0.000 <sup>#,*</sup>
Female	28 (96.6%)	169 (85.8%)	37 (61.7%)	98 (83.1%)	
Age (years)	32.2±8.8 <sup>a,c</sup>	35.6±12.0 <sup>a,c</sup>	35.6±11.7 <sup>a,b,c</sup>	40.4±12.6 <sup>b</sup>	0.001 <sup>†,*</sup>
Age					
18-39 years	26 (89.7%)	143 (72.6%)	45 (75.0%)	70 (59.3%)	
40-59 years	2 (6.9%)	44 (22.3%)	12 (20.0%)	35 (29.7%)	
> 60 years	1 (3.4%)	10 (5.1%)	3 (5.0%)	13 (11.0%)	
Underlying health					
No	25 (86.2%)	162 (82.2%)	40 (66.7%)	83 (70.3%)	0.066 <sup>#</sup>
Yes: Metabolic diseases	3 (10.3%)	23 (11.7%)	13 (21.7%)	20 (16.9%)	
Yes: Others	1 (3.4%)	12 (6.1%)	7 (11.7%)	15 (12.7%)	
Weight (kg)	44.9±3.1 <sup>a</sup>	53.9±5.9 <sup>b</sup>	65.4±7.0 <sup>c</sup>	78.9±14.5 <sup>d</sup>	0.000 <sup>†,*</sup>
Body mass index (kg/m <sup>2</sup> )	17.4±1.1 <sup>a</sup>	20.7±1.3 <sup>b</sup>	23.8±0.5 <sup>c</sup>	29.6±4.4 <sup>d</sup>	0.000 <sup>†,*</sup>
Waist circumference (cm)	62.7±4.0 <sup>a</sup>	73.8±7.1 <sup>b</sup>	81.9±7.1 <sup>c</sup>	91.1±10.7 <sup>d</sup>	0.000 <sup>†,*</sup>
Normal	29 (100.0%)	172 (87.3%)	39 (65.0%)	14 (11.9%)	0.000 <sup>#,*</sup>
Abdominal obesity	0 (0.0%)	25 (12.7%)	21 (35.0%)	104 (88.1%)	
Educational level					
Primary school or lower	1 (3.4%)	5 (2.5%)	2 (3.3%)	4 (3.4%)	0.065 <sup>#</sup>
Junior/Senior high school	6 (20.7%)	52 (26.4%)	12 (20.0%)	25 (21.2%)	
Diploma	10 (34.5%)	49 (24.9%)	6 (10.0%)	33 (28.0%)	
Bachelor's degree	12 (41.4%)	74 (37.6%)	38 (63.3%)	49 (41.5%)	

Parameters	Underweight	Normal	Overweight	Obese	p-value
	(n=29)	(n=197)	(n=60)	(n=118)	
Postgraduate	0 (0.0%)	17 (8.6%)	2 (3.3%)	7 (5.9%)	
Occupation					0.387 <sup>#</sup>
Student	3 (10.3%)	27 (13.7%)	5 (8.3%)	6 (5.1%)	
Officer	19 (65.5%)	96 (48.7%)	30 (50.0%)	67 (56.8%)	
Business owner/Freelancer	6 (20.7%)	67 (34.0%)	23 (38.3%)	40 (33.9%)	
Unemployed	1 (3.4%)	7 (3.6%)	2 (3.3%)	5 (4.2%)	
Marital status					0.003 <sup>#,*</sup>
Single	27 (93.1%)	140 (71.1%)	41 (68.3%)	76 (64.4%)	
Married	2 (6.9%)	48 (24.4%)	18 (30.0%)	32 (27.1%)	
Divorced	0 (0.0%)	2 (1.0%)	1 (1.7%)	9 (7.6%)	
Widowed	0 (0.0%)	7 (3.6%)	0 (0.0%)	1 (0.8%)	
Type of accommodation					0.000 <sup>#,*</sup>
House	19 (65.5%)	106 (53.8%)	30 (50.0%)	75 (63.6%)	
Condominium	7 (24.1%)	23 (11.7%)	19 (31.7%)	20 (16.9%)	
Dormitory	3 (10.3%)	68 (34.5%)	11 (18.3%)	23 (19.5%)	
Monthly income (baht)	21,983.0± 6,956.0 <sup>a</sup>	20,152.0± 5,953.0 <sup>a,b</sup>	20,458.0± 6,485.0 <sup>a,b</sup>	22,352.0± 6,685.0 <sup>b</sup>	0.019 <sup>#,*</sup>
Monthly expenditure on food					0.001 <sup>#,*</sup>
<10,000 baht	4 (13.8%)	21 (10.7%)	4 (6.7%)	9 (7.6%)	
10,001-15,000 baht	2 (6.9%)	20 (10.2%)	9 (15.0%)	16 (13.6%)	
15,001-20,000 baht	3 (10.3%)	49 (24.9%)	19 (31.7%)	10 (8.5%)	
20,001-25,000 baht	9 (31.0%)	66 (33.5%)	10 (16.7%)	34 (28.8%)	
25,001-30,000 baht	5 (17.2%)	25 (12.7%)	9 (15.0%)	25 (21.2%)	
>30,000 baht	6 (20.7%)	16 (8.1%)	9 (15.0%)	24 (20.3%)	
Average knowledge score	7.9±2.5 <sup>a,b</sup>	8.6±1.9 <sup>a,b</sup>	8.0±1.8 <sup>a</sup>	8.9±2.2 <sup>b</sup>	0.020 <sup>#,*</sup>
Knowledge level					0.070 <sup>#</sup>
Good	8 (27.6%)	66 (33.5%)	11 (18.3%)	46 (39.0%)	
Moderate	18 (62.1%)	119 (60.4%)	40 (66.7%)	64 (54.2%)	
Poor	3 (10.3%)	12 (6.1%)	9 (15.0%)	8 (6.8%)	

Data are presented as n (%) and mean ± standard deviation (SD). Significant differences were assessed using the Chi-square test<sup>#</sup> and ANOVA<sup>†</sup> with Tukey post-hoc test. \*A p-value of less than 0.05 was considered statistically significant. Different superscripts represent significant differences between groups.

## Differences in factors influencing street food selection and the types of foods chosen among study groups with varying weight statuses

Significant variation was observed in the frequency of street food purchases across different BMI categories ( $p=0.005$ ) (Table 2). Overweight individuals reported a greater frequency of street food purchases, with 40% indicating they purchased such foods 4-6 times per week, and an additional 40% purchasing 1-3 times per week, in contrast to individuals in other BMI categories. Moreover, individuals with a normal BMI exhibited a greater tendency to select street food options that were lower in sweetness, fat, or sodium compared to their counterparts in other BMI categories ( $p=0.045$ ) (Figure 1). Furthermore, overweight individuals were less likely to select street food from vendors employing appropriate cooking tools compared to individuals in other BMI categories ( $p=0.024$ ). Additionally, overweight individuals demonstrated a stronger preference for fried foods compared to other groups, while those with normal weight displayed the lowest preference for fried options ( $p=0.002$ ) (Figure 2).

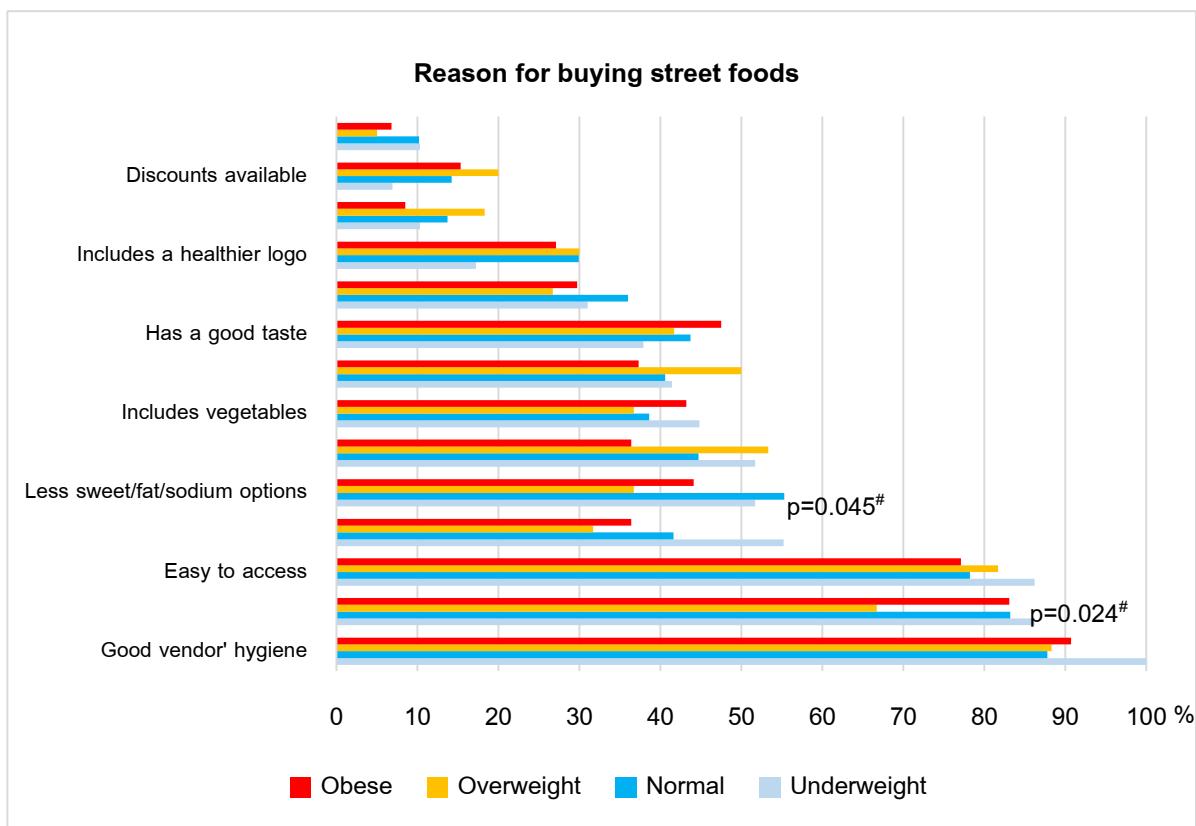
## Correlation between the frequency of consuming street food and influencing factors

The correlation between the frequency of street food consumption and various influencing factors is detailed in Table 3. Age exhibited a significant negative correlation with the frequency of street food consumption ( $p=0.043$ ), suggesting that as age increases, the frequency of consumption tends to decline. Additionally, individuals who perceive street food as easily accessible are more likely to consume it frequently ( $p=0.000$ ). A moderate positive correlation was also identified regarding the perception of value for money ( $p=0.000$ ), indicating that those who view street food as offering good value are inclined to consume it more frequently. In contrast, motivations related to trying new shops ( $p=0.000$ ) and seeking low-energy food options ( $p=0.029$ ) demonstrated negative correlations with street food consumption frequency, suggesting that individuals motivated to explore new shops are less likely to consume street food often, while those who consider it a low-energy option tend to consume it less frequently.

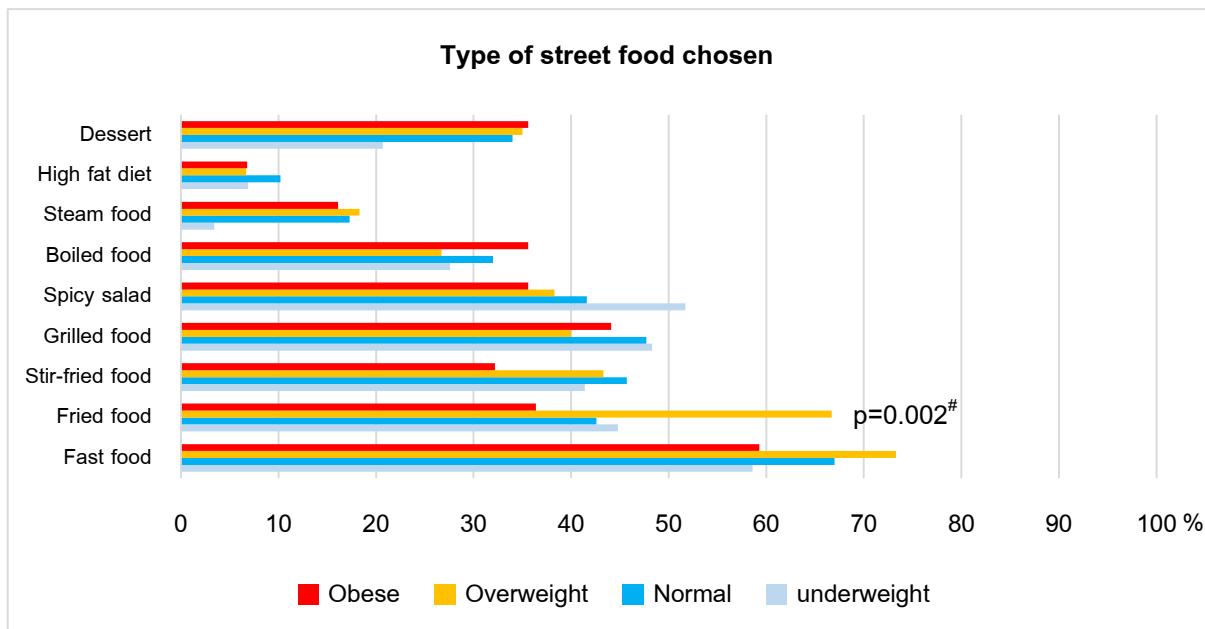
**Table 2** Comparison of the frequency of street food purchases among the study groups

Frequency of street food purchases	Underweight	Normal	Overweight	Obese	p-value
Daily	2 (6.9%)	11 (5.6%)	3 (5.0%)	5 (4.2%)	0.005*
4-6 times/week	3 (10.3%)	36 (18.3%)	24 (40.0%)	18 (15.3%)	
1-3 times/week	9 (31.0%)	80 (18.3%)	24 (40.0%)	18 (15.3%)	
2-3 times/month	9 (31.0%)	33 (16.8%)	3 (5.0%)	19 (16.1%)	
<1 time/month	6 (20.7%)	37 (18.8%)	14 (23.3%)	26 (22.0%)	

Data are presented as n (%). Significant differences were assessed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.



**Figure 1** Comparison of the percentages of each study group concerning the reasons for buying street food. Differences between groups were evaluated using the chi-square test, with a p-value of less than 0.05 considered statistically significant. \*MSG: Monosodium glutamate.



**Figure 2** Comparison of the type of street food chosen among different weight statuses. Differences between groups were evaluated using the chi-square test, with <sup>#</sup>a p-value of less than 0.05 considered statistically significant.

**Table 3** Correlation between the frequency of consuming street food and influencing factors

	r	p-value
Age	-0.101	0.043*
Reasons for buying street food		
Easy to access	0.346	0.000*
Value for money	0.335	0.000*
Trying new shops	-0.193	0.000*
Low energy option	-0.109	0.029*

Data were analyzed using Pearson correlation, and a p-value of less than 0.05 was considered statistically significant.

## Discussion

Street food selection is influenced by a multitude of factors that have significant implications for dietary choices and health outcomes <sup>11-13</sup>. Individuals may prioritize aspects such as taste, convenience, or nutritional value in varying ways, ultimately shaping their overall eating patterns. This study aims to investigate these factors among individuals differentiated by weight status, providing insights that can inform public health interventions designed to promote healthier eating behaviors. The results underscore the complex relationships between obesity, food choices, and socio-economic status. Notably, sex distribution varied significantly among the groups ( $p<0.001$ ), with a higher proportion of males in the overweight and obese categories. This finding aligns with existing literature that links gender differences to body mass index (BMI), likely reflecting variations in lifestyle and physical activity patterns between males and females <sup>14-15</sup>.

The observed trend of increasing obesity prevalence with age ( $p=0.024$ ) is also consistent with studies suggesting that metabolic changes and decreased physical activity contribute to elevated obesity rates among older adults <sup>16-18</sup>. The relationship between waist circumference and BMI categories is particularly concerning, as the obese group exhibited the highest average waist circumference ( $p=0.000$ ), which is associated with abdominal obesity and heightened health risks, including cardiovascular disease and metabolic syndrome.

Marital status and housing types also demonstrated significant differences between weight statuses ( $p<0.01$ ), suggesting that lifestyle, socioeconomic, and environmental factors may play a critical role in influencing weight status. Interestingly, the observation that obese individuals reported the highest average income ( $p=0.019$ ) challenges conventional beliefs that lower socio-economic status correlates with higher obesity rates due to restricted access to healthy food options <sup>19-20</sup>. This relationship is further illustrated by significant variations in food expenditure ( $p=0.001$ ), with overweight participants more likely to spend on food, potentially influencing their weight status.

Furthermore, street food purchasing habits varied significantly across BMI groups ( $p<0.05$ ), with overweight individuals being the most frequent consumers, as 80% reported purchasing street food

multiple times per week. This supports the notion that street food, often calorie-dense and high in fat, may contribute to weight gain, aligning with previous studies linking higher BMI to increased consumption of food prepared outside the home <sup>21</sup>.

Knowledge scores related to nutrition differed significantly by BMI category ( $p=0.020$ ), with obese individuals achieving the highest scores and underweight individuals the lowest. In contrast, normal-weight individuals demonstrated more health-conscious behaviors by selecting street food options lower in sweetness, fat, or sodium ( $p=0.045$ ). This finding suggests that while greater knowledge may not directly prevent weight gain, it plays a complex role in shaping health-related behaviors <sup>11-13</sup>.

The overweight group's preference for fried foods ( $p=0.002$ ) emphasizes the necessity for public health initiatives that encourage healthier cooking methods, as the consumption of fried foods is associated with higher caloric intake and obesity. Additionally, overweight individuals were less likely to select vendors employing appropriate cooking tools ( $p=0.024$ ), indicating that convenience may be prioritized over food safety or quality, potentially exacerbating unhealthy dietary habits. Correlation analysis revealed that age has a significant negative correlation with street food consumption ( $p=0.043$ ), suggesting that older individuals may prioritize health more than their younger counterparts. This demographic shift in dietary preferences could guide targeted educational campaigns aimed at younger populations, emphasizing the long-term health consequences of their dietary choices. Moreover, perceptions of street food as easily accessible ( $p=0.000$ ) and providing good value ( $p=0.000$ ) significantly influenced consumption frequency, consistent with literature that highlights accessibility and affordability as critical determinants of food choices, particularly in urban settings<sup>11, 22</sup>. Conversely, motivations to try new shops ( $p=0.000$ )

The seek low-energy food options ( $p=0.029$ ) negatively correlated with street food consumption, indicating that health-conscious consumers are less likely to engage with street food. This points to a potential area for public health intervention, promoting healthier street food options that appeal to consumers seeking variety while addressing health concerns. Such initiatives could help bridge the gap between convenience and health, fostering better dietary choices without sacrificing the enjoyment of food.

However, several limitations must be acknowledged. The cross-sectional design restricts the ability to establish causality between street food purchasing habits and weight status. Additionally, reliance on self-reported data introduces the potential for reporting bias. The focus on street food consumers in urban Bangkok may limit the generalizability of findings to other regions with different dietary patterns and food environments. Furthermore, key factors such as physical activity levels and psychological influences on food choices were not evaluated, which could have provided a more comprehensive understanding of the relationship between street food consumption and BMI.

## CONCLUSION

In conclusion, this study highlights significant differences in dietary preferences, purchasing behaviors, and demographic characteristics associated with body mass index. While socio-economic status, education, and marital status emerged as influential factors, the data challenges traditional views linking income to obesity, suggesting a more complex relationship that requires further examination. The findings also reveal an opportunity to promote healthier street food options, particularly for overweight individuals, who exhibited a higher frequency of consuming calorie-dense foods. Additionally, the negative correlation between age and street food consumption indicates that health-focused educational initiatives targeting younger populations could effectively encourage healthier dietary habits. Ultimately, the insights derived from this research can inform public health strategies designed to combat obesity and promote healthier eating behaviors across diverse populations. By understanding the factors influencing street food selection, stakeholders can develop interventions that enhance the nutritional quality of street food while ensuring it remains accessible and appealing to consumers.

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## CONFLICTS OF INTEREST

All authors declare that they have no conflicts of interest concerning the publication.

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## Research Article (FF22)

# Development of high-energy and high-protein snacks (Hi OVO CHICKY) for Patients with Renal Replacement Therapy

Khataleeya Kaewkoon<sup>1</sup>, Thanattha chaimongkol<sup>1</sup>, Rinrada Talearnngkul<sup>1</sup>,  
Petehmanee Thongjang<sup>1</sup>, Kajeepan Keawso<sup>1\*</sup>

<sup>1</sup>*Nutrition Department of Phyathai 2 Hospital, Bangkok, Thailand*

## ABSTRACT

End-stage renal disease patients receiving hemodialysis (ESRD on HD) have been shown in numerous studies to be malnourished. At the Phyathai 2 Hospital hemodialysis center, it was found that 92% and 81% of patients, respectively, consumed insufficient energy and protein. Additionally, 43% of patients took oral nutrition supplements but remained inadequate due to their dislike of the taste and the high cost. These patients prefer Thai snacks for their soft and crispy texture. The objective is to develop high-energy and protein snacks for ESRD on HD by developing Thai custard and crispy rice. Develop the recipe by selecting protein from egg whites, egg white powder, and chicken breast. Calculate the nutritional value using the program INMUCAL-Nutrient v.4 and analysis in the laboratory. Then, evaluate the satisfaction (5-point hedonic scale) in the general population before adjusting the recipe for 26 patients. Thai custard contains 215 kcal of energy, 10 g of protein, 264 mg of potassium, 55 mg of phosphorus, and 254 mg of sodium. Crispy rice contains 293 calories, 8 g of protein, 84 mg of potassium, 28 mg of phosphorus, and 273 mg of sodium per serving. According to ESRD HD patients' satisfaction, Thai custard was favored at a medium-high level, while crispy rice was preferred highly. Thai custard and crispy rice contain twice and four times, respectively, as much protein as similar products on the market. In further study, clinical studies are recommended. The product can serve as a model for other malnourished patient groups.

Key words: Thai custard, crispy rice, high energy and protein snack, snack for patients with renal replacement therapy

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\* Correspondence: kajeepan\_kea@phyathai.com

## INTRODUCTION

The number of patients receiving renal replacement therapy (RRT) through hemodialysis tends to increase each year. According to 2020 statistics from the Nephrology Society of Thailand, there were 129,724 patients<sup>1</sup>. Research by Niroj et al. found that 30-80% of these patients did not receive sufficient energy and 70 - 90% of patients did not consume inadequate protein. Most patients had insufficient eating behaviors, poor-quality diets, and altered taste perceptions, leading to reduce their appetite and lower food intake<sup>2</sup>. Research by Jukkrit et al. found that 120 patients with end-stage renal disease receiving hemodialysis at Maharaj Nakorn Chiang Mai Hospital consumed an average of  $0.89 \pm 0.68$  grams of protein/ kg/ day and an average of  $21.23 \pm 10.11$  kilocalories/ kg/ day, which are below the recommendations set by the Nephrology Society of Thailand<sup>3</sup>.

Patients with chronic kidney disease undergoing renal replacement therapy experience a protein-energy wasting rate of 50–70%, which contributes to increased mortality, infections, and a higher incidence of cardiovascular events<sup>4</sup>. The 2018 guidelines for medical practice by the Nephrology Society of Thailand and the Society of Parenteral and Enteral Nutrition of Thailand provide recommendations for patients with kidney failure undergoing hemodialysis. Energy intake should be at least 35 kcal/ kg of ideal body weight/ day, and for those over 60 years old, at least 30 kcal/ kg of ideal body weight/ day. Protein intake should be at least 1.1-1.4 g/ kg of ideal body weight/ day. Sodium intake should be limited to 1.8–2.5 g/ day, potassium to 2,000–2,500 mg/ day, and phosphorus to 800–1,000 mg/ day<sup>4</sup>. Of the 26 hemodialysis patients who agreed to participate in this study at Phyathai 2 Hospital, a nutrition questionnaire was used. Dietitians conducted interviews using a food frequency questionnaire and gathered information on the usual diet from the patient or their caregiver. The results of the nutritional questionnaire for the patients in the hemodialysis center at Phyathai 2 Hospital showed that 92 percent of patients did not consume enough energy, and 81 percent did not consume enough protein. On dialysis days, 31 percent of patients ate less than usual due to the time required to travel to the hospital and undergo dialysis. Additionally, most patients in the hemodialysis center were elderly (73 percent) and experienced physical changes, oral health issues, altered taste perception, digestive problems, and mental health challenges, all of which contributed to reduced food intake. While 43% of participants took oral nutritional supplements, they still did not meet their energy and protein needs due to dislike of the taste, water intake restrictions, and the high cost of the supplements.

Food products available in Thailand for patients with end-stage renal disease undergoing renal replacement therapy include Albupro Plus. This product was researched by Associate Professor Suwimol Sapwarabol, Ph.D., from the Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University. Albupro Plus is a dietary supplement developed with high egg white protein. It comes in two forms: a drink formula, with 1 sachet (25 grams) providing 100 kilocalories of energy and 10 grams of protein, and a thick soup formula, with 1 serving offering 18 grams of protein<sup>5</sup>.

A study was conducted on the development of an ice cream replacement product for kidney disease patients undergoing peritoneal dialysis. The ingredients used in this product include rice milk,

egg whites, coconut condensed milk, sugar, vanilla pods, and two flavors: cinnamon and lemon. Sensory perception was assessed using a Likert scale to evaluate taste, texture, and overall acceptability. The results of the study showed that the satisfaction scores for the two flavors were not significantly different<sup>6</sup>.

The study of food products for dialysis patients in Thailand is still quite limited. Therefore, the research team reviewed studies on similar high-protein products and explored product development for patients with other diseases, as follows: A study on the development of a high-protein soy milk pudding recipe using a sugar substitute for HIV-infected individuals with oral issues. The main protein source was isolate whey protein, and the satisfaction score was at an acceptable level among the volunteers<sup>7</sup>. A study on the development of high-protein, reduced-sugar soy milk candy for HIV-infected individuals, also using isolate whey protein as the primary protein source. Each serving of candy contained 7 grams of protein. Sensory quality was assessed using a 9-point hedonic scale, and the formula with sugar and sucralose received an overall average satisfaction score that was accepted by the volunteers<sup>8</sup>. A study on the development of high-protein crispy rubies made from egg whites for cancer patients. Steamed egg whites were used in place of water chestnuts, with different toppings (coconut milk, cereal coconut milk, cow's milk, and soy milk). The sensory quality was evaluated using a 9-point hedonic scale, and the satisfaction scores for all formulas were not significantly different<sup>9</sup>.

According to the nutritional questionnaire of patients in the hemodialysis center at Phyathai 2 Hospital, they prefer Thai snacks for their soft and crispy texture. However, due to chronic kidney disease, these patients must avoid their favorite snacks. For this reason, the nutrition department at Phyathai 2 Hospital plans to develop a snack recipe that is high in energy and protein specifically for patients with end-stage renal disease receiving renal replacement therapy. The goal is to support their medical treatment by providing a snack with a texture and taste that patients find acceptable, helping them to meet their nutritional needs more effectively.

## MATERIALS AND METHODS

Based on a questionnaire of hemodialysis patients at Phyathai 2 Hospital, two Thai desserts were developed to meet their needs: 1. High-energy and high-protein Thai custard, and 2. High-energy and high-protein crispy rice. The ingredients for the high-energy and high-protein Thai custard include Coconut Cream Alternative from 4Care Co., Ltd., Equal sugar (a sugar substitute made from 99.78% erythritol and 0.22% sucralose) imported by MERISANT (THAILAND) LTD, as well as other ingredients such as eggs, mung beans, coconut sugar, rice flour, salt, and pandanus leaves, all sourced from the market. For the high-energy and high-protein crispy rice, the ingredients include egg white powder from KIN YOO DEE COMPANY LIMITED, along with minced chicken, chicken eggs, rice bran oil, garlic, pepper, sugar, and salt, all of which are also purchased from the market.

The recipes were developed by selecting protein sources such as egg whites, egg white powder, and chicken breast, based on their Protein Digestibility Corrected Amino Acid Score (PDCAAS) and Digestible Indispensable Amino Acid Score (DIAAS)<sup>10</sup>. PDCAAS has been adopted by the FAO/WHO

as the preferred method for measuring the protein value in human nutrition. This method compares the concentrations of amino acids. The highest PDCAAS value a protein can achieve is 1.0, indicating that the protein provides 100% (or more) of all the amino acids required in the diet. Chicken breast and eggs both have a PDCAAS value of 1.0. In the newer scoring system, the Digestible Indispensable Amino Acid Score (DIAAS), protein quality is based on the relative digestible content of indispensable amino acids and the amino acid requirement pattern. DIAAS values can exceed 1.0, with chicken breast having a value of 1.08 and eggs a value of 1.13<sup>10</sup>. This study selected raw materials based on their high PDCAAS and DIAAS scores. The formula for high-energy, high-protein Thai custard is developed by increasing the number of eggs to achieve the desired texture. Coconut cream alternatives are used instead of coconut milk, and sweeteners are substituted for some of the sugar to make it suitable for patients. The taste and texture are similar to traditional Thai custard available on the market. For the high-energy, high-protein crispy rice, protein from chicken breast, eggs, and egg white powder is added. Since crispy rice typically contains little protein, the formula is adjusted by gradually increasing the amount of chicken breast, eggs, and egg white powder to maintain a crispy texture without becoming stale. How to make high-energy, high-protein Thai custard: Soak mung beans in hot water, then blend coconut sugar, coconut cream alternatives, rice flour, mung beans, salt, and Equal® sugar. Add egg whites and blend until smooth. Pour the mixture into aluminum foil cups and bake at 180°C for 15 minutes. For high-energy, high-protein crispy rice: Steam the egg whites. Then, mix chicken, egg whites, salt, pepper, sugar, garlic, and soup blend. Knead the mixture with flour and egg white powder. Once mixed, wrap the mixture in food wrap to form a cylindrical shape. Steam until fully cooked (about 30 minutes), then let it cool and freeze overnight. Slice the rice crackers into thin sheets and sun-dry them for 3 days. To fry, heat a pan and fry until crisp.

Nutritional values were calculated by using the INMUCAL-Nutrient v.4 program to ensure higher energy and protein content than standard market formulas. The nutritional content was also analyzed in a standard laboratory. For human research, IRB approval was obtained from the Phyathai-Paolo Group.

Sensory acceptability was assessed using a 5-point hedonic scale in a group of 50 general participants before being studied on hemodialysis patients. In the general group, the satisfaction assessment revealed that Thai custard passed all criteria, including appearance, color, smell, taste, texture, and overall acceptability. However, the crispy rice did not meet the criteria for taste and acceptability. As a result, the team redeveloped the high-energy and high-protein crispy rice formula before proceeding with tests on kidney disease patients.

Inclusion criteria for selecting patients to join the project were as follows: patients with chronic kidney disease receiving renal replacement therapy via hemodialysis at the Hemodialysis Center, Phyathai 2 Hospital; individuals aged 20 years and over; Thai nationals; and those without mental illnesses or intellectual disabilities that impair communication, who can consume food orally. Exclusion criteria included: individuals unable to perceive or make decisions independently, those with progressing physical illnesses, patients receiving food via a feeding tube, patients/relatives unable to participate due

to inconvenience, those allergic to food ingredients, and individuals with sensory disorders affecting taste or smell. A total of 26 hemodialysis patients agreed to participate in the project. The recommended sensory acceptability group size was 25–50 participants <sup>11</sup>. The first sensory acceptability test used a 5-point Hedonic scale to assess satisfaction with the product's appearance, color, smell, taste, texture, and overall acceptability. The scale divides preferences into five levels: Level 5 = Like the most, Level 4 = Like very much, Level 3 = Like moderately, Level 2 = Like a little, and Level 1 = Like the least. The results were reported through preference analysis. Method of calculating satisfaction scores: Scores are assigned based on the 1-5 scale, from least to most liked, according to the level of satisfaction reported by the patients. The mean and standard deviation are then calculated to determine overall satisfaction (**Figure 1**).

Sensory acceptability form for high-energy and high-protein Thai snack

Thai custard

<b>1. Appearance</b>	<b>2. Color</b>
<input type="checkbox"/> Like least	<input type="checkbox"/> Like least
<input type="checkbox"/> Like a little	<input type="checkbox"/> Like a little
<input type="checkbox"/> Like moderately	<input type="checkbox"/> Like moderately
<input type="checkbox"/> Like very much	<input type="checkbox"/> Like very much
<input type="checkbox"/> Like the most	<input type="checkbox"/> Like the most
Suggestion _____	Suggestion _____
<b>3. Smell</b>	<b>4. Taste</b>
<input type="checkbox"/> Like least	<input type="checkbox"/> Like least
<input type="checkbox"/> Like a little	<input type="checkbox"/> Like a little
<input type="checkbox"/> Like moderately	<input type="checkbox"/> Like moderately
<input type="checkbox"/> Like very much	<input type="checkbox"/> Like very much
<input type="checkbox"/> Like the most	<input type="checkbox"/> Like the most
Suggestion _____	Suggestion _____

**Figure 1.** Sensory Acceptability Form

Sensory testing for general participants is conducted in a designated room, while assessments for patients take place at the hemodialysis center after they have completed their dialysis sessions. The assessment rounds are organized according to the days the patients undergo dialysis and are conducted over approximately one month. The assessment begins with an explanation of the criteria for evaluating the six sensory items and the scales used. Following this introduction, high-energy, high-protein Thai custard, crispy rice, and drinking water are served to the participants.

## RESULTS AND DISCUSSION

The first sensory acceptability test was for 50 general participants, and the patient test was for 26 patients at the hemodialysis center of Phyathai 2 Hospital (**Table 1**).

**Table 1.** Characteristics of the Participants.

Characteristics	General participants (N = 50)		Hemodialysis participants (N = 26)	
	Male	Female	Male	Female
Participants	24 (48%)	26 (52%)	10 (38%)	16 (62%)
Age (years)				
20-30	3 (6%)	4 (8%)	0	0
30-40	7 (14%)	6 (12%)	3 (11%)	1 (4%)
40-50	4 (8%)	5 (10%)	2 (8%)	1 (4%)
>50	10 (20%)	11 (22%)	5 (19%)	14 (54%)
BMI (kg/m <sup>2</sup> )	N/A	N/A	21.26*	20.50*
			(17.08-29.63)*	(14.76-29.00)*
Co-morbid (diabetes)	N/A	N/A	4 (15%)	9 (35%)

\* Median (Range)

Ingredients of high-energy and protein, Thai custard: chicken eggs (egg white) 53.8%, coconut cream alternative 21.5%, green peas 10.7%, coconut sugar 5.3%, Equal sugar 5.3%, rice flour 3.2%, salt 0.2%, and pandanus leaves. Ingredients of high energy and protein, crispy rice: minced chicken 15.4%, chicken eggs (egg white) 24.9%, tapioca flour 27.2%, rice bran oil 14.2%, egg white powder 7.8%, garlic 4.7%, pepper 3.8%, sugar 1.5%, and salt 0.5% (**Figure 2**).



**Figure 2.** High-energy and high-protein Thai custard and crispy rice

In the first sensory acceptability test involving 50 general participants, the high-energy and high-protein Thai custard received high marks for all acceptability measures (**Table 2**). However, the high-

energy and high-protein crispy rice did not pass in terms of taste and overall acceptability. As a result, the ingredients were adjusted from salt (with reduced sodium and added potassium) to regular salt, while controlling the amount used.

When developing the formulas for high-energy and high-protein Thai custard and crispy rice, both were evaluated for sensory acceptability in hemodialysis patients and passed the criteria.

**Table 2.** Sensory acceptability scores for high-energy and high-protein Thai custard and crispy rice in hemodialysis patients

Variables	Thai custard		Crispy rice	
	Mean	SD	Mean	SD
Appearance	3.27	0.96	4.16	0.80
Color	3.31	0.97	4.40	0.71
Smell	3.58	0.99	3.72	0.79
Taste	3.50	0.95	3.96	0.84
Texture	3.81	0.80	4.20	0.82
Overall acceptability	3.69	0.84	4.00	0.76

According to hemodialysis patients' satisfaction, Thai custard was favored at a medium-high level, while crispy rice was highly preferred.

**Table 3.** Nutrition Analysis of high-energy and protein Thai custard and crispy rice per 1 serving

Food testing	Thai custard (150 g)	Crispy rice (50 g)
Calories (kcals)	215.00	293.00
Carbohydrate (g)	26.10	18.45
Protein (g)	10.08	7.95
Fat (g)	7.73	20.80
Phosphorus (mg)	54.90	28.00
Potassium (mg)	264.00	84.00
Sodium (mg)	254.00	273
Sugars (g)	8.44	0.93
Dietary fiber (g)	1.88	1.33

\*The laboratory has been accredited in compliance with ISO/IEC 17025 standards.

The laboratory analysis results found that Thai custard contains 215 kcal of energy, 10 g of protein, 264 mg of potassium, 55 mg of phosphorus, and 254 mg of sodium (Table 3). A

serving of 150 grams of protein-fortified custard contains 49% carbohydrates, 19% protein, and 32% fat of the total energy distribution. This formula contains twice as much protein as commercial egg custard and bean custard.

Crispy rice contains 293 calories, 8 g of protein, 84 mg of potassium, 28 mg of phosphorus, and 273 mg of sodium per serving. A serving of 50 grams of crispy rice contains 25% carbohydrates, 11% protein, and 64% fat in the total energy distribution. This recipe uses good fat from Coconut Cream Alternative, made from rice bran oil, which contains 4 times more protein than commercial shrimp crackers.

The study included 26 hemodialysis patients, which is a relatively small sample size. In general, a sample size of 25-50 participants is recommended for sensory acceptability studies. Due to the short data collection period of one month. However, the findings could be applicable to patients who require high-energy and high-protein diets, such as the elderly, cancer patients, and burn patients.

This research is still a pilot stage. There has been no study on the effects of consuming high-energy and high-protein snacks on changes in nutritional parameters such as albumin, pre-albumin, kidney function, electrolytes, and body composition, which are planned for the future studies.

## CONCLUSION

Thai custard and crispy rice contain twice and four times as much protein, respectively, as similar products on the market. A serving of Thai custard provides protein equivalent to 3 egg whites, while a serving of crispy rice provides protein equivalent to 2.5 egg whites. Both recipes are accepted by the general public and patients undergoing renal replacement therapy. They could be further developed for other patient groups requiring high-energy and high-protein diets, offering benefits such as improved nutrition, better quality of life, reduced hospitalization time, enhanced good recovery, and decreased patient expenses.

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## Research Article (FF23)

### Preparation of Cream Cheese from Rice Bran Wax Organogel

Preedaporn Sirimangkalakorn<sup>1\*</sup>, Supathra Lilitchan<sup>1\*</sup>, Kornkanok Aryusuk<sup>2</sup>

<sup>1</sup>Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand

<sup>2</sup>Division of Biochemical Technology, School of Bioresources and Technology, King Mongkut's University of Technology Thonburi (KMUTT), Bangkok, Thailand

#### ABSTRACT

Cream cheese is widely used in both savory and sweet culinary applications. Traditional cream cheese can contain up to 60 percent fat, with 50 percent of that being saturated fat. Multiple studies have shown that consuming a high-fat diet raises the risk of chronic diseases. Substituting milk fat with vegetable oil in cream cheese improves its fat composition. Therefore, this study aims to replace the fat in cream cheese by using a blended oil of rice bran oil (RBO), *camellia oleifera* seed oil (CSO), and perilla seed oil (PSO), combined in appropriate ratios and incorporated into an organogel. The objective of this study is to create an organogel cream cheese with reduced fat content and lower saturated fatty acids. The study examines the physicochemical properties and nutritional value of the blended oil organogel cream cheese product in comparison to full-fat commercial cream cheese (CO). The study found that the organogel cream cheese had lower firmness and spreadability compared to commercial cream cheese, making it easier to apply and spread. It contains less than half the total fat of the commercial formula, resulting in lower energy content. The results suggest that blended oil organogels can serve as a fat substitute in cream cheese products, providing less energy. However, to increase firmness, it is recommended to either change the type of organogelator or increase the amount used. The reason for choosing RBW as the organogelator in this study is that previous studies have shown it provides a firmness and spreadability similar to full-fat commercial cream cheese.

**Key words:** organogel, cream cheese, blended oil, rice bran wax

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\* Correspondence: supathra.lil@mahidol.ac.th, preedaporn.ratta@gmail.com

## INTRODUCTION

Cream cheese is a popular ingredient used in a wide variety of baked goods and savory dishes. It is made with buttermilk and contains up to 60% fat by weight, more than 50% of that being saturated fat. Beyond its nutritional value, fat plays a crucial role in defining the sensory and functional properties of cream cheese. As a result, traditional cream cheese is unsuitable for individuals with abnormal blood lipid levels. Low fat cream cheese, while a healthier option, is often less flavorful than its full-fat counterpart and is less readily available in Thailand. However, research by Bemer et al.<sup>1</sup> found that replacing saturated fat with healthier unsaturated fats using an edible organogel made from rice bran wax as an organogelator and soybean oil as the liquid phase can improve the fatty acid profile of cream cheese. In this study, blended oils are therefore an interesting alternative to replace saturated fats in cream cheese. Therefore, we chose to use rice bran oil (RBO), *Camellia oleifera* seed oil (CSO) and Perilla seed oil (PSO) mixed in a ratio of 80:10:10 percent to obtain the fatty acid composition as specified by the World Health Organization (WHO).

Rice bran oil (RBO) is an excellent source of unsaturated fatty acids, with a low content of saturated fatty acids (SFA) and a high content of monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA). Its fatty acid profile, with a ratio of 25:38.4:36.6 percent, closely aligns with the recommendations set by the WHO (SFA:MUFA:PUFA=1:1.5:1). Additionally, rice bran oil is rich in antioxidants, including vitamin E (in the forms of tocopherols and tocotrienols), phytosterols, and  $\gamma$ -oryzanol, making it a beneficial choice for promoting heart health and preventing metabolic disorders<sup>2</sup>. *Camellia oleifera* seed oil (CSO) is rich in monounsaturated fatty acids (MUFA), with over 70% being omega-9. It also contains approximately 80% catechin, a potent antioxidant. However, it has relatively low levels of polyunsaturated fatty acids (PUFA) and saturated fatty acids (SFA)<sup>3</sup>. Perilla seed oil (PSO) is an excellent source of  $\alpha$ -linolenic acid (18:3, n-3) and linoleic acid (18:2, n-6), making it rich in essential omega-3 and omega-6 fatty acids. However, it has lower levels of monounsaturated fatty acids (MUFA) and saturated fatty acids (SFA)<sup>4</sup>. Since no single refined oil offers an ideal fatty acid composition as recommended by the WHO, blending different oils is a practical approach to modify the fatty acid profile and achieve a balanced fat ratio. However, replacing milk fat with liquid oil affects the physical properties of cream cheese, so the oil structure must be modified into a semi-solid form, known as an organogel. Organogels are a type of gel consisting of an organic liquid phase trapped within a three-dimensional, cross-linked network<sup>5</sup>. The most important component of an organogel is the gel-forming agent, known as the organogelator. In this study, rice bran wax (RBW) is used as the organogelator. Since RBW is widely utilized in the food industry, it is favored for its low gelation concentration, affordability, and safety.

However, no research has yet explored the use of blended oil as organogels in cream cheese. Previous studies have only shown that organogels made from soybean oil, with RBW as the organogelator, produced physicochemical properties similar to those of full-fat commercial cream cheese. Therefore, this study will focus on preparing organogels from blended oils using RBW as the

organogelator to evaluate and compare their physicochemical properties and nutritional value to full-fat commercial cream cheese. The goal is to develop a healthier cream cheese with lower fat content and reduced levels of saturated fatty acids. Objective of this study were to prepare cream cheese from blended oil-based rice bran wax organogels substitute milk fat to reduce fat content and lower saturated fatty acids and to analyze the physicochemical properties, and nutritional value of cream cheese made from blended oil rice bran wax organogels to compare with commercial full fat cream cheese. Hypothesis : Replacing milk fat with a blended oil-based organogel results in lower SFA, higher MUFA and PUFA, and includes omega-3, omega-6, and polyphenols. The proposed product can have textural properties similar to full-fat cream cheese.

## MATERIALS AND METHODS

### 1. Materials

The oils used in the study were 100% rice bran oil, 100% *Camellia oleifera* seed oil, and 100% cold-pressed perilla seed oil. Other ingredients used to make cream cheese include skim milk liquid, skim milk powder, whey protein isolate, salt, microorganisms, and rennet were purchased in Thailand. Food additive was stabilizer, and rice bran wax was food grade. All chemicals used in this study were analytical grade.

### 2. Preparation of blended oil

To prepare blended oil, rice bran oil (80%) was combined with *Camellia oleifera* seed oil (10%) and perilla seed oil (10%). The mixture was stirred using a mechanical stirrer at 200 rpm for 15 minutes at 60°C to ensure thorough blending. After mixing, the blend was cooled to room temperature and stored in a refrigerator (4-5°C) before analysis.

### 3. Preparation of RBW organogel from blended oil

Rice bran wax 10% wt. was dispersed in the blended oil mixture and heated to 85°C using a mechanical stirrer at 200 rpm. The heated dispersion was then cooled in an ice bath to 24°C. Once cooled, the rice bran wax organogel was stored in a freezer for 24 hours. Then, store in a refrigerator at 4-5°C before analysis.

### 4. Preparation of cream cheese from rice bran wax organogel

Adapted from Bemer et al.<sup>1</sup> First, the organogel (11% wt.) was heated to 85°C at 200 rpm, then heated skim milk (70°C for 15 seconds) was added at 77% wt. The mixture was blended using a homogenizer at 10,000 rpm for 4 minutes. During blending, skim milk powder (10% wt.), whey protein isolate (WPI) (1% wt.), were added. Second, the mixture was cooled to 30°C, and culture, and rennet were gently stirred in. The samples were then incubated at 30°C for 18 hours. Once coagulated, the pH was measured between 4.5-4.8. The curd was cut, and heated water was added. The whey was drained using a filter cloth for 12 hours at 4°C. Finally, salt, and stabilizer were mixed into the samples using a

spatula until smooth. The organogel cream cheese samples were refrigerated for 24 hours before analysis of physicochemical properties and nutritional value.

### 5. Analysis of chemical properties of blended oil, organogel, organogel cream cheese

Analyzed acid value and peroxide value according to AOAC (1995) method 940.28<sup>6</sup> and method 965.33<sup>6</sup> respectively.

### 6. Analysis of physical properties of cream cheese

#### 6.1 The color of organogel cream cheese

The color of the samples was measured using an instrumental hunter lab colorimeter. (ColorFlex EZ, Hunter Associates Laboratory, Inc., Virginia, USA)

#### 6.2 The texture of organogel cream cheese

The texture analysis, as measured using a texture analyzer (TA1, Ametek Lloyd Instruments Ltd., West Sussex, United Kingdom), was adapted from Adulpadungsak (2020)<sup>7</sup>.

### 7. The composition of cream cheese

The composition of the cream cheese was analyzed using proximate analysis according to AOAC (2023)<sup>6</sup> includes moisture, ash, crude protein, crude fat, crude fiber, and carbohydrate (nitrogen free extract) by calculating.

### 8. Statistical analysis

The completely randomized design (CRD) was statistically analyzed using SPSS version 18 software. The results, measured in triplicate, are reported as the mean  $\pm$  standard deviation. An independent t-test was used to compare the means between two groups of samples at a 95% confidence interval. The significance of differences between the means of three groups was assessed using Duncan's Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

### 1. Chemical properties of blended oil, and organogel

The acid value (AV) and peroxide value (PV) of blended oil, organogel and cream cheese stored in the refrigerator (4-5°C) are shown in **Table 1**. The av of cream cheese was significant differences ( $P < 0.05$ ) from BO and organogel but not exceed the limit of the standard ( $\square 4.0$  mg KOH/g fat)<sup>8</sup>. The PV was used to analyze oxidative stability of oil. The organogel was significant differences ( $P < 0.05$ ) from BO and cream cheese. The PV of all organogels were not exceed 10 meg/kg, based on the FDA Thailand standard<sup>8</sup>.

**Table 1.** The acid value and peroxide value of blended oil, organogel and organogel cream cheese samples stored in the refrigerator (4-5°C).

Character	Formula		
	Blended oil	RBO	RBC
AV(mg KOH/g)	1.00 ± 0.06 <sup>a</sup>	0.96 ± 0.13 <sup>a</sup>	1.85 ± 0.14 <sup>b</sup>
PV (meq/kg)	1.95 ± 0.3 <sup>b</sup>	1.06 ± 0.06 <sup>a</sup>	1.68 ± 0.07 <sup>b</sup>

Note: mean±sd; RBO: rice bran wax organogel; RBC: rice bran wax organogel cream cheese.

<sup>a-c</sup>Different letters in the same row in each category represent statistically significant differences (P < 0.05)

## 2. Physical properties of cream cheese

### 2.1 The color of organogel cream cheese

The color values (L\*, a\*, b\*) of the cream cheese samples are presented in **Figure 1 and**

**Table 2.** The L\* value indicates lightness, ranging from 0 (black) to 100 (white). The a\* value represents the green-red axis, with negative values indicating green and positive values indicating red. The b\* value represents the blue-yellow axis, with negative values indicating blue and positive values indicating yellow. The L\* value of RBC was significant differences (P < 0.05) from CO because the RBC was lighter than CO. The a\* value of RBC was a negative value, which meant towards green rather than red and it was significant differences (P < 0.05) from CO. The b\* value had significant differences (P < 0.05) from CO. The CO was yellower than RBC because the amount of fat in formula was higher than RBC and added color to make it look more appetizing.



**Figure 1.** The CO (a) and RBC (b) cream cheeses samples

**Table 2.** The physical properties of cream cheese samples stored in the refrigerator (4-5°C).

Character	Formula		p-value
	CO	RBC	
L*	88.54±0.10	93.73±0.61	0.004
a*	1.40±0.02	-1.31±0.05	<0.001
b*	20.98±0.31	12.91±0.17	<0.001
Firmness (N)	1.18 ± 0.07	0.21 ± 0.04	<0.001
Work of shear (Nmm)	3.65 ± 0.33	0.90 ± 0.23	<0.001

Note: mean±sd; CO: commercial full fat cream cheese; RBC: rice bran wax organogel cream cheese; p-value: significant differences at  $p < 0.05$

## 2.2 The texture of organogel cream cheese

The textural properties of the organogel cream cheese samples, including firmness and spreadability (work of shear), were measured after being stored at refrigeration temperature (4-5°C), as shown in Table 2. Firmness and spreadability are commonly used to assess the textural properties of products like cream cheese, butter, margarine, and chocolate spread. The firmness and spreadability of the organogel cream cheese showed significant differences ( $P < 0.05$ ) compared to the control (CO), but it was easier to spread than the control. Factors affecting the firmness differences from the control formula may include the amount of fat used, the type of organogelator and other ingredients such as milk content, butterfat, etc.

## 3. The composition of cream cheese

The composition of cream cheese is presented in **Table 3**. The moisture content of the cream cheese showed significant differences ( $P < 0.05$ ) compared to the control (CO) due to the less efficient whey extraction process compared to industrial factories. However, it remained within the USDA-specified criteria for reduced-fat cream cheese, which limits moisture content to no more than 70%<sup>9</sup>. The crude protein content also showed significant differences ( $P < 0.05$ ) compared to the control, as it had a higher protein content due to the addition of whey protein isolate. The crude fat content showed significant differences ( $P < 0.05$ ) compared to the control, with the addition of organogel reducing the fat content to less than half of that in the control, making it suitable for people with non-communicable diseases (NCDs). No crude fiber was found in either of the cream cheese products. The ash was significant differences ( $P < 0.05$ ) compared to the control. Carbohydrate content also showed significant differences ( $P < 0.05$ ) compared to the control due to the addition of a stabilizer to enhance the stability of the cream cheese. The energy content of the RBC showed significant differences ( $P < 0.05$ ) compared

to the control, with the RBC containing 35% less energy than the full-fat cream cheese due to the reduced crude fat content.

**Table 3.** The composition of cream cheese samples per 100 grams

Composition	Formula		p-value
	CO	RBC	
Moisture (gram)	55.67±0.06	64.31±0.06	<0.001
Crude protein (gram)	6.18±0.04	10.14±0.01	0.002
Crude fat (gram)	31.06±0.34	14.79±0.17	0.002
Crude fiber (gram)	0.00±0.00	0.00±0.00	-
Ash (gram)	1.45±0.01	1.52±0.01	0.014
Carbohydrate (gram)	5.59±0.40	9.24±0.13	0.032
Energy (Kcal)	326.62 ±4.81	210.63±2.09	0.006

Note: mean±sd; CO: commercial full fat cream cheese; RBC: rice bran wax organogel cream cheese; p-value: significant differences at  $p < 0.05$

## CONCLUSION

The organogel cream cheese was made using blended oil-based rice bran wax organogels. This formulation had significantly reduced fat content (52% less than the control), lower saturated fatty acids (SFA), and lower energy (35% less than full-fat cream cheese), making it a suitable option for individuals with non-communicable diseases (NCDs). The findings indicate that blended oil organogels can effectively replace fat in cream cheese products. However, the cream cheese showed reduced firmness compared to the control, which resulted in easier spreadability. To address this, it is recommended to either change the type of organogelator or increase the quantity used.

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## Research Article (FF24)

### Development of a Nutrient-Dense Popsicle from Tempe and Pineapple for Supporting Energy and Protein Intake in Stunted Children in Indonesia

Adelya Desi Kurniawati\*, Belvana Alrizqi, Fanny Fauri Salsabillah Surya, Audrey Kinanti

Fadhillah, Gumlilang Lintang Insani, Rahma Micho Widyanto, Olivia Anggraeny

*Nutrition Department, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia*

#### ABSTRACT

The prevalence of stunting in Indonesia reached 21%, which is considered high according to WHO standards. Addressing this health issue, stunted children require nutrient-dense foods, particularly those high in energy and protein. This study aims to develop a high-energy, protein-rich popsicle made from tempe, pineapple, and pineapple peel juice as an interlude food for stunted children. This study was conducted with a completely randomized design (CRD) method with five formulations, comparing different ratios of pineapple, tempe, and pineapple peel juice, F1 (100:0:0), F2 (75:10:15), F3 (50:20:30), F4 (25:30:45), and F5 (0:40:60). The final product was then analyzed for chemical characteristics (proximate composition, energy, antioxidant activity, and Vitamin C content) and organoleptic properties (color, taste, aroma, texture, and overall appearance). Statistical analysis revealed significant differences ( $p<0.05$ ) in protein, fat, moisture, ash, energy, and vitamin C levels among the formulations, while carbohydrate content was insignificant. The best formulation based on chemical characteristics was F5, accounting for 194.45 Kcal energy, 7.92% protein, 4.5% fat, 28.31% carbohydrates, 57.25% moisture, and 0.84% ash. Additionally, it supplies 32.12 mg/100g, and antioxidant activity recorded at IC50 score 417.6 ppm. However, the popsicle's acceptability test showed that the panelists accepted F3 as the most accepted formulation. One serving size popsicle (50 g) of F3 contributes 45.67% of the daily energy and provides 198% of the daily protein needs from snacks (15% of daily need), suggesting that the final product could be a beneficial alternative snack for undernourished children requiring high energy and protein support.

**Key words:** popsicle, tempe, pineapple, stunting

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\* Correspondence:adel.kurniawati@ub.ac.id

## INTRODUCTION

Lactose intolerance, a clinical syndrome triggered by the consumption of lactose-containing foods, often leads to acute gastrointestinal symptoms such as diarrhea, which can hinder nutrient absorption and contribute to malnutrition and stunting<sup>1,2</sup>. In Indonesia, stunting remains a major public health issue. The stunting prevalence in Indonesia for 2022 is 21.6%, a significant reduction from previous years (24.4%) but still a critical concern affecting millions of children<sup>3</sup>. Stunting is multifactorial, not only due to sub-optimal nutritional intake and co-morbidities, but also due to poverty, and environmental health, including the availability of clean water. Recognizing the urgency of addressing stunting, the Indonesian government has set an ambitious goal to reduce the national stunting rate to 14% by 2024<sup>4</sup>.

One of the government's approaches to addressing the high incidence of stunting is by providing supplementary foods made from local ingredients. However, most of these supplementary food products are still dairy-based. The prevalence of lactose intolerance in Asian populations up to 90% in adults, is age-related. Data on the Indonesian population show the prevalence of lactose malabsorption in pre-elementary school (age, 3–5 years), 9 elementary schools (age, 6–11 years), 10 and junior high school (age, 12–14 years) children to be 21.3%, 57.8%, and 73%, respectively<sup>5</sup>. Therefore, fortified dairy substitutes and lactose-free options should be made available, ensuring that children receive the necessary nutrients for growth, even in the absence of dairy consumption. Popsicles present an innovative and practical solution to this problem.

Popsicles are a popular snack, especially among children, which offer a vehicle for nutrient fortification in a format that is easy to consume and highly appealing, particularly for children with poor appetites or texture sensitivities often seen in malnourished or stunted populations. Popsicles, with their cold and refreshing nature, are more likely to be accepted by children, even those with picky eating habits or poor appetites<sup>6</sup>. However, popsicles made with cow's milk are unsuitable for children who are lactose intolerant. Therefore, there is an urgent need to develop fortified, lactose-free popsicles using plant-based ingredients, such as tempe, which provides a rich source of protein and energy. By integrating natural fruit purees, such as pineapple fruit and pineapple peel juice, these popsicles can also deliver natural sugars, fiber, and essential vitamins, creating a balanced and nutritionally dense snack. Such products not only address the nutrient gaps left by the exclusion of dairy but also present an opportunity for improving the overall dietary intake of children at risk of stunting.

Tempe is a local food made from soybeans fermented by the fungus *Rhizopus* sp and has complete and balanced nutritional content which is very good for toddlers<sup>7,8</sup>. The tempe fermentation process produces enzymes that can break down complex organic compounds into simpler compounds so that nutrients such as protein in tempe can be easily absorbed by the body<sup>9</sup>. Pineapple is a rich source of vitamin C and antioxidants, making it a popular and nutritious fruit<sup>10</sup>. However, its consumption at the household level often results in waste, particularly the peel. Interestingly, pineapple peels also

contain valuable nutrients, including vitamin C, vitamin A, vitamin B, flavonoids, carotenoids, and the enzyme bromelain<sup>11,12</sup>. By combining the nutrients found in pineapple flesh, pineapple peel juice, and tempe, it is possible to create a food product that supports the nutritional needs of toddlers, providing both essential macronutrients and micronutrients.

The goal of this study is to develop a healthy, lactose-free complementary food alternative that can be easily produced at the household level. This product would provide high acceptability, energy, micronutrients, antioxidants, and vitamin C, ultimately enhancing the nutritional quality and health of toddlers with lactose intolerance.

## MATERIALS AND METHODS

### Research Design

This research was conducted in a Completely Randomized Design (CRD) with one factor: the ratio of pineapple fruits: tempe: pineapple peel juice, with 5 formulations as follows: F1 (100%:0:0), F2 (75%:10%:15%), F3 (50%:20%:30%), F4 (25%:30%:45%), dan F5 (0:40%:60%) (**Table 1**). Each formulation was replicated three times, resulting in 15 experimental units. The analysis conducted includes chemical parameters such as moisture content, ash, carbohydrates, protein, fat, total energy, vitamin C content, and antioxidant activity. Moreover, the organoleptic evaluation includes color, taste, flavor, textures, and overall appearance.

### Popsicle preparation

The tempe paste was prepared by combining tempe and pineapple peel juice in a 2:3 ratio, while the pineapple paste was made from fresh pineapple fruit. The tempe paste and pineapple paste were then combined in a pot and heated over low heat. Coarsely chopped dates were added, and the mixture was stirred continuously to prevent lumps from forming. Coconut milk was gradually incorporated into the mixture and blended thoroughly. In a separate step, a small portion of the popsicle mixture was mixed with cornstarch to prevent clumping before being returned to the pot and stirred thoroughly. A digital thermometer was used to monitor the temperature, and once it reached 60-70°C, the mixture was pasteurized for 5 minutes before turning off the heat. The mixture was then allowed to cool for approximately 5 minutes. After cooling, the popsicle mixture was weighed, poured into molds, and frozen for 6-7 hours.

**Table 1.** The formulation of tempe-pineapple popsicle

Ingredient	Formulation (%)				
	F1	F2	F3	F4	F5
Pineapple fruit	74.0	55.5	37.0	18.5	0.0
Tempe	0.0	7.4	14.8	22.2	29.6
Pineapple peel juice	0.0	11.1	22.2	33.3	44.4
Dates			11.9		
Cornstarch			1.5		
Coconut milk			12.6		
<b>Total</b>			100		

The temple-pineapple popsicle formulation consists of three main ingredients: pineapple fruit, tempe, and pineapple peel juice, along with supporting ingredients like Sukari dates, cornstarch, and coconut milk.

#### **Chemical Analysis (Proximate, energy, vitamin C, and antioxidant activity)**

For quantitative determination of the proximate composition of the tempe-pineapple popsicles, moisture was determined using a hot air oven (Association of Official Analytical Chemists; AOAC 952.08)<sup>13</sup>, dried samples at 105°C, until constant weight. Crude protein was determined according to the Kjeldahl method (AOAC 992.23)<sup>13</sup>; total nitrogen was multiplied by a protein factor of 6.25. Total fat was determined according to the acid hydrolysis method (AOAC 948.15)<sup>13</sup>, using a Soxhlet extractor at 60°C, until constant weight. Ash was determined according to the gravimetric method (AOAC 930.30)<sup>13</sup> incinerated samples at 550°C, until constant weight. Total carbohydrate was determined according to the difference method by calculation. The energy was determined by calculation based on the contents of carbohydrate, protein, and lipid multiplied by a factor of 4, 4, and 9 respectively, and then added the results together. Antioxidant activity was measured using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method<sup>14</sup>. The vitamin C content was tested using the iodometric titration method<sup>15</sup>.

#### **Organoleptic Analysis**

Before sensory evaluation, the popsicle samples were stored for one day (24 hours) at -20°C to reach a temperature of -10 to -8°C. The samples were then assigned random numbers. The panelists were asked to score and comment on the organoleptic characteristics like color, taste, flavor, textures, and overall appearance of the different variations of prepared samples and control. The sensory evaluation was conducted based on the Indonesian National Standard (SNI 01-2346-2006), with 25 panelists measuring these sensory attributes on a 7-point hedonic scale<sup>16</sup>. The highest score represents extremely like, and the lowest represents extremely dislike. (7 = like very much, 6 = like, 5 = like slightly, 4 = nor like or dislike, 3 = dislike slightly, 2 = dislike, and 1 = dislike very much). This research has

received approval for ethical feasibility from the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Brawijaya No. 1399/UN10.F17.10.4/TU/2023.

### Statistical Data Analysis

The descriptive statistical analyses were done using the IBM SPSS Statistics 25 Software package. The recorded data were subjected to a one-way analysis of variance (one-way ANOVA). The average value is compared with several Duncan distance tests. In all cases, p-values <0.05 were considered significantly different.

### RESULTS

In this study, the formulations consist of different ratios of pineapple fruit, tempe, and pineapple peel juice. The varying proportions of these ingredients directly affect the chemical and organoleptic properties of the formulations.

**Table 2** depicts the statistical analysis of water, protein, fat, ash, energy, and vitamin C content across the formulations and shows significant differences (p-value<0.05), as indicated by the distinct letter notations. This suggests that these components vary meaningfully between formulations. In contrast, carbohydrate content and antioxidant activity do not exhibit statistically significant differences (p-value<0.05). Notably, the protein, fat, energy, and vitamin C content significantly increase from F1 to F5, indicating that F5 is the most nutrient-dense formulation overall. This trend underscores the potential of F5 for improving nutritional intake.

**Table 2.** The chemical characteristics of popsicles made of pineapple, tempe, and pineapple peel juice in 100 grams of sample.

Formulation	F1	F2	F3	F4	F5
Water (%)	68.903 ± 1.387 <sup>c</sup>	67.107 ± 0.658 <sup>c</sup>	64.883 ± 0.523 <sup>bc</sup>	61.233 ± 0.597 <sup>ab</sup>	58.437 ± 2.508 <sup>a</sup>
Protein (%)	0.927 ± 0.092 <sup>a</sup>	2.370 ± 0.195 <sup>b</sup>	4.877 ± 0.345 <sup>c</sup>	6.760 ± 0.205 <sup>d</sup>	7.920 ± 0.347 <sup>e</sup>
Fat (%)	2.330 ± 0.379 <sup>a</sup>	2.750 ± 0.115 <sup>a</sup>	3.260 ± 0.216 <sup>ab</sup>	3.797 ± 0.29 <sup>bc</sup>	4.497 ± 0.540 <sup>c</sup>
Carbohydrates (%)	27.357 ± 1.312	24.096 ± 0.727	26.327 ± 0.792	27.433 ± 0.895	28.307 ± 2.107
Ash (%)	0.483 ± 0.023 <sup>a</sup>	0.550 ± 0.23 <sup>a</sup>	0.6533 ± 0.176 <sup>b</sup>	0.777 ± 0.041 <sup>c</sup>	0.840 ± 0.021 <sup>c</sup>
Energy (Kcal)	134.103 ± 5.304 <sup>a</sup>	143.123 ± 2.577 <sup>a</sup>	154.153 ± 1.358 <sup>ab</sup>	170.943 ± 1.326 <sup>bc</sup>	185.377 ± 12.283 <sup>c</sup>
Vitamin C	24.513 ± 2.064 <sup>a</sup>	20.480 ± 0.692 <sup>a</sup>	22.050 ± 1.239 <sup>a</sup>	25.537 ± 2.102 <sup>a</sup>	32.120 ± 1.953 <sup>b</sup>
Antioxidant activity	56.120 ± 6.961	60.387 ± 6.928	49.137 ± 12.017	45.870 ± 8.325	41.763 ± 7.858

The statistical data was calculated by one-way ANOVA. Each value in the table is represented as Mean ± SD.

Using Duncan's Multiple Range Test (P < 0.05), a different superscript within a row is represented as significantly different.

F1 was 100% pineapple, 0% tempe, 0% pineapple peel juice

F2 was 75% pineapple, 10% tempe, 15% pineapple peel juice

F3 was 50% pineapple, 20% tempe, 30% pineapple peel juice

F4 was 25% pineapple, 30% tempe, 45% pineapple peel juice

F5 was 0% pineapple, 40% tempe, 60% pineapple peel juice

Organoleptic evaluation conducted on a seven-point hedonic scale of the tempe pineapple popsicle was summarized in **Table 3**. The 25 semi-trained panelists participated in this test, using seven hedonic scales based on Indonesian National Standard (SNI) number 01-2346-2006<sup>16</sup>. In this research, organoleptic analysis was carried out on five levels of ratio formulation of pineapple, tempe, and pineapple peel juice. This organoleptic test is aimed at determining the level of acceptance of the popsicle based on five parameters: color, taste, flavor, texture, and overall appearance. According to the results presented, there are significant differences in taste, texture, and overall appearance. However, there are no significant differences in the color and flavor of tempe pineapple popsicles, which indicates that these characteristics were not strongly affected by the different formulations. The web radar chart showed that taste was the most affected parameter, which the increasing of tempe proportion in the mixture has negatively affected the taste.

**Table 3.** The organoleptic evaluation of popsicles made of pineapple, tempe, and pineapple peel juice.

Formulation	F1	F2	F3	F4	F5
Parameters					
Color	4.960 ± 0.280	4.760 ± 0.240	5.320 ± 0.214	4.800 ± 0.258	4.800 ± 0.252
Taste	5.760 ± 0.226 <sup>c</sup>	3.000 ± 0.265 <sup>ab</sup>	3.360 ± 0.336 <sup>b</sup>	2.440 ± 0.258 <sup>a</sup>	3.880 ± 0.393 <sup>b</sup>
Aroma	5.120 ± 0.260	4.600 ± 0.271	4.560 ± 0.295	4.360 ± 0.264	4.600 ± 0.277
Texture	4.800 ± 0.271 <sup>ab</sup>	4.160 ± 0.320 <sup>a</sup>	5.280 ± 0.303 <sup>b</sup>	4.680 ± 0.287 <sup>ab</sup>	4.960 ± 0.297 <sup>ab</sup>
Overall appearance	4.920 ± 0.276 <sup>ab</sup>	4.640 ± 0.244 <sup>a</sup>	5.440 ± 0.217 <sup>b</sup>	4.800 ± 0.300 <sup>ab</sup>	5.040 ± 0.227 <sup>ab</sup>

The statistical data was calculated by one-way ANOVA. Each value in the table is represented as Mean ± SD. Using Duncan's Multiple Range Test (P < 0.05), a different superscript within a row is represented as significantly different.

7 = like very much, 6 = like, 5 = like slightly, 4 = nor like or dislike, 3 = dislike slightly, 2 = dislike, and 1 = dislike very much

F1 was 100% pineapple, 0% tempe, 0% pineapple peel juice

F2 was 75% pineapple, 10% tempe, 15% pineapple peel juice

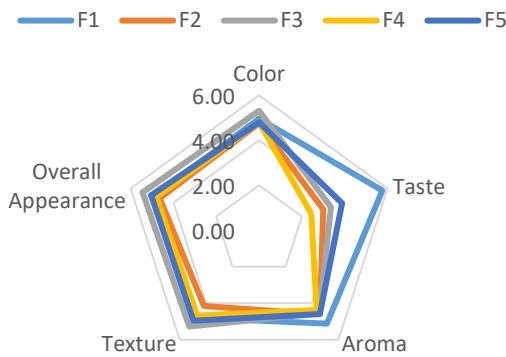
F3 was 50% pineapple, 20% tempe, 30% pineapple peel juice

F4 was 25% pineapple, 30% tempe, 45% pineapple peel juice

F5 was 0% pineapple, 40% tempe, 60% pineapple peel juice

**Figure 1** shows that formulation F1, which did not contain tempe paste, achieved the highest sensory acceptance for both taste and aroma. This indicates that the increased addition of tempe paste reduces the panelists' acceptance of the popsicle. However, the sensory evaluation results indicate that formulation F3, consisting of 50% pineapple, 20% tempe, and 30% pineapple peel juice, demonstrates a clear superiority over the other formulations, particularly in terms of color, texture, and overall appearance. Its consistently high scores across these attributes suggest that F3 offers both visual

appeal and desirable textural qualities, contributing to its favorable reception. Furthermore, while F5 excels in taste, F3 exhibits a more balanced profile across all sensory parameters, positioning it as the most well-rounded formulation in the analysis. This balance makes F3 particularly noteworthy, as it effectively meets multiple sensory criteria important to consumer preferences.



**Figure 1.** The web radar diagram for the organoleptic evaluation visually represents the sensory attributes of five formulations of popsicles made from pineapple flesh, tempe, and pineapple peel juice. This evaluation encompasses five key parameters: color, taste, aroma, texture, and overall appearance.

## DISCUSSION

### Chemical Properties of Tempe-pineapple Popsicle

The popsicles were analyzed for water content, ash, protein, fat, total carbohydrate contents, energy, Vitamin C, and antioxidant activity as shown in **Table 2**. The statistical results of the formulations in the study are analyzed based on significant differences across various parameters using a one-way ANOVA. **Table 2** reveals that water, protein, fat, ash, energy, and vitamin C content are significantly difference within formulation groups ( $p<0.05$ ). Meanwhile, carbohydrate content and antioxidant activity did not show significant differences ( $p>0.05$ ), meaning the formulations did not greatly impact these parameters. The significant increase in protein, fat, and energy in formulations with higher tempe and pineapple peel juice demonstrates that these ingredients contribute to the nutritional enhancement of popsicles.

Water content is a key factor in determining the quality of ice cream products including popsicles. The statistical results showed that water content has a significant difference among the formulations ( $p<0.05$ ). F1 (68.903%) and F2 (67.107%) have the highest water content, while F5 (58.437%) has the lowest. The higher proportions of tempe and pineapple peel juice result in lower moisture retention. It influences texture by affecting ice crystal size, with lower water content producing smaller crystals and a smoother texture<sup>17,18</sup>. Additionally, moisture impacts the stability and structure of the popsicle, as excessive water can cause it to melt quickly and lose its shape.

Protein, fat, and carbohydrate content contribute to the total solid in the popsicle, which plays a key role in the production of crystals and influences the final product's texture. **Table 2** depicts that protein and fat content in the popsicle formulations showed a significant difference among formulations ( $p<0.05$ ). Although the carbohydrate levels did not show significant differences across the treatments ( $p>0.05$ ), the highest level was observed in the F5 formulation. These three nutrients are greatly influenced by the added tempe formulation, as tempe contains significantly higher amounts of protein, fat, and carbohydrates compared to pineapple. Tempe, a well-established plant-based protein source made from fermented soybeans<sup>9,19</sup>, typically contains around 13-20% protein, 8.8% fat, and 29.6% carbohydrate content, which significantly contributes to the overall protein, fat, and carbohydrate levels in the popsicle formulations when included in higher quantities<sup>7,19,20</sup>. Additionally, coconut milk, which was consistently added across all formulations, is rich in fat with around 35.2% fat content<sup>21</sup>, contributing to the overall fat content of the popsicles. In contrast, pineapple fruit has a much lower macronutrient content, around 0.5-1% protein, 0.1% fat, and 17.53% carbohydrates<sup>10</sup>, which explains why formulations with more pineapple fruit and less tempe, such as F1, exhibited lower protein levels.

Protein, fat, and carbohydrates have a significant impact on the energy density of a food product. Energy content in popsicles showed a significant difference across formulations ( $p<0.05$ ). This increase in energy density is primarily attributed to the higher levels of tempe and coconut milk in the formulation, both of which are rich in macronutrients. Tempe, being a significant source of protein, fat, and carbohydrates, contributes substantially to the calorie value of the popsicles<sup>22</sup>. In addition, coconut milk as the additional ingredient is known for its high fat content which contributes to the final energy density of the product<sup>21</sup>. Thus, F5, with the highest amounts of tempe paste proportion, emerged as the most energy-dense formulation (185.377 Kcal), while F1 (134.103 Kcal) had the lowest. This aligns with the general principle that foods with higher protein, fat, and carbohydrate content tend to provide more calories.

The proportion of pineapple peel juice in a formulation showed a significant difference in vitamin C ( $p<0.05$ ). The study found that the formulation containing the most pineapple peel juice (F5) had the highest concentration of vitamin C, at 32.120 mg/100g, while the formulation with the least pineapple peel juice (F1) contained 24.513 mg/100g. This indicates that increasing the proportion of pineapple peel juice in the formulation directly correlates with higher vitamin C levels in the final product. Pineapple peel is rich in vitamin C, which contributes to its antioxidant activity<sup>23</sup>. However, despite its high vitamin C levels, the study found that varying the ratios of tempe and pineapple peel juice did not significantly affect the overall antioxidant levels ( $p>0.05$ ), suggesting that the antioxidant capacity remains relatively stable, regardless of pineapple peel juice content.

### Organoleptic Properties of Tempe-pineapple Popsicle

The sensory or organoleptic test is a science that uses the human senses to measure the texture, aroma, flavor, and appearance including the color of food products. Sensory evaluation can be

used to assess any desired or undesired changes in product or formulation materials, identify areas for development, and determine whether optimization has been obtained<sup>24</sup>. This research evaluated the organoleptic characteristics of tempe pineapple popsicles including taste, aroma, texture, color, and overall appearance as depicted in **Table 3** and **Figure 1**.

The sensory evaluation of the tempe-pineapple popsicles revealed several key findings across various parameters, notably taste, aroma, texture, color, and overall appearance. Taste emerged as the most critical factor in panelist acceptance, with significant differences noted among formulations ( $p<0.05$ ). Formulation F1, which contained no tempe paste, was preferred by panelists (5.76), likely due to the absence of the distinct nutty flavor associated with tempe, which may be perceived as undesirable by some consumers. This nutty flavor arises from the breakdown of soybean proteins and fats during fermentation, aligning with previous studies linking similar flavors in soybean products to decreased overall liking<sup>19,25</sup>. The inclusion of pineapple peel juice, which contains the enzyme bromelain, aims to mitigate this flavor by hydrolyzing proteins and enhancing palatability<sup>23,26</sup>.

While aroma scores showed no significant differences ( $p>0.05$ ), with F1 receiving the highest acceptance (5.12), the pleasant, sweet aroma of pineapple dominated. The presence of esters, particularly ethyl hexanoate and methyl hexanoate, contributed to this aroma, while the other formulations experienced a slightly unpleasant scent due to increased tempe paste and the activity of lipoxygenase during fermentation<sup>7,27</sup>. It has been reported that esters were the most abundant pineapple volatiles, in particular, ethyl hexanoate and methyl hexanoate which have the highest contribution to the pineapple aroma<sup>28</sup>. Texture evaluations revealed significant differences ( $p<0.05$ ), with the addition of tempe resulting in higher total solids producing a denser taste, and flour-like texture in the popsicles, which may further reduce panelist satisfaction. The ice crystal size in frozen desserts is also related inversely to the total solids of the formulations, which might enhance the viscosity and restrict the diameter of ice crystals to produce a smoother texture<sup>17,18</sup>. However, the reduction of dry texture through pineapple peel juice's enzymatic activity improved mouthfeel.

Color assessment indicated no significant differences ( $p>0.05$ ), with formulation F3 receiving the highest score (5.32). The popsicles exhibited a brownish-yellow hue, attributed to carotenoid pigments from pineapple<sup>10</sup>. Formulation F3's balanced ratio resulted in a harmonious color blend. Overall appearance also displayed significant differences ( $p<0.05$ ), with F3 achieving the highest score (5.44), indicating it was perceived as the most visually appealing.

The De Garmo Effectiveness Index analysis confirmed that F3 was the top formulation in terms of overall sensory acceptance, indicating its superior balance across taste, aroma, texture, color, and overall appearance parameters. Organoleptic evaluation is of paramount importance, particularly when considering the target demographic of children, who are frequently characterized as selective eaters. Despite the nutritional richness of a product, its efficacy is compromised if it fails to engage this target group. Given that the popsicle is designed as an alternative snack for stunted children, ensuring their willingness to consume it is essential. Thus, formulation F3, which demonstrated the most balanced

outcomes across sensory attributes, was selected as the best formulation choice. While F3 does not boast the highest energy density, it provides an impressive 198% of the daily protein requirements from snacks and contributes 45.67% of the daily energy intake from snacking, positioning it as a highly beneficial option for meeting children's nutritional needs.

## CONCLUSION

In conclusion, the development of tempe-pineapple popsicles demonstrated that the variation in ingredient proportions, particularly tempe, significantly influenced the nutritional composition and sensory properties of the final product. Increasing the proportion of tempe led to higher protein, fat, and energy content, with F5 (0% pineapple, 40% tempe, 60% pineapple peel juice) emerging as the most nutrient-dense formulation, which can be used as a snack for stunted toddlers who require high protein and high energy intake. However, sensory evaluation revealed that consumer acceptance, particularly in taste, decreased with higher tempe content due to its nutty flavor and heavier texture. The addition of pineapple peel juice helped mitigate the dryness associated with tempe and gave more balanced sensory properties. Therefore, the F3 formula with the ratio of 50% pineapple flesh, 20% tempe, and 30% pineapple peel juice had better acceptance compared to F5, which had the highest energy content. However, further optimization is needed to balance the nutritional benefits with consumer preferences. Overall, this study highlights the potential of incorporating functional ingredients like tempe and pineapple in popsicle formulations but emphasizes the need for careful formulation to enhance both nutritional value and sensory appeal.

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## Research Article (FF25)

### Enhancing Spinach Noodles with Blanched and Irradiated Jerusalem Artichoke Powder

Tikumporn Ninprapai, Charida Pakasap, Krittiya Khuenpet\*

Department of Food Science and Technology, Faculty of Science and Technology, Thammasat University, Rangsit Center, Klong Nueng, Klong Luang, Pathum Thani 12120

#### ABSTRACT

Spinach noodles still require improvements in both texture and functionality. Adding dietary fiber from Jerusalem artichoke (JA) might enhance these qualities. The objectives of this research were to examine effects of blanching and gamma irradiation on properties of Jerusalem artichoke powder (JAP), and to evaluate impact of adding pretreated JAP on quality of spinach noodles. Sliced JA were divided into two groups: non-blanched (NB) and blanched (B). All samples were dried and milled into JAP. The JAP samples were either non-irradiated (NI) or gamma irradiated at 2.5 kGy (I2.5). The treated JAP was assessed for its quality properties, such as color, water holding capacity, and water swelling capacity. The selected JAP was then added into spinach noodles formulation at 0%, 5%, 7.5%, and 10% to evaluate its impact on noodle quality containing color, cooking yield, cooking loss, cooking time and tensile strength. Blanching and gamma irradiation decreased lightness ( $L^*$ ) and increased redness ( $a^*$ ) and yellowness ( $b^*$ ) of JAP. Both treatments improved water-holding and water-swelling capacities of JAP. In spinach noodles, the addition of B-I2.5 at 7.5% maintained acceptable cooking yield and reduced cooking time, while it affected noodle color. The addition of NB-I2.5 at 5% preserved the light green color of spinach noodles, increased cooking yield, and did not significantly affect cooking time. Blanching and gamma irradiation improve properties of JAP, making it a suitable additive for spinach noodles. The study recommended using 7.5% B-I2.5 for achieving optimal quality, while 5% NB-I2.5 was suggested as an option for better color retention.

**Key words:** blanching, gamma irradiation, Jerusalem artichoke, spinach noodle

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\* Correspondence: krittiya23@tu.ac.th

## INTRODUCTION

Noodle and pasta products are considered some of the most important staple foods for many populations around the world. In a recent survey, China ranked first with 42,210 million servings, while Thailand ranked the 9<sup>th</sup> out of 56 countries, with 3,950 million servings in 2023<sup>1</sup>. Traditional formulas of these products lack essential nutritional components such as dietary fiber, vitamins, and minerals. Vegetables, which are rich in vitamins and minerals, present an opportunity to improve the nutritional quality of these staples. The World Health Organization (WHO) recommends that individuals consume at least 400 grams of vegetables each day. This makes the fortification of pasta with vegetable additives particularly interesting. Although consumers recognize the health benefits of consuming vegetables, their eating habits often result in insufficient vegetable intake. Therefore, adding vegetables into staple foods such as pasta, noodles or bread could be an effective solution<sup>2-4</sup>.

Spinach (*Amaranthus* spp.) contains various health-promoting compounds, including proteins, fats, carbohydrates, iron, and vitamins A, B, and C. It is also a rich source of antioxidants, such as flavonoids, phenolic compounds, carotenoids, and vitamin C<sup>5</sup>. Several researchers have investigated the addition of spinach to noodle products. Ramu et al<sup>2</sup> reported that instant noodles containing 20% spinach paste were the most favorably received. This level led to increased moisture, protein, fat, and ash content, while carbohydrate content decreased, and the appearance turned a darker green. Shere et al<sup>6</sup> observed an increase in cooking loss with higher levels of spinach puree in the formulation, which may be attributed to improve binding of starch granules with the added vegetable puree within the gluten matrix. Nowadays, flour products rich in dietary fiber are widely available and have attracted increased consumer interest compared to regular foods. Dietary fiber is often added to products like whole grain bread, noodles, biscuits, and steamed bread<sup>7</sup>.

Jerusalem artichoke (*Helianthus tuberosus*) is now commonly added to processed foods for its health benefits, as it is rich in fructooligosaccharides, oligosaccharides, phytochemicals, and inulin. Due to its unique chemical composition, JA tubers are also used to produce flour, inulin, syrup, glucose-fructose powder and pectin, and are included in other food products such as baked goods, sweets, and pharmaceuticals<sup>8,9</sup>. Several studies have explored the use of JA in noodle products. Singthong and Thongkaew<sup>10</sup> showed that adding 3% JA powder to glass noodles enhanced the fiber content while maintaining a good texture profile. Similarly, Nadir Abd-ES et al<sup>11</sup> found that incorporating JA powder improved the sensory qualities of pasta.

However, some research recommends that the amount of fiber added to bakery and pasta products should be limited to up to 5% w/w. Adding more than 10% may negatively affect qualities such as color, texture, cooking loss, and sensory attributes. Modification methods are applied to convert insoluble dietary fiber into soluble fiber to improve its physicochemical and physiological properties. These techniques include mechanical degradation, chemical treatment, enzymatic processes, and

microbiological fermentation. In general, using a combination of these methods may have a greater effect than any single approach<sup>12</sup>.

Blanching is a common step performed before drying. There are various blanching methods, including hot water blanching, steam blanching, microwave blanching, and infrared blanching. Among others, hot water blanching is the most widely used method due to its simplicity. This process involves immersing products in hot water (70–100°C) for several minutes. It is particularly effective at stopping enzyme activity and preserving color and nutrients before drying<sup>13,14</sup>.

Gamma irradiation ( $\gamma$ -irradiation) is gaining attention for its effectiveness and practicality in creating degraded products without using chemical initiators or generating harmful by-products. It is a useful physical method for modifying polysaccharides through processes like cross-linking, grafting, and degradation<sup>15</sup>. The  $\gamma$ -irradiation can cause proteins to unfold and denature, leading to formation of new structures. Research has shown that  $\gamma$ -irradiation disrupts the molecular structure of peanut protein, exposing hydrophobic groups and enhancing its functional properties. Additionally, when the  $\gamma$ -irradiation dose is below 10 kGy, it does not affect the nutritional properties of most foods but significantly extends their shelf life<sup>16</sup>.

There is limited research on the effects of combining various pretreatment methods with irradiation. The objective of this study was to investigate effects of blanching and  $\gamma$ -irradiation on characteristics of JAP and to determine impact of adding pretreated JAP on quality of spinach noodles.

## MATERIALS AND METHODS

### Materials

The Jerusalem artichoke tubers (JAT), specifically the KKU3 variety, were sourced from Kasiwattana Farm in Khon Kaen, Thailand. The tubers were harvested in October 2023. Spinach, wheat flour, egg, and salt were purchased from a local market near Thammasat University.

### Production of Jerusalem artichoke powder

Jerusalem artichoke powder preparation was adapted from Khuenpet et al. <sup>17</sup>. The JAT were cleansed and sliced to a thickness of 2-3 mm using a slicer (FS-Slicer from Fresh Sealer, China). The slices were then immersed in a 0.5% citric acid solution for 5 min. After draining, JAT slices were divided into two groups: the first group was unblanched, and the other was blanched in boiling water at 100°C for 2 min. Both JAT slice groups were dried at 65°C for 8 h in a tray dryer (PG 9-4, Progress, Thailand) until moisture content of samples was below 7% wb to ensure uniform drying, ease of grinding, and to prevent the growth of brown rot fungi<sup>17,18</sup>. The dried slices from each sample group were ground into a fine powder and screened through a U.S. No. 100 (149  $\mu$ m) sieve<sup>19</sup>. The Jerusalem artichoke powder (JAP) samples, both unblanched and blanched, were then filled and packed in aluminum bags, stored at room temperature ( $25\pm 2^\circ\text{C}$ ), then analyzed within 1 week. The samples were gamma irradiation at doses of 0 and 2.5 kGy using a Cobalt-60 gamma source in a carrier-type gamma irradiator (JS 8900

IR-155, MDS Nordion, Canada) at the Thailand Institute of Nuclear Technology (TINT) located in Nakornnayok, Thailand. An analysis was conducted on the color characteristics ( $L^*$ ,  $a^*$ ,  $b^*$  and  $\Delta E$ ), water holding capacity, and water swelling capacities of the powders.

### Spinach noodle preparation

The production of spinach noodles followed the methodology described by Ramu et al<sup>2</sup>. The spinach leaves were cleansed and blanched to decrease the oxalate levels. The blanched leaves were blended with water in a food mixer (Tefal, DO821838, Thailand) at a ratio of 1:4 for 5 min. The spinach paste was filtered through a white cloth to obtain spinach extract. The control noodles were prepared by combining wheat flour 61%, egg 17%, salt 1%, and spinach extract 21% until a dough was formed. Then, the dough was flattened and sliced into noodles with a width of 4 mm applying a noodle maker (Junxifu, KFK01-2003, China). To examine improvements in quality of noodles, gamma irradiated-unblanched and blanched JAP samples were utilized. Each sample of JAP, produced under varied conditions of unblanched and blanched JAP, and exposed to varying doses of gamma irradiation, was mixed into the dough at a ratio of 10% of the dough's total weight. Noodle samples were kept in polyethylene plastic box with lid at room temperature ( $25\pm2^\circ\text{C}$ ) and analyzed within 6 hours. The color values ( $L^*$ ,  $a^*$ ,  $b^*$  and  $\Delta E$ ) of the noodle samples were measured, together with their cooking time, cooking yield, and cooking loss.

### Color determination

Color ( $L^*$ ,  $a^*$  and  $b^*$ ) was determined using a color meter (Hunter Lab, Color Flex CX2687, USA). JAP and noodle samples were placed into a transparent plastic cup and covered with opaque lid. Color values are expressed as lightness ( $L^*$ ), redness ( $a^*$ ) and yellowness ( $b^*$ ). Total color difference ( $\Delta E$ ) is represented the difference of color between two samples and calculated according to equation (1).

$$\Delta E = \sqrt{\Delta L^*{}^2 + \Delta a^*{}^2 + \Delta b^*{}^2} \quad (1)$$

### Water holding capacity

The water holding capacity of JAP samples was evaluated described by Zhu et al<sup>20</sup>. A quantity of 0.5 g of JAP was poured into a test tube, and then 10 ml of distilled water were added. The tube was tightly sealed, and the mixture was stirred constantly at  $25^\circ\text{C}$  for 18 h. After that the mixture conducted centrifugation at a speed of 3,000 rpm for 20 min. The solid residue that was left was measured ( $M_1$ ) and then dried in a hot air oven until it reached a constant weight ( $M_2$ ). The water holding capacity of the JAP samples was determined using the given formula (2).

$$\text{Water holding capacity (g/g)} = (M_1 - M_2) / M_2 \quad (2)$$

### Water swelling capacity

The water swelling capacity of JAP samples was determined following the methodology

described by Zhu et al<sup>20</sup>. An amount of 0.5 g of JAP samples (M<sub>0</sub>) were mixed with 10 ml of distilled water in a 10 ml glass measuring cylinder. The mixture was left to stand at room temperature for 24 h. The initial volume (V<sub>0</sub>) and the volume after swelling (V<sub>1</sub>) were determined and calculated using equation (3):

$$\text{Water swelling capacity (ml/g)} = (V_1 - V_0)/M_0 \quad (3)$$

### Cooking time

A quantity of 10 g of noodles were prepared by boiling them in 1,000 ml of water at their boiling point. The noodles were examined at 15-second intervals by compressing them between transparent glass slides. Once the noodles are fully cooked when the center within the noodles had completely vanished and the optimal cooking time has been measured<sup>21</sup>.

### Cooking yield and cooking loss

To evaluate the cooking yield and loss of the noodles, a quantity of 10 g (W<sub>0</sub>) was cooked in 300 ml of pre-measured boiling water (W<sub>1</sub>) for the required optimal cooking time. During the cooking process, the noodles were subjected to a draining period of 5 min and then measured in terms of weight (W<sub>2</sub>). The remaining water was removed by evaporation in a hot air oven at a temperature of 100 °C until the beaker was completely free of moisture. The beaker was then weighed again (W<sub>3</sub>). The calculations for cooking yield and cooking loss were carried out using the formulas represented as equation (4) and (5).

$$\text{Cooking yield (\%)} = ((W_2 - W_0)/W_0) \times 100 \quad (4)$$

$$\text{Cooking loss (\%)} = ((W_3 - W_1)/W_0) \times 100 \quad (5)$$

### Tensile strength

The tensile strength of the noodle products was measured using a Texture Analyzer (Plus Upgrade, Stable Micro System, USA). Spaghetti tensile grips (A/SPR) were used for the analysis. The test speed was set to 5 mm/s, with a distance of 50 mm between the parallel rollers<sup>22</sup>.

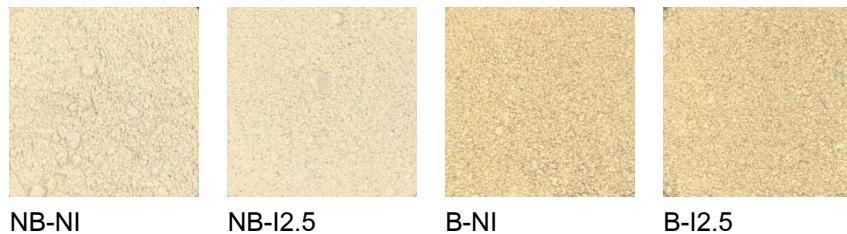
### Statistical analysis

Statistical analyses were performed by SPSS Version 22 software. The experiment followed a Factorial design to evaluate the effects of two factors: blanching (non-blanching and blanching) and  $\gamma$ -irradiation doses (0 and 2.5 kGy) on the quality of Jerusalem artichoke powder (JAP). In addition, a Completely Randomized Design (CRD) was used to study the addition of treated JAP into spinach noodles at 0, 5, 7.5, and 10%. Data were analyzed using the CRD method, and each experiment was conducted in triplicate. Duncan's multiple range test was applied to assess statistical differences between means, with a significance level of  $p \leq 0.05$ .

## RESULTS

### Effect of blanching and $\gamma$ -irradiation on quality of Jerusalem artichoke powder

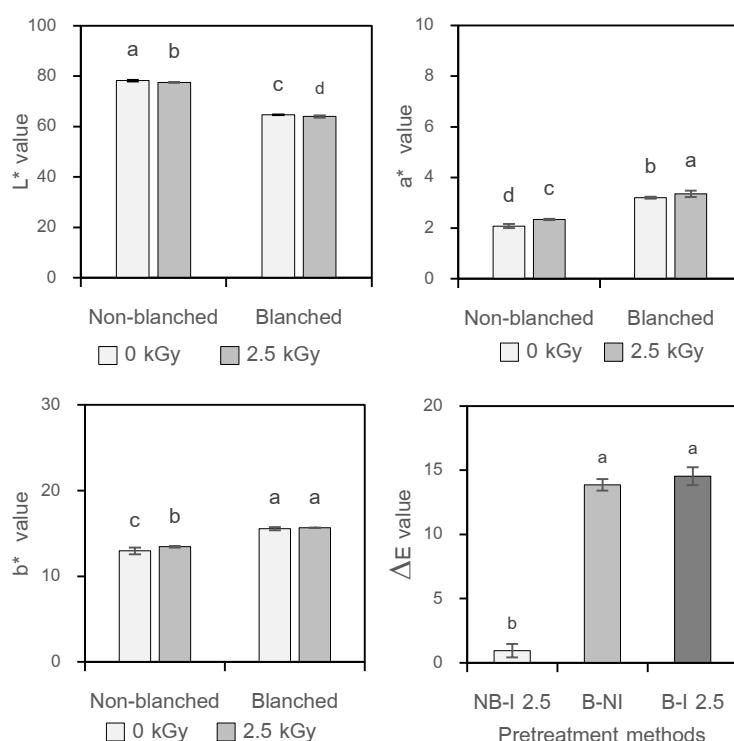
**Figure 1** shows effects of blanching and  $\gamma$ -irradiation on appearance of JAP. Blanched samples (B-NI and B-I2.5) exhibited noticeable darkening, while non-blanched samples (NB-NI and NB-I2.5) had a lighter brown color. These results indicated that blanching plays a significant role in promoting browning.



**Figure 1.** Effect of blanching and  $\gamma$ -irradiation on appearance of JAP samples

NB = Non-blanched, NI = Non-irradiated, B = Blanched and I = Irradiated at 2.5 kGy

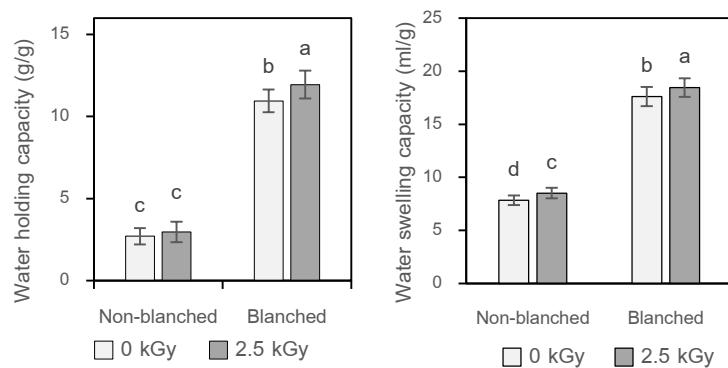
The color tone observed in photographs corresponded with  $L^*$ ,  $a^*$ , and  $b^*$  color values as shown in **Figure 2**. Blanched samples (B-NI and B-I2.5) had lower  $L^*$  values, while  $a^*$  and  $b^*$  values were higher compared to non-blanched samples (NB-NI and NB-I2.5). Blanching caused greater color change compared to non-blanching. As a result, when non-blanched and non-irradiated JAP (NB-NI) was used as initial color reference, the  $\Delta E$  of blanched samples (B-NI and B-I2.5) was nearly 13 times higher than that of the NB-I2.5 sample.



**Figure 2.** Effect of blanching and  $\gamma$ -irradiation on the color values ( $L^*$ ,  $a^*$ ,  $b^*$  and  $\Delta E$ ) of JAP

<sup>a,b,c,d</sup>Different letters above the bars indicate statistically significant difference ( $p \leq 0.05$ )

**Figure 3** illustrates effect of blanching and  $\gamma$ -irradiation on water holding capacity (WHC) and water swelling capacity (WSC) of JAP. Blanched samples exhibited higher WHC and WSC than non-blanching samples. This suggests that blanching improves the ability of JAP to retain and absorb water. Irradiation at 2.5 kGy further increased both WHC and WSC in both blanched and non-blanching samples compared to non-irradiated samples (0 kGy).



**Figure 3.** Effect of blanching and  $\gamma$ -irradiation on water holding capacity and water swelling capacity of JAP

<sup>a,b,c,d</sup>Different letters above the bars indicate statistically significant difference ( $p \leq 0.05$ )

The development of noodle quality, WHC and WSC are important indicators for improving texture and cooking performance. A higher WHC allows noodles to retain more moisture, resulting in a softer, more elastic texture after cooking. WSC helps noodles expand during boiling, providing a desirable chewy texture<sup>23</sup>. In this research, both blanched and non-blanched JAP, treated with  $\gamma$ -irradiation, were selected for addition into spinach noodle to compare their effects on quality attributes.

#### The application of blanching and gamma irradiation-treated JAP in spinach noodles

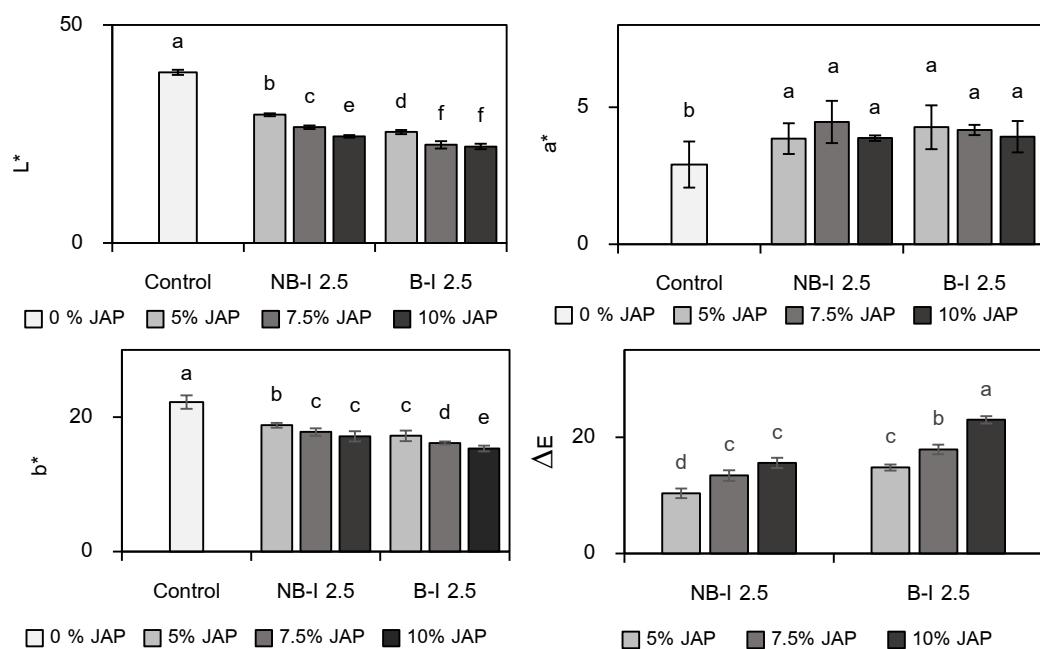
**Figure 4** illustrates appearance of cooked spinach noodles fortified with various levels (5%, 7.5%, and 10%) of non-blanching and blanched  $\gamma$ -irradiated JAP. The control sample, which did not contain JAP, appears obviously lighter in color compared to the fortified samples. As the concentration of both non-blanching irradiated (NB-I2.5) and blanched irradiated (B-I2.5) JAP increased, the cooked noodles showed a gradual darkening. The cooked spinach noodles enriched with NB-I2.5 and B-I2.5 showed a yellow-green color. They appeared considerably darker than control. This darkening became more noticeable at higher content.



**Figure 4.** Appearance of cooked spinach noodles fortified with NB-I2.5 and B-I2.5 at 0, 5, 7.5 and 10%

NB = Non-blanching, NI = Non-irradiated, B = Blanched and I2.5 = Irradiated at 2.5 kGy

**Figure 5** shows that the color values ( $L^*$ ,  $a^*$ ,  $b^*$ , and  $\Delta E$ ) of cooked spinach noodles decreased in lightness ( $L^*$ ) and yellowness ( $b^*$ ) as the content of treated JAP increased, resulting in darker and less yellow noodles. The control sample had the lightest color, while noodles fortified with B-I2.5 7.5-10% were the darkest, with no significant differences between them. Redness ( $a^*$ ) increased slightly with treated JAP addition, but there were no significant differences between NB-I 2.5 and B-I 2.5 fortified noodles. The total color difference ( $\Delta E$ ) of cooked spinach noodles increased as more content of treated JAP was added. The use of B-I2.5 had a greater effect on color changes than NB-I 2.5 at the same levels.



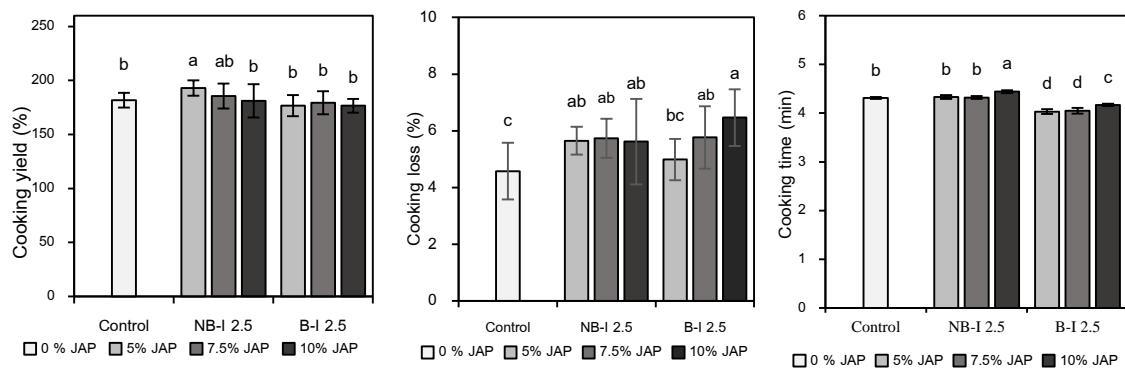
**Figure 5.** Color values ( $L^*$ ,  $a^*$ ,  $b^*$ ,  $\Delta E$ ) of cooked spinach noodle sample (control), spinach noodle sample fortified with NB-I 2.5 and B-I 2.5 at 5-10%.

a,b,c,d Different letters above the bars indicate statistically significant difference ( $p \leq 0.05$ )

JAP = Jerusalem artichoke powder, NB = Non-blanch, NI = Non-irradiated, B = Blanched and I2.5 = Irradiated at 2.5 kGy

Cooking yield, cooking loss and cooking time of cooked spinach noodle samples (control) and spinach noodle samples fortified with NB-I 2.5 and B-I 2.5 at 5-10% are shown in **Figure 6**. The results showed that the highest cooking yield was found in spinach noodles with NB-I2.5 at 5%. However, the addition of NB-I2.5 at 7.5-10% and B-I2.5 at 5-10% showed no significant difference from control. The addition of both NB-I2.5 and B-I2.5 increased cooking loss of spinach noodles. However, increasing of NB-I2.5 content did not affect the change in cooking loss, while increasing the B-I2.5 level significantly increased cooking loss ( $p \leq 0.05$ ). The addition of NB-I2.5 at 5-7.5% exhibited no significant difference in cooking time from control sample, but when NB-I 2.5 added up to 10%, the cooking time of the

spinach noodles increased significantly ( $p \leq 0.05$ ). The addition of B-I2.5 at 5–10% reduced cooking time of spinach noodles.

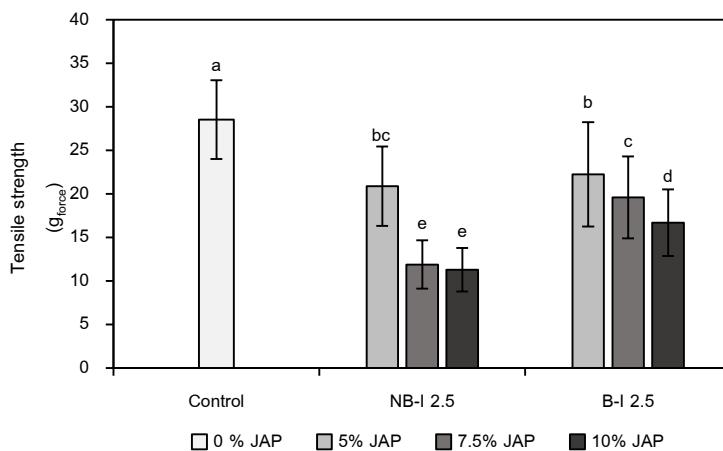


**Figure 6.** Cooking time, cooking yield and cooking loss of cooked spinach noodles (control), spinach noodle fortified with NB-I2.5 and B-I2.5 at 5, 7.5 and 10%.

a,b,c,d... Different letters above the bars indicate statistically significant difference ( $p \leq 0.05$ )

JAP = Jerusalem artichoke powder, NB = Non-blanchered, NI = Non-irradiated, B = Blanched and I2.5 = Irradiated at 2.5 kGy

**Figure 7** shows tensile strength of cooked spinach noodles (control), spinach noodle sample fortified with NB-I2.5 and B-I2.5 at 5–10%. The addition of NB-I2.5 and B-I2.5 at all levels decreased tensile strength of spinach noodles. The lowest tensile strength values were found in noodles formulated with NB-I2.5 7.5–10%. When comparing effects of NB-I2.5 and B-I2.5 at the same amount, it was found that tensile strength of NB-I2.5 added noodles were lower than those of B-I2.5 added noodles.



**Figure 7.** Tensile strength of cooked spinach noodles sample (control), spinach noodle sample fortified with NB-I 2.5 and B-I 2.5 at 5–10%.

a,b,c,d... Different letters above the bars indicate statistically significant difference ( $p \leq 0.05$ )

JAP = Jerusalem artichoke, NB = Non-blanchered, NI = Non-irradiated, B = blanched and I 2.5 = irradiated at 2.5 kGy

## DISCUSSION

### Effect of blanching and $\gamma$ -irradiation on quality of JAP

Blanched JAP had lower  $L^*$  values than non-blanching JAP due to the oxidation of  $Fe^{2+}$  and o-diphenolic acid complexes during blanching. This oxidation forms  $Fe^{3+}$ -o-diphenolic acid complexes, which create a bluish-grey color when the blanched JA slices are exposed to air<sup>24</sup>. The irradiated samples (NB-I2.5 and B-I2.5) also showed lower  $L^*$  values compared to non-irradiated samples (NB-NI and B-NI). This is because  $\gamma$ -irradiation can induce Maillard reactions similarly to heating process<sup>25</sup>, which leads to further darkening of JAP. The results are in agreement with the report of Hamza et al<sup>26</sup>, gamma irradiation causes darkening color in date palm seed powder due to Maillard reaction.

Water holding capacity (WHC) and Water swelling capacity (WSC) of fiber indicate its hydration properties, which are key factors in a food system that influence the texture of a product<sup>27</sup>. The results showed that blanched JAP samples had higher WHC and WSC compared to non-blanching samples. This result agree with Kilini et al<sup>28</sup>, they reported that blanching treatment increased water holding capacity of dried persimmon pulp and peel compared to unblanched samples. Water holding capacity is related to the amount of soluble dietary fiber<sup>29</sup>. The blanching step causes the loosening of the dietary fiber structure and exposure to more hydrophilic groups, which increases level of soluble dietary fiber<sup>27</sup>. Thus, blanched JAP had higher water holding capacity than unblanched JAP. Another reason is that the blanching process breaks down the major proteins into subunits, leading to an increase in water binding sites in denatured proteins<sup>30</sup>. This may promote water holding capacity of blanched JAP.

Gamma-irradiation at 2.5 kGy significantly increased WHC and WSC of JAP compared to non-irradiated samples. The WHC of JAP increased because irradiation breaks glycosidic bonds and degrades polysaccharides, creating more space for water molecule retention<sup>15</sup>. In addition,  $\gamma$ -irradiation treatment unfolds structure of protein and exposes internal groups, therefore increasing their interaction with water molecules<sup>16</sup>.

### The application of blanching and gamma irradiation-treated JAP in spinach noodles

The decrease in  $L^*$  and  $b^*$  values of cooked noodles might be associated with Maillard reaction, as JAP contains proteins and sugars that act as key components in this reaction. The blanching step may have contributed to these changes by changing the structure of JAP, making its proteins and sugars more reactive. Irradiation-induced non-enzymatic browning in JAP<sup>25</sup> resulted in a darker color in the spinach noodles when NB-I2.5 and B-I2.5 were added. Cooked spinach noodles with B-I2.5 had lower  $L^*$  and  $b^*$  values compared to those with NB-I2.5, while the  $\Delta E$  value was higher.

The cooking yield of spinach noodles with NB-I2.5 5% was higher than that of the control sample, but it decreased as the amount of NB-I2.5 increased. The reduction in cooking yield might be due to the loss of solids during cooking<sup>31</sup>. Dietary fiber in the added material can interact with gluten proteins through hydrogen bonding, which leads to a weaker and more open gluten structure<sup>32</sup>. This weakened structure may result in increased solid loss during cooking. However, the addition of NB-I2.5

at 7.5-10% and B-I2.5 at 5-10% showed no significant difference in cooking yield compared to the control sample.

One of the key factors in evaluating the overall quality of noodles is cooking loss. This refers to the total amount of solids found in the cooking water after the noodles are cooked, which can result from both the leaching of amylose and the dissolution of water-soluble proteins<sup>33</sup>. The results showed that the addition of NB-I2.5 and B-I2.5 increased cooking loss of spinach noodles. Increasing the content of NB-I 2.5 did not significantly affect cooking loss, however higher levels of B-I2.5 resulted in a significant rise in cooking loss. The increase in cooking loss of spinach noodles with added NB-I2.5 and B-I2.5 was likely due to the weakening of the gluten network by dietary fiber, which led to the leaching of amylose during cooking<sup>34</sup>. Gluten is composed of two types of proteins known as gliadin and glutenin. Glutenin subunits are linked together through disulfide bonds, while gliadin interacts with glutenin via non-covalent hydrophobic interactions and hydrogen bonding. The addition of another chemical compound disrupted the gluten network by forming new hydrogen bonds and changing the disulfide bridges, which led to the folding or abnormal aggregation of protein molecules and resulted in a network with different mechanical properties<sup>35</sup>. The addition of dietary fiber causes dehydration of gluten due to its competitive water-binding capacity, which induces a conformational change in gluten matrix and collapse of the gluten network<sup>32</sup>.

A high-quality noodle requires a short cooking time, which indicates good water absorption during cooking<sup>36</sup>. The cooking time of spinach noodles with NB-I2.5 5-10% added was not significantly different from the control, but when NB-I2.5 levels reached 10%, the cooking time increased. The addition of B-I2.5 significantly decreased cooking time compared to the control noodle. The decrease in cooking time resulted from the disruption of gluten matrix by soluble fiber, which enhanced water absorption into the noodles. The soluble fiber leads to the formation of channels and pores, which accelerates water transport<sup>37</sup>. Blanching can change insoluble dietary fiber into soluble dietary fiber by dissolving insoluble dietary fiber through thermal treatment<sup>27</sup>. Therefore, the addition of B-I2.5 can improve the cooking quality of spinach noodles by decreasing the cooking time.

The tensile strength of noodles mainly depends on gluten protein network and the firm structure of fiber<sup>38</sup>. The reduction in tensile strength of the spinach noodles when increased amount of NB-I2.5 and B-I2.5 may be attributed to insoluble dietary fiber causing binding steric hindrance, which negatively affects the elastic characteristic of gluten<sup>34</sup>. Rushchitc et al<sup>39</sup> found that the fortification of JAP in dumplings decreases gluten content, which reduces elasticity and increases hardness. Koh et al<sup>22</sup> reported that the addition of seaweed powder interfered with the gluten proteins in the noodle system, resulting in the weakening of the starch-protein interaction and reducing the tensile strength of noodles.

## CONCLUSION

The blanching process of JAP resulted in a darker color but provided higher water holding and swelling capacity compared to non-blanching samples. Additionally, samples treated with 2.5 kGy  $\gamma$ -irradiation showed a significant increase in both water holding and swelling capacity. The addition of NB-I2.5 and B-I2.5 at 5-10% led to a decrease in lightness ( $L^*$ ) and yellowness ( $b^*$ ) of spinach noodles. The use of B-I2.5 was optimized at 7.5%, as it did not significantly affect cooking yield while reducing cooking time significantly. However, B-I2.5 affected color of noodles, which could impact customer acceptance. Alternatively, NB-I2.5 was an option for spinach noodles. The addition of 5% NB-I2.5 maintained a light green color, characteristic of vegetable-based noodles, increases cooking yield, and did not significantly increase cooking time. This research suggests that the pretreatment and modification of JA can increase its usability as a raw material in noodle products. Therefore, the findings provide a potential guideline for incorporating JA into healthier food products in the future.

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## Research Article (FF26)

### Development of Fresh Noodle from Wheat Flour, Chick Pea and Irradiated Jackfruit Flour Supplemented with Water Meal

Suteera Vatthanakul<sup>1\*</sup>, Natchaya Jewsuwan<sup>1</sup>, Piraya Choksakulkeat<sup>1</sup>

<sup>1</sup>Department of Food Science and Technology, Faculty of Science and Technology, Thammasat University, Khlong Nueng, Khlong Luang, Pathum Thani.

#### ABSTRACT

Noodles are a widely popular food, however generally has low nutritional value, leading to problems related to nutrient deficiencies. This aim to enhance essential nutrients in noodle products. In this study, fresh noodles were developed to enhance their nutritional value using a base of grains by adjusting the ratio between chickpea flour and irradiated jackfruit seed flour at three levels: 1:1, 1:2, and 1:3. Dietary fiber was supplemented with water meal powder at two levels: 5% and 10%. It was found that increasing the ratio of irradiated jackfruit seed flour and decreasing the ratio of chickpea flour tended to increase cooking yield, decrease cooking loss, and increase noodle tensile strength. Conversely, increasing the amount of dried water meal powder reduced the color values ( $L^*$ ,  $a^*$ , and  $b^*$ ), decreased cooking yield, increased cooking loss, and reduced noodle tensile strength. The noodles had low fat content and high protein and dietary fiber content of 0.3 grams, 18.38 grams, and 29.12 grams, respectively. This affected a decrease in the porosity of the internal structure of fresh noodles due to the increase in the protein matrix around the starch granules, affected the water-holding capacity, and led to a more uniform surface structure of the noodles. Sensory evaluation revealed that noodles with a chickpea flour to irradiated jackfruit seed flour ratio of 1:3 and 5% dried water meal powder received the highest overall preference scores. This study indicates that fresh noodles enriched with water meal powder and chickpea flour can be developed into a healthy food option that is well accepted by consumers

**Key word:** fresh noodles, microstructure, scanning electron microscopy, water meal

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\* Correspondence: emmesuteera@gmail.com

## INTRODUCTION

Due to their widespread cultural influence, noodles are a popular meal consumed all across the world. The market for noodles is growing and expanding annually, indicating the food's ongoing appeal to people of all ages<sup>1</sup>. Noodles are usually made from wheat, which provides a smooth, soft, and elastic texture as the raw material which produced a smooth, soft and elastic texture<sup>2</sup>. Therefore, the main nutrient is carbohydrates with insufficient protein to meet daily dietary needs, if consumed regularly, may lead to malnutrition. Noodles contain 8.5% to 12.5% protein<sup>3</sup>, along with a deficiency of other essential nutrients such as dietary fiber and vitamins. Consequently, there has been considerable research on enhancing the nutritional value of noodles using various protein sources. Such as chickpea flour is an important protein source, whereas wheat flour contains 10-12% protein<sup>4</sup>, while chickpea flour has 17-22% protein<sup>5</sup>. There is research that uses chickpea flour to develop noodles enriched with nutritional value<sup>6</sup>. Moreover, consumers are increasingly aware of the importance of dietary fiber, which helps reduce the risk of various diseases, including lowering blood cholesterol levels and reduce the risk of colon cancer, among other things<sup>7</sup>. The water meal, an alternative raw material commonly used to enhance nutrition in food, contains up to 48.2 % protein<sup>8</sup> and has a fiber content of 25%<sup>9</sup>. It is a small aquatic plant that primarily reproduces through sexual or asexual budding, allowing the plant to propagate rapidly, with a doubling time of every 2.3 days<sup>9</sup>. This enables quick large-scale production, demonstrating its potential as a health promoting food. Finally, Jackfruit seeds are important agricultural by-product with high nutritional value, serving as an excellent energy source<sup>10</sup>. Every 100 grams of jackfruit seeds provide 153 kilocalories, containing 5.5 grams of protein, 32.2 grams of carbohydrates, 0.2 grams of fat, and are rich in vitamins and phosphorus. Additionally, they possess prebiotic properties and are classified as resistant starch type II (RS2), which is beneficial for blood sugar control and promoting gut health. Due to the structural and functional properties of jackfruit seed starch, it is a promising ingredient for producing healthy noodles. Therefore, this research aimed to develop noodles enriched with nutritional value in terms of protein and fiber from chickpea flour and water meal powder. Additionally, it studies the ratio of irradiated jackfruit seed flour to improve the texture and strength of the noodles by examining the appropriate proportions for noodle production and assessing the chemical and physical properties of the fresh noodles.

## MATERIALS AND METHODS

### Materials

To prepare irradiated jackfruit seed flour, start by cleaning jackfruit seeds obtained from Thai Market thoroughly until all mucus is removed. Peel off the outer shell and crush the seeds into smaller pieces. Dry them to a moisture content of about 5-8% using a temperature of 50°C with overnight heating. After that, finely grind the seeds to reduce their size, sieve them through a 100 mesh screen, and then irradiate them with an electron beam at 2 KGy.

## Other Ingredients

Besan chickpea flour (Besan brand), Prungthip salt, xanthan gum, and wheat gluten from Chemipan Company, Imperial brand sodium carbonate, and water meal powder from Kalasin Province

## Sample preparation

Preparation of Fresh Noodles (Adapted from AACC Method 62-40.01) Mix besan chickpea flour and irradiated jackfruit seed flour (sieved to 94.5% fineness) with 1% salt, 3% xanthan gum, 1.5% sodium carbonate, and 40% water. Knead until the dough is uniform and smooth. Let the dough rest for 20 minutes. Then, pass the dough through an automatic noodle extruder to produce fresh noodles.

## Study the optimal ratios between chickpea flour, irradiated jackfruit seed flour, and varying levels of water meal powder

The study will examine ratios of chickpea flour to irradiated jackfruit seed flour in the proportions of 1:1, 1:2, and 1:3, and varying levels of water meal powder at 5% and 10% by weight. In total, seven formulations were described in **Table 1**.

**Table 1.** The Formulation of noodles

Formulation	Water Meal powder	Wheat gluten : Chick flour : irradiated jackfruit flour	Salt	Xanthan gum	Sodium Carbonate	Water
Control	0	15 : 39.75 : 39.75	1	3	1.5	40
F1	5	15 : 37.25 : 37.25	1	3	1.5	40
F2	10	15 : 34.75 : 34.75	1	3	1.5	40
F3	5	15 : 24.83 : 49.67	1	3	1.5	40
F4	10	15 : 23.17 : 46.33	1	3	1.5	40
F5	5	15 : 18.625 : 55.875	1	3	1.5	40
F6	10	15 : 17.375 : 52.125	1	3	1.5	40

## Proximate analysis

The proximate composition of samples of fresh noodles was determined following AOAC<sup>11</sup>. The parameters considered were: Moisture (925.10), ash (923.03), protein (920.87), fat (920.85), and fiber (32-10) were determined using standard analytical methods.

## Color

The color of fresh noodle determined according to the method of<sup>12</sup> using the HunterLab Colorflex 45-0 (LAV) model using the Hunter scale for L\*, a\* and b\*. L\* value is a measurement of brightness (0-100); a\* value represents the red-green coordinates (- is green while + is red); b\* value indicates the blue yellow coordinates (- is blue while + is yellow).

### Textural analysis

Cooked noodle samples (cooking conditions: 30 grams of noodles in 1 liter of distilled water at 100 °C) were placed in aluminum trays and covered with cheesecloth, then left to cool at room temperature (25 °C). For testing, a 10 cm long noodle was tied to the force sensor of the spaghetti tensile testing machine (A/SPR) equipped with a 5 kg load cell. The tensile resistance was tested at a constant crosshead speed of 3 mm/s. The tensile resistance value (Storce) represents the maximum force applied to pull the noodles apart with a texture analyzer, Stable Micro System TA-XTPlus 2.2.7 model, United Kingdom.

### Determination quality of noodles after cooking

Cooking loss and cooking yield determined according to the method of<sup>13</sup> with a slight modification. Initially, Cooking yields or percentage of weight after boiling, uncooked noodles (5 grams) were then boiled (100 °C) in 200 milliliters for 5 minutes. The noodles were drained on a strainer for 1 minute to remove excess water. The cooked noodles were weighed and calculated the percentage yield using the following formula:

$$\text{Percentage Yield} = \frac{\text{Weight of Cooked Noodles}}{\text{Weight of before cooked Noodles}} \times 100$$

And Cooking loss or percentage of solid lost during boiling, dried the remaining water from cooking the noodles in a hot air oven at 105°C until completely dry. After drying, weighed the beaker and calculated the percentage of loss using the following formula:

$$\text{Percentage of loss} = \frac{\text{Weight of Beaker After Drying} - \text{Weight of Empty Beaker}}{\text{Weight of noodles}} \times 100$$

### Sensory evaluation

Fresh noodle samples after precooking (100 g) were cut into 10 cm pieces before testing. The sensory attributes of the noodles were evaluated by 30 panelists. The panelists were asked to evaluate attributes each sample included appearance, color, flavor, texture (stickiness and elasticity) and overall acceptability. The samples were rated on a 9-point hedonic scale (ranging from 1 = dislike extremely to 9 = like extremely)

### Scanning Electron Microscopy (SEM)

The microstructure profile of fresh noodle samples was analyzed by scanning electron microscopy (JEOL JSM-IT500HR, Japan). The samples were freeze-dried and broken into small section. A piece of noodle sample was adhered to aluminum specimen holder with double-sided conductive adhesive, then coated with a layer of gold. The SEM image of samples was obtained by scanning at 500X and 1000X magnification and accelerating voltage of 15 kV. Each data represents the mean of three replicates.

## Statistical analyses

Each data is presented as mean value represents of three replicates with standard deviation (mean $\pm$ SD). Significant differences were analyzed using one-way analysis of variance (ANOVA), and data from the sensory evaluation were arranged in a randomized complete block design (RCBD). Compare the means using Duncan's New Multiple Range Test and analyze the statistical data at a 95% confidence level ( $p>0.05$ ) using SPSS for Windows software.

## RESULTS AND DISCUSSION

### Proximate analysis

From the study of the chemical composition of all 7 noodle formulations, including the control, it was found that moisture content tended to increase with higher ratios of irradiated jackfruit seed flour and water meal powder. As water meal powder has a high fiber content which affects its water-holding capacity. Additionally, the moisture content increased when the ratio of chickpea flour was reduced and the ratio of irradiated jackfruit seed flour was increased, as irradiated jackfruit seeds have good water-holding capacity<sup>14</sup>. The protein content tended to decrease with an increase in the ratio of irradiated jackfruit seed flour and a decrease in chickpea flour, as the reduction in chickpea flour, which is high in protein, resulted in lower protein content in the noodles. Additionally, the values for fiber, fat, and ash showed statistically significant differences ( $p<0.05$ ).

### Color

$L^*$  value or brightness, the control sample, which did not include water meal powder, showed the highest brightness value. The brightness decreased with the addition of water meal powder. Among the samples with added water meal powder, the noodles with 5% water meal powder had higher brightness values compared to those with 10% water meal powder.  $a^*$  value or green-red, the control sample had the highest  $a^*$  value, indicating the reddest coloration among all noodle samples. When 10% water meal powder was added, the  $a^*$  value tended to be lower compared to the sample with 5% water meal powder, which had a less green and more red hue.  $b^*$  value or blue-yellow, the control sample had the highest  $b^*$  value, indicating the most yellow coloration. With the addition of 5% water meal powder, the  $b^*$  value was lower than the control but higher than in the sample with 10% water meal powder, which had a lower  $b^*$  value.

### Textural quality

The tensile strength results showed **Table 2**, a decreasing trend as the level of water meal powder increased. This is because the higher amount of water meal powder increased the fiber content, which high absorbed for water<sup>15</sup>. This disrupted the structural integrity of the noodles, leading to a reduction in tensile strength. This finding is consistent with the other study<sup>16</sup>, which investigated the effects of adding high-fiber Baegu (Liang) leaves to noodles and found that the tensile strength decreased as the amount of amaranth leaves increased. Moreover, it was observed that the F5 formula, which had a ratio of 15% chickpea flour, 18.625% irradiated jackfruit seed flour, and 55.875% water meal powder with 5% water meal powder addition, had the highest tensile strength value of 22.90 gforce. This differs from the control noodles, which had no added water meal powder and had the lowest tensile strength of 7.69 gforce. This difference is likely due to the high protein content in chickpea flour, irradiated jackfruit seed flour, and water meal powder, which contributes to a more organized protein network within the noodles, making them stronger and more resilient. Consequently, more force is required to break the noodles compared to the control formula.

**Table 2.** Proximate composition of fresh noodle

Sample	Mean ± standard deviation				
	Moisture (%)	Fat (%)	Protein (%)	Fiber (%)	Ash (%)
Control	30.79 ± 0.12 <sup>d</sup>	0.14 ± 0.14 <sup>d</sup>	18.42 ± 0.80 <sup>b</sup>	25.41 ± 2.35 <sup>b</sup>	2.94 ± 0.04 <sup>f</sup>
F1	30.26 ± 0.04 <sup>e</sup>	0.28 ± 0.11 <sup>cd</sup>	20.25 ± 0.04 <sup>a</sup>	28.06 ± 1.52 <sup>ab</sup>	3.60 ± 0.04 <sup>d</sup>
F2	30.30 ± 0.03 <sup>e</sup>	1.26 ± 0.03 <sup>a</sup>	20.73 ± 0.34 <sup>a</sup>	30.88 ± 3.19 <sup>a</sup>	3.97 ± 0.07 <sup>b</sup>
F3	31.38 ± 0.05 <sup>c</sup>	0.67 ± 0.03 <sup>b</sup>	19.01 ± 0.67 <sup>b</sup>	28.00 ± 0.26 <sup>ab</sup>	3.42 ± 0.06 <sup>e</sup>
F4	32.90 ± 0.08 <sup>b</sup>	0.29 ± 0.02 <sup>cd</sup>	18.62 ± 0.37 <sup>b</sup>	29.11 ± 0.14 <sup>a</sup>	3.80 ± 0.04 <sup>c</sup>
F5	31.75 ± 0.08 <sup>c</sup>	0.43 ± 0.07 <sup>c</sup>	18.38 ± 0.16 <sup>b</sup>	29.12 ± 1.42 <sup>a</sup>	3.38 ± 0.02 <sup>e</sup>
F6	34.79 ± 0.07 <sup>a</sup>	0.40 ± 0.11 <sup>c</sup>	11.48 ± 0.29 <sup>c</sup>	29.43 ± 0.84 <sup>a</sup>	4.33 ± 0.03 <sup>a</sup>

Means with different superscripts within the same column are significantly different (p<0.05)

### Cooking yields and cooking loss

The measurement of cooking quality revealed that increasing the ratio of irradiated jackfruit seed flour and water meal powder resulted in a different percentage of cooking yield compared to the control formula (**Table 3**). Noodles with 5% watermeal powder had a higher cooking yield than those with 10% watermeal powder affected an adding too much water meal powder may affect the internal structure of the noodles which is consistent with the findings of other researchers<sup>16</sup>. The gluten network may be weakened by water meal, with amylose leaching during cooking<sup>17</sup>. Meanwhile, the percentage of cooking loss of F5 noodle formula no significant differences from the control, which is 7.27%.

**Table 3.** Color, cooking yields and cooking loss and textural quality

Sample	Mean $\pm$ standard deviation					
	L*	a*	b*	Cooking yield (%)	Cooking loss (%)	Tensile Strength (g <sub>force</sub> )
Control	41.06 $\pm$ 0.36 <sup>a</sup>	0.29 $\pm$ 0.08 <sup>d</sup>	8.22 $\pm$ 0.10 <sup>a</sup>	188.96 $\pm$ 0.62 <sup>b</sup>	7.66 $\pm$ 0.42 <sup>b</sup>	7.69 $\pm$ 0.44 <sup>d</sup>
F1	24.61 $\pm$ 0.29 <sup>f</sup>	0.91 $\pm$ 0.07 <sup>a</sup>	6.44 $\pm$ 0.07 <sup>c</sup>	213.86 $\pm$ 0.24 <sup>a</sup>	9.70 $\pm$ 0.30 <sup>a</sup>	8.53 $\pm$ 0.49 <sup>c</sup>
F2	22.73 $\pm$ 0.24 <sup>g</sup>	0.90 $\pm$ 0.07 <sup>a</sup>	5.73 $\pm$ 0.09 <sup>e</sup>	165.24 $\pm$ 0.35 <sup>f</sup>	7.65 $\pm$ 0.36 <sup>b</sup>	7.73 $\pm$ 0.45 <sup>d</sup>
F3	28.63 $\pm$ 0.29 <sup>c</sup>	0.67 $\pm$ 0.06 <sup>b</sup>	4.84 $\pm$ 0.03 <sup>f</sup>	177.00 $\pm$ 0.98 <sup>c</sup>	9.37 $\pm$ 1.25 <sup>a</sup>	8.26 $\pm$ 0.30 <sup>cd</sup>
F4	26.11 $\pm$ 0.13 <sup>e</sup>	0.41 $\pm$ 0.04 <sup>c</sup>	3.57 $\pm$ 0.02 <sup>g</sup>	168.45 $\pm$ 0.40 <sup>d</sup>	9.81 $\pm$ 0.65 <sup>a</sup>	11.5 $\pm$ 0.21 <sup>b</sup>
F5	34.84 $\pm$ 0.15 <sup>b</sup>	0.82 $\pm$ 0.06 <sup>a</sup>	7.71 $\pm$ 0.09 <sup>b</sup>	177.45 $\pm$ 0.43 <sup>c</sup>	7.27 $\pm$ 0.61 <sup>b</sup>	22.90 $\pm$ 0.53 <sup>a</sup>
F6	27.52 $\pm$ 0.17 <sup>d</sup>	0.12 $\pm$ 0.02 <sup>e</sup>	6.08 $\pm$ 0.03 <sup>d</sup>	166.89 $\pm$ 0.24 <sup>e</sup>	10.43 $\pm$ 0.24 <sup>a</sup>	-

Means with different superscripts within the same column are significantly different (p<0.05)

### Sensory evaluation

Regarding the sensorial analysis mean scores for color, flavor, texture and overall acceptability of all 7 fresh noodle formulations, using a 9-point hedonic scale, showed that the 20 testers gave the highest overall liking scores to both the control sample and the F5 sample, as shown in the **Figure 4**. Therefore, the F5 noodle formula was selected, which has a ratio of 15% wheat gluten, 18.625% chickpea flour, and 55.875% irradiated jackfruit seed flour, with an addition of 5% water meal powder.

**Table 4.** The results of the sensory evaluation of the cooked fresh noodle 7 samples

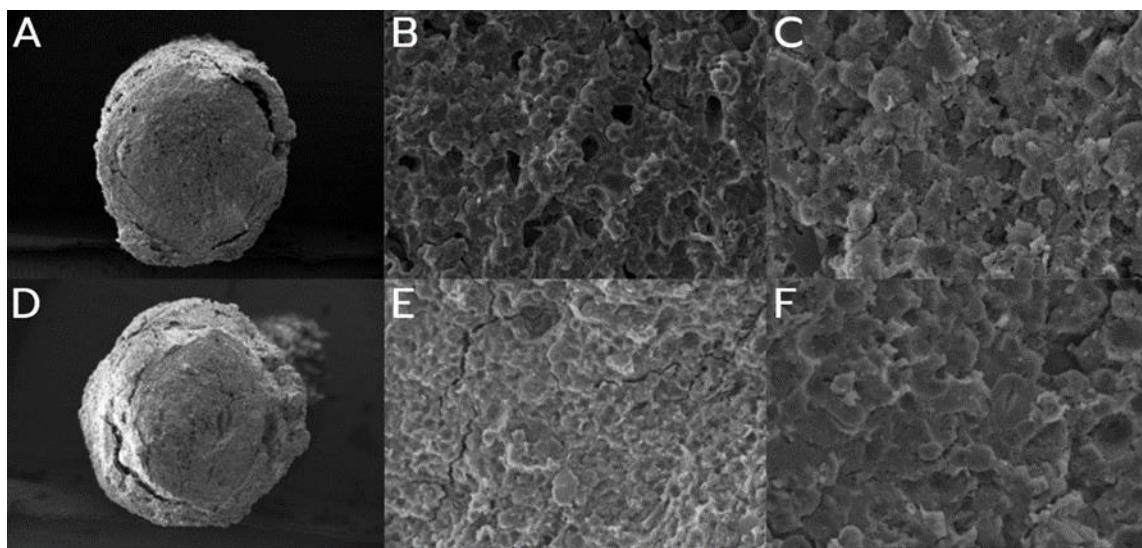
Sample	Mean $\pm$ standard deviation					
	Appearance	Color	Taste	Flavor	Texture	Overall liking
Control	6.65 $\pm$ 1.60 <sup>a</sup>	6.05 $\pm$ 1.73 <sup>a</sup>	5.15 $\pm$ 1.53 <sup>ab</sup>	4.70 $\pm$ 1.59 <sup>ab</sup>	5.10 $\pm$ 1.77 <sup>ab</sup>	5.35 $\pm$ 1.73 <sup>a</sup>
F1	5.40 $\pm$ 1.93 <sup>bc</sup>	5.25 $\pm$ 1.91 <sup>ab</sup>	3.85 $\pm$ 1.49 <sup>c</sup>	4.30 $\pm$ 1.72 <sup>bc</sup>	4.10 $\pm$ 1.71 <sup>c</sup>	4.15 $\pm$ 1.53 <sup>c</sup>
F2	5.15 $\pm$ 1.87 <sup>c</sup>	4.65 $\pm$ 1.95 <sup>b</sup>	3.85 $\pm$ 1.42 <sup>c</sup>	4.10 $\pm$ 1.59 <sup>bc</sup>	4.15 $\pm$ 1.57 <sup>c</sup>	3.95 $\pm$ 1.39 <sup>c</sup>
F3	6.00 $\pm$ 1.65 <sup>ab</sup>	5.10 $\pm$ 1.86 <sup>b</sup>	5.05 $\pm$ 1.67 <sup>ab</sup>	4.65 $\pm$ 1.81 <sup>ab</sup>	5.40 $\pm$ 1.50 <sup>a</sup>	5.15 $\pm$ 1.73 <sup>ab</sup>
F4	4.90 $\pm$ 1.91 <sup>c</sup>	4.65 $\pm$ 1.76 <sup>b</sup>	3.95 $\pm$ 1.54 <sup>c</sup>	3.85 $\pm$ 1.60 <sup>c</sup>	3.90 $\pm$ 1.41 <sup>c</sup>	4.00 $\pm$ 1.41 <sup>c</sup>
F5	6.10 $\pm$ 1.12 <sup>ab</sup>	5.40 $\pm$ 1.55 <sup>ab</sup>	5.40 $\pm$ 1.93 <sup>a</sup>	5.20 $\pm$ 1.67 <sup>a</sup>	5.10 $\pm$ 1.74 <sup>ab</sup>	5.35 $\pm$ 1.76 <sup>a</sup>
F6	5.10 $\pm$ 1.99 <sup>c</sup>	5.40 $\pm$ 1.54 <sup>b</sup>	4.40 $\pm$ 1.76 <sup>bc</sup>	4.20 $\pm$ 1.90 <sup>bc</sup>	4.50 $\pm$ 1.85 <sup>bc</sup>	4.55 $\pm$ 1.83 <sup>bc</sup>

Means with different superscripts within the same column are significantly different (p<0.05)

### Scanning Electron Microscopy

For microstructure, the SEM images of the fresh noodle from wheat flour, chickpea, and irradiated jackfruit flour supplemented with water meal to observe the network structure in the products are shown in Figure 1. From the SEM images, the microstructure of the noodle addition water meal powder and ratio of irradiated jackfruit seed flour that increased the result in porosity was decreased, and there was

a more compact and dense network of protein matrix around the starch granules when compared to the control sample. And addition of water meal (**Figure. 1A**) could improve the integrity of protein coating and result in a smoother surface. The smoother microstructure and reduced porosity help improve the uniform distribution of starch and protein in the noodles, increasing the chewiness and contributing to higher tensile strength. This makes the noodles more resistant to pulling forces, preventing them from breaking or deforming easily<sup>18</sup>. This is consistent with the tensile strength found in the samples where water mimosa was added, and the proportion of irradiated jackfruit seed starch increased, showing a tensile strength of 22.90 g<sub>force</sub>, while the control noodles had a tensile strength of only 7.69 g<sub>force</sub>.



**Figure 1.** Scanning electron microscope (SEM) image of fresh noodle samples A) represented control sample 40X, B) 500X of A, C) 1000X of A. D) represented F5 sample (ratio between chickpea flour and irradiated jackfruit seed flour levels 1:3 with water meal powder at 5%) 40X, E) 500X of D, F) 1000X of D.

## CONCLUSION

The development of high- protein healthy noodles using chickpea flour, irradiated jackfruit seed flour, and dried water meal powder found that the use of water meal powder in the formula helps improve the noodle's structure and functional quality. However, using too much water meal powder can cause dietary fiber from the water meal to interfere with the structure and reduce the quality. This was evident when increasing the water meal powder from 5% to 10%, resulting in noodles with lower quality. Therefore, a noodle formula with 5% water meal powder was chosen. Additionally, the influence of the chickpea flour to irradiated jackfruit seed flour ratio showed that reducing the amount of chickpea flour and increasing the irradiated jackfruit seed flour improved the noodle quality as well. The noodle formula that received the highest overall preference was formula F5, with a chickpea flour to irradiated jackfruit seed flour ratio of 1:3, which aligns with the physical analysis results of the noodles.

## ACKNOWLEDGEMENT

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# **Abstract**

## **Oral Presentation (OP)**

**The 2nd Southeast Asia Public  
Health Nutrition Conference  
(2nd SEA-PHN)**

## OP01: Research Article

### Analysis the Determinants of Stunting among 6-23 Months Children in Papua: Structural Equation Modeling Approach

Dewi Hapsari Ratna M<sup>1\*</sup>, Siti Helmyati <sup>2</sup>, Shinta Prawitasari <sup>3</sup>

<sup>1</sup>*Postgraduate Program in Public Health; Faculty of Medicine, Public Health and Nursing; Universitas Gadjah Mada, Indonesia*

<sup>2</sup>*Department of Nutrition and Health; Faculty of Medicine, Public Health and Nursing; Universitas Gadjah Mada, Indonesia*

<sup>3</sup>*Department of Obstetrics and Gynecology; Faculty of Medicine, Public Health and Nursing; Universitas Gadjah Mada, Indonesia*

#### ABSTRACT

Stunting remains a significant issue in eastern Indonesia, especially Papua Islands. Both Papua and West Papua Province were being a top five of highest stunting incidence with 34.6% and 30%, respectively. Previous studies have already affirmed this outcome by using different statistical approaches, yet some factors indicate the influence of other factors within the system. The aim of this study was to establish the major factors associated and the paths showing how these risk factors influence stunting in Papua. Data from Indonesian Nutritional Status Survey year 2022 were used for this study. A sample of 2,189 children, whose socio-demographics, maternal characteristics and children's health history, was considered. The study used structural equation modelling analysis, which consists of three latent variables, to identify the multifaceted natures and paths of the risk factors that influence stunting among 6-23 months children. From three predetermined latent variables, only socio-demographics had a significant total effect ( $\beta=0.27$ ;  $p<0.001$ ) on stunting among 6-23 months children. Maternal characteristics contributed as the highest total effect among others, but statistically insignificant ( $\beta=0.95$ ;  $p>0.05$ ), while children's health history showed a negative direct effect towards stunting ( $\beta=-0.18$ ;  $p>0.05$ ). For the further analysis, the most dominant indicators to influence stunting in Papua within socio-demographics variables were maternal knowledge and wealth index. Socio-demographics, especially maternal knowledge and wealth index significantly affect stunting of children among 6-23 months in Papua. An approach from different levels of policy makers should focus on nutrition sensitive intervention to address prevention and decreasing stunting.

**Key words:** child stunting, determinants, eastern Indonesia, SEM, Papua

\* Correspondence: dewi.hapsari94@gmail.com

## OP02: Research Article

### The Potency of Postprocessed Fish Bone as Biomaterial for Hydroxyapatite Synthesis

**Masagus Muhammad Prima Putra<sup>1\*</sup>, Dian Isyabillah Anggraini<sup>1</sup>, Yolanda Lativa<sup>1</sup>, Retno Ardhani<sup>2</sup>**

<sup>1</sup> *Fish Product Technology, Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada, <sup>2</sup> Faculty of Dentistry, Universitas Gadjah Mada*

#### ABSTRACT

Hydroxyapatite is a biomaterial that plays a role to stimulate tooth and bone growth. Previously, HA was reported to be produced from various materials, including fresh fish bone. However, no report has been published on the utilization of postprocessed fish bone as a biomaterial for HA synthesis. Thus, this research was done to synthesize and characterize the hydroxyapatite (HA) from post-processing bone, namely fried catfish (*Clarias* sp.) and smoked ariid catfish (*Arius* sp.). Hydroxyapatite was synthesized by sol-gel method with various sintering temperatures, including 800°C, 900°C, and 1000°C, for 4 hours. Hydroxyapatite was synthesized by sol-gel method using CaO and H<sub>3</sub>PO<sub>4</sub> as precursors with various sintering temperatures, including 800°C, 900°C, and 1000°C, for 4 hours. The resulted HA powder was characterized by SEM-EDX and FTIR, followed by Ca/P ratio, functional group and structure analysis. The fresh bone from each material was used as a control. The analysis of Ca/P ratio for HA from friend catfish and smoked ariid catfish boned ranging from 1.71 - 2.63. The Ca/P ratio from tempering temperature of 900°C successfully promotes the development of HA with Ca/P ratio closest to the characteristics of pure HA, which is 1.67. Furthermore, the characteristics of fresh bone HA synthesized with the same sintering temperature showed similarities with the characteristics of HA from postprocessed bone. The results of this study indicated that postprocessed bones from by-products of the restaurant industry have the potential to be used as raw material for making HA with similar characteristics to fresh bones.

**Key words:** catfish, friend, hydroxyapatite, smoked, sol-gel method

\* Correspondence: primaputra@ugm.ac.id

## OP03: Research Article

### The Effects of Policy Announcements Abolishing Temporary Street Food Selling Areas in Public Places on Vendors' Performance: A Comparative Analysis of Knowledge, Attitudes, and Practices

Kulratida Rakglud <sup>1</sup>, Rewadee Chongsuwat <sup>1</sup>, Chanchira Phosat <sup>1,\*</sup>

<sup>1</sup> Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand

#### ABSTRACT

Street food vendors potentially impact consumer health outcomes, thereby influencing the broader public health landscape. This study aimed to evaluate the knowledge, attitudes, and practices of street food vendors-factors that can affect the availability of healthy food options. A descriptive cross-sectional study was conducted using a questionnaire. Data comparison was performed between two distinct phases: during the announcement of the abolition of temporarily permitted selling areas (Phase 1) and after the announcement (Phase 2). The study included 218 and 227 participants in Phase 1 and 2, respectively. Notable differences were observed between the phases: Phase 2 had a higher proportion of younger vendors (46.3% aged 18-39 years compared to 28.4% in Phase 1;  $p=0.000$ ) and a greater number of vendors with a bachelor's degree (53.7% compared to 14.0%;  $p=0.000$ ). Despite similar overall health conditions across the phases, Phase 2 showed fewer annual health check-ups (30.0% compared to 77.1%;  $p=0.000$ ) and less necessary training (27.3% compared to 65.1%;  $p=0.000$ ). Vendors in Phase 1 exhibited higher levels of knowledge ( $11.7\pm1.3$  compared to  $9.9\pm2.3$ ;  $p=0.000$ ) and better practices (99.5% compared to 73.1%;  $p=0.000$ ). These findings indicate a decline in vendor performance following the announcement, possibly due to reduced enforcement by authorities. This underscores the need for targeted strategies to effectively regulate and enhance street food vendor practices on a sustainable basis.

**Key words:** street food, street food policy, street food vendor, KAP

\* Correspondence: chanchira.pho@mahidol.ac.th

## OP04: Research Article

### Assessing Anemia Risk in Young Children Using Non-Invasive Screening and Nutritional Correlates in Northeast Thailand

**Suchaorn Saengnipanthkul<sup>1\*</sup>, Prapassara Sirikarn<sup>2,3</sup> Sasupang Musikaboonlert<sup>3</sup>, Ly Cong Tran<sup>4</sup>, Maneerat Phuwanant<sup>5</sup>**

<sup>1</sup> Division of Nutrition, Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

<sup>2</sup> Department of Epidemiology and Biostatistics, Faculty of Public Health, Khon Kaen University, Khon Kaen, Thailand

<sup>3</sup> Department of Nutrition, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

<sup>4</sup> Doctor of Philosophy Program in Clinical Sciences, Khon Kaen University, Khon Kaen, Thailand

<sup>5</sup> Department of Pediatrics, Faculty of Medicine, Prince of Songkla University, Hat Yai District, Songkhla, Thailand

#### ABSTRACT

Anemia is a critical global health issue, particularly affecting young children in developing regions. This study aimed to assess the prevalence of at-risk anemia using a non-invasive screening and explore the relationship between caregivers' knowledge, attitudes, and practices related to complementary feeding and anemia in infants. A cross-sectional, clustered randomized study of 2,000 children aged 6 months –5 years was conducted in Northeast Thailand using Masimo Rad-67 and a nutrition survey. Demographically, the median age of children was 31.1 months (IQR 15.43, 44.09), 20.3% had a maternal history of thalassemia trait, 28.0% were currently breastfeeding, and 33.8% were consuming fortified formula while only 24.6% met the adequate daily iron intake. Although 92.1% of caregivers were likely to prepare meals with iron-rich foods, only 68.1% had received knowledge about these foods. Iron supplementation was received by 48.2% of participants according to government policy. Participants with a higher risk of iron deficiency anemia (IDA) tended to have higher underweight and wasting rates (8.8% vs 12.3%) respectively. Interestingly, participants under 2 years of age without a risk of IDA showed a higher percentage of consuming iron-fortified formula (>600 ml/day). The prevalence of at-risk anemia, determined by the Masimo Rad-67 non-invasive screening tool, was 36.9% with no significant differences between rural and urban areas. Factors associated with at-risk anemia included age under 24 months, female gender, positive maternal thalassemia trait screening, wasting, and parental concern about iron deficiency. Notably, iron supplementation appeared to offer protective benefits.

**Key words:** anemia, iron deficiency, non-invasive screening, iron supplementation, young children

\* Correspondence: suchsa@kku.ac.th

## OP05: Research Article

### FTO rs9939609 Gene Polymorphism Related to High Sugar Intake in Obese Adults

**Sakawrut Poosri<sup>1</sup>, Usa Boonyuen<sup>1</sup>, Pattaneya Prangthip<sup>1\*</sup>**

<sup>1</sup> Tropical Medicine, Mahidol University, Thailand

#### ABSTRACT

The risk of obesity is influenced by lifestyle factors, genetics, and the environment. The complex interaction of lifestyle and genetic factors determines the obesity. Research on the connection between genetics and nutrition has not focused much on this topic thus far. The objective of the current study is to examine the potential influence of single nucleotide polymorphisms (SNPs) of fat mass obesity-associated protein (FTO) gene rs9939609 in the food intake that raises the risk of obesity in adults. The study comprised adult (18-59 years), healthy participants with body mass indexes (BMIs) ranging from 18.5 to 30 kg/m<sup>2</sup>. Using DNA from blood samples, FTO rs9939609 genotyping was done. The Asian categorization system was used to classify the subjects by comparing their BMI across several groups. Dietary consumption, blood for biochemical analysis, and anthropometry were evaluated. Variable associations and correlations were examined in regard to genotype. The blood biochemistry across genotypes is not significantly different, but the trend in the risk allele is higher than that of the dominant group. When compared to homozygous dominant participants, the intake of sugar and saturated fat was considerably higher in obesity risk allele carriers. For the high sugar intake risk allele, rs9939609 (TA+AA), the odds ratio was 2.23 (95% CI, 1.05–4.74, P<0.035). The relationship between high intakes of sugar the FTO risk alleles is highlighted by the study's findings. Higher levels of sugar were found in FTO rs9939609 risk allele carrier, which may be the important factor raising the risk of obesity in adults.

**Key words:** single nucleotide polymorphisms (SNPs), FTO gene, obesity

\* Correspondence: pattaneeya.pra@mahidol.ac.th

## OP06: Research Article

### Factors Associated with Stunting in Children Under Five in Thailand

Ameen Mhamad <sup>1,2\*</sup>, Nurin Dureh<sup>1</sup>, Apiradee Lim<sup>1</sup>

<sup>1</sup>Department of Mathematics Computer Science, Faculty of Science Technology,

Prince of Songkla University, Pattani Campus, Pattani, Thailand

<sup>2</sup>Regional Health Promotion Center 12, Yala, Thailand

#### ABSTRACT

Stunting among children affects their wellbeing and growth, especially in children under five years of age, which is the golden period of brain development. This study aims to examine the prevalence and factors influencing stunting among children under five. Thailand Multiple Indicator Cluster Survey (MICS) 2022 data were used in this study, with 9,263 children under-five year olds. The study analyzed the 14 independent variables comprised of child (age, gender, and health insurance), maternal (age, education, marital status, and insurance), and household (region, area, wealth index, language, and household's head age, gender and education) characteristics. The Chi-squared and multiple logistic regression (MLR) were used for data analysis. The results showed that 14.9 percent of children under-five were stunted. Child's gender and age, mother's age and education, household head's age and education, regions, wealth index, and language were significant factors related to stunting. MLR analysis revealed that children under 12 months old were 2.36 times more likely to be stunted compared to those aged 48-59 months (95% CI [1.96, 2.85]). Children who lived with mothers had lower secondary education were 1.35 times more likely to be stunted compared with higher education (95% CI [1.13, 1.62]). Compared to the central region, children in the southern region were 1.40 times more likely to be stunted (95% CI [1.1, 1.71]). Parent education were significantly associated with under-five stunting. Effective maternal and child health policies must focus on the southern region, particularly improved parent's nutrition literacy to reduce under-five child stunting in Thailand.

**Key words:** stunting, children under five, multiple indicator cluster survey, Thailand

\* Correspondence: 6520330006@email.psu.ac.th

## OP07: Research Article

### Effect of *Wolffia globosa* Incorporation on the Physical, Phytochemical and Antioxidant Properties of Breadsticks

May Phy Wai<sup>1</sup>, Sathaporn Ngamukote<sup>1</sup>, Sirichai Adisakwattana<sup>1</sup>, Tanyawan Suantawee<sup>1\*</sup>

<sup>1</sup>Phytochemical and Functional Food Research Unit for Clinical Nutrition, Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand.

#### ABSTRACT

Unhealthy diets high in fats, sugars, carbohydrates, and low in fiber are linked to an increased risk of non-communicable diseases (NCDs) such as obesity, hypertension, diabetes, and heart disease. This has driven people towards healthier lifestyles and foods enriched with fiber and phytochemicals. *Wolffia globosa*, or duckweed, is a nutrient-dense plant rich in protein, fiber, phytochemicals, and antioxidants, offering health benefits including lowering blood glucose levels. This study aims to develop nutrients enriched breadsticks by utilizing duckweed. Nutritionally enhanced breadsticks were developed by using 5%, 10% and 15% of *Wolffia globosa* powder (WP). The effect of WP on breadsticks' hardness, fracturability, color, total phenolic compounds (TPC), total flavonoid contents (TFC), antioxidant power (DPPH radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP)) and consumer acceptability by 9-point hedonic scale were then evaluated. Results showed that adding 5-15% WP significantly increased the breadsticks' hardness and fracturability while reducing lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ ) of the breadsticks ( $p < 0.05$ ). TPC, TFC, and antioxidant power increased significantly with 10% and 15% WP ( $p < 0.05$ ). In terms of acceptability, consumer acceptance was not negatively impacted by 5% and 10% WP, while 15% WP received neutral ratings. Our findings indicate that incorporating high phytochemical and antioxidant rich WP into breadsticks enhances their bioactive compounds and antioxidant activity while also being well-received by consumers. These results suggest that WP could be a valuable addition for creating healthier, antioxidant-enriched food products, offering more nutritious options for consumers.

**Key words:** *Wolffia globosa*, phytochemicals, breadsticks, antioxidant, consumer acceptability

\*Correspondence: Tanyawan.S@chula.ac.th

## OP08: Research Article

### The Potential Use of Banana Blossom as a Functional Ingredient in Kombucha Beverage for the Prevention of Type 2 Diabetes Risk

Thitirat Poolsawat<sup>1,2</sup>, Bandhita Wanikorn<sup>1,2</sup>, Wilawan Sinthuprap<sup>1,3\*</sup>

<sup>1</sup>Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand.

<sup>2</sup>Specialized Research Unit: Functional Food and Human Health Laboratory, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand. <sup>3</sup>Specialized Research Unit: Probiotic and Prebiotics for Health, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand.

#### ABSTRACT

The risk of acquiring type 2 diabetes is reduced by reducing glucose absorption into the bloodstream via antioxidants in body cells. Banana blossom (BB) has antioxidant and anti-inflammatory properties and inhibits the activity of carbohydrate-digesting enzymes *in vivo*. These properties make it suitable for creating functional food and beverage products as kombucha which fermented tea drinks contain of functional benefits from raw materials and products from microbial growth. This study focuses on developing functional beverages like banana blossom kombucha. The dried banana blossoms (DBB) to water ratios of 0.75% and 2.25% were investigated and fermented for 21 days. Chemical properties (total acid as acetic acid) and functional properties (total phenolic content, antioxidant activity by the DPPH method, and  $\alpha$ -glucosidase inhibition) were examined. DBB had 38.66 mg GAE/g of total phenolic compounds, 4.69 mg TE/g of DPPH antioxidant activity, and 94.12%  $\alpha$ -glucosidase inhibition. BB kombucha with a ratio of 2.25% showed total acid as acetic acid increased during fermentation and had significantly the highest total acid at 1.24% ( $p < 0.05$ ) at day 21, with the highest phenolic content, the antioxidant activity of DPPH and inhibition of  $\alpha$ -glucosidase compared with 0.75%. BB can be used as a functional ingredient in commercial functional foods and beverages like kombucha drinks to promote health and reduce risk factors for type 2 diabetes by using a ratio of 2.25% BB in water.

**Key words:** risk of type 2 diabetes, banana blossom, kombucha, functional properties

\* Correspondence: fagiwlw@ku.ac.th

## OP09: Research Article

### Effectiveness of Local Supplementary Feeding on Under-fives' Nutritional Status in Magelang Utara, Indonesia

Nara Citarani<sup>1\*</sup>, Retno Wulan Sari<sup>2</sup>

<sup>1</sup> Postgraduate Program in Public Health, Faculty of Medicine, Public Health, and Nursing,

Universitas Gadjah Mada, Yogyakarta, Indonesia

<sup>2</sup> Magelang Utara Primary Health Care, Magelang City, Indonesia

#### ABSTRACT

The Indonesian Ministry of Health initiated a local supplementary feeding program, namely PMT Lokal, to overcome the nation's rising prevalence of under-fives' wasting. This study aimed to assess the effect of the PMT Lokal program on under-fives' nutritional status in Magelang Utara Subdistrict. This study was an analysis of secondary data, collected by Magelang Utara Primary Health Care in 2023. The anthropometric data of 229 under-fives were collected longitudinally, before and after one, two, and three months of the program. The local supplementary food is ready-to-eat food prepared by a food service provider daily. The nutritional status changes were tested numerically with one tailed paired t-test and categorically with McNemar test. In a month, the PMT Lokal program increased under-fives' weight-for-age (mean difference = 0.15,  $p < 0.001$ ) and weight-for-height (mean difference = 0.25,  $p < 0.001$ ) index. After a month, underweight (McNemar OR = 7.25, 95% CI: 2.55-28.38,  $p < 0.001$ ) and wasted (McNemar OR = 3.75, 95% CI: 1.68-9.47,  $p = 0.0004$ ) under-fives were more likely to have normal WAZ and WHZ status compared to the opposite direction. The same results were found after two and three months of the program. No statistically significant improvement was found on under-fives' height-for-age index and stunted status. The PMT Lokal program improved under-fives' WAZ, WHZ, underweight, and wasted status in Magelang Utara Subdistrict.

**Key words:** wasting, underweight, under-fives, local supplementary feeding program, nutrition intervention

\* Correspondence: naracitarani@mail.ugm.ac.id

## OP10: Research Article

### Local Food ad a Supplementary Feeding Program for Pregnant Women with Chronic Energy Deficiency: Evaluation in Yogyakarta, 2024

**Aulia Rahmadini Saputri<sup>1\*</sup> Asma Rizkiyani<sup>1</sup> Khairani Fauziah<sup>1</sup>**

<sup>1</sup>*Public Health Postgraduate Program; Faculty of Medicine, Public Health, and Nursing; Gadjah Mada University, Indonesia*

#### ABSTRACT

Chronic Energy Deficiency in pregnant women is a serious nutritional problem in Indonesia, posing significant health risks to both mothers and their unborn children. The Supplementary Feeding Program aims to address this deficiency. In recent years, the Indonesian government provided biscuits as supplementary food; however, only 50% of pregnant women consumed them due to their monotonous taste. To enhance consumption, the program has shifted to using varied local food ingredients that align better with local eating habits. This research evaluates the input, process, and output indicators of the local supplementary feeding program in Yogyakarta. This descriptive qualitative study was conducted from April 22 to June 28, 2024, involving 18 Community Health Centers in Yogyakarta. Research subjects included nutritionists, midwives, and heads of administration. Data were collected through monitoring and evaluation forms filled out by nutritionists and Focus Group Discussion to identify challenges in program implementation. Most input and process indicators achieved over 80%. However, only 44.44% of health centers developed clear terms of reference and formed an implementation team. Food safety measures were implemented in 77.78% of health centers. Variability in output indicators was observed due to differences in implementation schedules. Challenges included inadequate food safety and hygiene, along with delays in distribution. The local supplementary feeding program in Yogyakarta has made progress, particularly with local catering contributions. However, improvements in program management, food supervision are needed for optimal results.

**Key words:** chronic energy deficiency, pregnant women, local supplementary feeding, program evaluation, Yogyakarta

\*Correspondence: auliarahmadinisaputri2000@mail.ugm.ac.id

## OP11: Research Article

### Empowerment-Based Nutrition Communication Training Improves Nutrition Advocacy and Diet Quality in Nutrition Undergraduates

Ang Zheng Feng<sup>1</sup>, Chin Yit Siew<sup>1\*</sup>, Nurzalinda Zalbahar<sup>1</sup>, Diyana Nawar Kasimon<sup>2</sup>, Lim Poh Ying<sup>3</sup>

<sup>1</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

<sup>2</sup> UPM-UNICEF C4D Programme, Faculty of Modern Languages and Communication, Universiti Putra Malaysia

<sup>3</sup> Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

#### ABSTRACT

Nutrition undergraduates require soft skills improvement to advocate for non-communicable diseases prevention, but many practising unhealthy eating habits. Hence, the Nutrition Communication, Empowerment, and Leadership (NutriCEL) programme was developed to improve their nutrition advocacy skills and diet quality. This cluster randomised controlled trial was conducted among nutrition undergraduates from two randomly selected local universities in Klang Valley, Malaysia. The students from one university were assigned to the intervention group (IG, n=54), while the students from the other university formed the control group (CG, n=52). Both groups completed a 3-day food record and online surveys, consisting of validated questionnaires that evaluated their health promotion competencies and youth empowerment, at both pre-intervention and post-intervention. The IG participated in NutriCEL while the CG received a nutrition consultation. Generalised estimating equations were used to determine the impacts of NutriCEL after adjusting for covariates. The health promotion competencies of the IG improved significantly post-intervention ( $\beta=2.862$ ,  $p=0.014$ ) compared to the CG at pre-intervention. Although improvements in youth empowerment and diet quality were not statistically significant, further analysis revealed a significant increase in leadership competency ( $\beta=1.278$ ,  $p=0.005$ ) and a significant reduction in fat intake ( $\beta=-5.448$ ,  $p=0.037$ ) at post-intervention compared to the CG at pre-intervention. The NutriCEL improves health promotion and leadership competencies among nutrition undergraduates, with a notable reduction in fat intake post-intervention. Hence, it is recommended that NutriCEL be integrated into nutrition courses to enhance students' advocacy skills and diet quality, contributing to better nutrition advocacy.

**Key words:** health promotion, communication, empowerment, leadership, healthy eating index

\* Correspondence: chinys@upm.edu.my

## OP12: Research Article

### Empowering Mothers and Their Children Through Nutrition and Urban Farming: The Impact of the PUTRA Community Nutrition Ambassador Program (PUTRACNAP) in Urban Poor Settings

Yit Siew Chin<sup>1\*</sup>, Nur Amalin Juhari<sup>1</sup>, Juju Nakasha Jaafar<sup>2</sup>, Sukanya Sereenonchai<sup>3</sup>,  
Poh Ying Lim<sup>4</sup>, Nurzalinda Zalbahar@Zabaha<sup>1</sup>, Wan Ying Gan<sup>1</sup>, Norhasmah Sulaiman<sup>1</sup>

<sup>1</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

<sup>2</sup> Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia

<sup>3</sup> Faculty of Environment and Resource Studies, Mahidol University

<sup>4</sup> Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

#### ABSTRACT

The double burden of malnutrition poses a significant challenge in urban poor households. Mothers play a critical role in shaping their children's eating habits and health, making them central to interventions aimed at improving family outcomes. The PUTRA Community Nutrition Ambassador Programme (PUTRACNAP) was designed to empower mother-child pairs through nutrition education and urban farming, with the goal of enhancing nutritional knowledge, maternal-child relationships, and nutritional status. This cluster-randomized controlled trial evaluated the effectiveness of PUTRACNAP in 10 low-cost flats in Kuala Lumpur, involving 37 mother-child pairs (children aged 7-12 years). The intervention group (19 pairs) participated in a 12-week program with interactive nutrition and farming activities, while the control group (18 pairs) received basic nutrition advice. Outcomes were assessed at pre-intervention, post-intervention, and six-month follow-up using standardized questionnaires and health assessments. The intervention group showed a significant increase in children's nutrition knowledge and a significant improvement in mother-child relationships over time compared to the control group, after adjusting for covariates ( $p<0.05$ ). Additionally, the intervention group demonstrated significantly higher maternal haemoglobin levels and children's height-for-age (HAZ) at the six-month follow-up compared to the control group ( $p<0.05$ ). However, no significant improvements in maternal nutrition knowledge or body composition between the groups. These findings highlight the potential of integrating nutrition education with urban farming to improve maternal-child relationships and address malnutrition in both mothers and children. The PUTRACNAP model emphasizes empowering mothers and children to promote sustainable health outcomes for their families in urban poor settings.

**Key words:** malnutrition, nutrition education, urban farming, mothers, children, empowerment

\* Correspondence: chinys@upm.edu.my

# **Abstract**

## **Free-oral Presentation (F)**

**The 2nd Southeast Asia Public  
Health Nutrition Conference  
(2nd SEA-PHN)**

## F01: Research Article 0020

### Improving PUFA Incorporation in Brain and Cell Membrane

**Theo van Kempen<sup>1\*</sup>, Nan Ma<sup>1</sup>, Lotte Smolders<sup>1</sup>, Anita Hartog<sup>1</sup>**

<sup>1</sup> AAK Netherlands BV, Netherlands

#### ABSTRACT

- Not available-

\* Correspondence: theo.van.kempen@aak.com

## F02: Research Article

### Calf Circumstances Identified Malnutrition in Head and Neck Cancer Patients

Tran Chau Quyen<sup>1</sup>, Nguyen Thi Loan<sup>1\*</sup>, Do Tat Cuong<sup>1</sup>, Bui Thi Kim Hue<sup>1</sup>, Tran Thi Nam<sup>1</sup>,  
Bui Vinh Quang<sup>1</sup>, Le Thi Le Quyen<sup>1</sup>

<sup>1</sup>Hanoi Oncology Hospital

#### ABSTRACT

Head and neck cancer (HNC) is associated with a high risk of malnutrition due to the impact of tumors and treatments on swallowing, breathing, and communication. Implementing a simple and effective tool to identify malnutrition in these patients is crucial, especially in settings with limited hospital nutrition staff, as it can guide timely nutritional interventions. From May to December 2021, patients aged 18-65 diagnosed with HNC were consecutively enrolled at Hanoi Oncology Hospital, Vietnam. Measurements of weight, height, mid-arm circumference (MAC), and calf circumference (CC) were conducted using standard protocols. The Patient-Generated Subjective Global Assessment (PG-SGA) was also utilized. Malnutrition was defined by the following criteria: BMI < 18.5 kg/m<sup>2</sup>, MAC < 23 cm in women and < 24 cm in men, CC  $\leq$  33 cm in women and  $\leq$  34 cm in men, and PG-SGA levels B or C. Among 150 participants (117 men and 33 women), the most common cancers were laryngeal/hypopharyngeal (40%), nasopharyngeal (33%), and oral cavity (22%). The prevalence of malnutrition identified by BMI, MAC, and CC was 25.6%, 32.5%, and 70.1% in men and 12.1%, 21.2%, and 84.8% in women, respectively. PG-SGA identified 73.5% of men and 97.0% of women as malnourished. Calf circumference closely correlated with the malnutrition rates identified by PG-SGA, indicating that CC may serve as a reliable surrogate marker for assessing malnutrition risk in head and neck cancer patients.

**Key words:** head and neck cancer, malnutrition, calf circumference, PG-SGA, BMI

\* Correspondence: loanbvubhn@gmail.com

## F03: Research Article 0043

### Mapping the Diet-Obesity-Cardiometabolic Nexus Through Multidimensional Profiling and Modeling of Food Consumptions in Malaysians Adult Population

Jun-Hao Lim<sup>1</sup>, Ayesha Sualeheen<sup>2</sup>, Ban-Hock Khor<sup>3</sup>, Gaiyal Viliy Balasubramanian<sup>4</sup>, Khun-Aik Chuah<sup>5</sup>, Karuthan Chinna<sup>6</sup>, Sreelakshmi Sankara Narayanan<sup>7</sup>, Kalyana Sundram<sup>8</sup>, Zulfitri Azuan Mat Daud<sup>1</sup>, Tilakavati Karupaiyah<sup>8\*</sup>

<sup>1</sup> Department of Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia,

<sup>2</sup> School of Exercise and Nutritional Science, Faculty of Health, Deakin University, Burwood, Victoria, Australia,

<sup>3</sup> Faculty of Food Science and Nutrition, University Malaysia Sabah, Kota Kinabalu, Malaysia,

<sup>4</sup> Dietetics Program, Faculty of Health Sciences, University Kebangsaan Malaysia, Kuala Lumpur, Malaysia,

<sup>5</sup> Nutrition Program, Faculty of Health Sciences, University Kebangsaan Malaysia, Kuala Lumpur, Malaysia,

<sup>6</sup> Faculty of Business and Management, UCSI University, Cheras, Kuala Lumpur, Malaysia,

<sup>7</sup> School of Biosciences, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, Selangor, Malaysia,

<sup>8</sup> Malaysia Palm Oil Council, Menara Axis, Petaling Jaya, Selangor, Malaysia

### ABSTRACT

While traditional dietary pattern (DP) methods provide insight into how foods are grouped, the specific connections between foods in real-world settings and their contributions to obesity and cardiometabolic risk (CMR) remain unclear. This study aims to deepen our understanding of the diet-obesity-CMR relationship through multidimensional dietary profiling and modeling techniques. This cross-sectional study recruited 558 adults free of chronic diseases. Dietary intake was assessed using 3-day diet records and profiled using a combination of a priori (diet quality, DQ), a posteriori (Principal Component Analysis, PCA), hybrid method (Reduced-Rank Regression, RRR), and the novel food network analysis (Gaussian Graphical Model, GGM). The diet-obesity-CMR relationship was examined using Partial Least Square Structural Equation Modeling. Obesity was evident in 25.4% of the participants. The average DQ was poor ( $36.9 \pm 10.1$  out of 100). PCA identified four habitual DPs (Home Food, Chinese Traditional, Plant Food and Sugar-Sweetened Beverages patterns) and RRR established one DP (Obesogenic pattern). GGM identified four habitual DPs similar to those from PCA and illustrated the food networks connecting these DPs. Significant diet-obesity-CMR relationships (all  $p < 0.05$ ) were found for DQ (SIE=-0.069), Plant FoodPCA (SIE=-0.079), Obesogenic (SIE=0.115), Sugar-Sweetened BeveragesGGM (SIE=0.071), Plant FoodGGM (SIE=-0.082), and Imbalance Home FoodGGM (SIE=0.050) patterns. GGM revealed whole grain as the central food in connecting healthy dietary patterns and breaking unhealthy food chains to combat obesity and CMR. Reversing the diet-obesity-CMR cascade requires public health strategies that promote healthy dietary patterns emphasizing whole grain.

**Key words:** dietary pattern, obesity, cardiometabolic risk

\* Correspondence: tilly\_karu@yahoo.co.uk

## F04: Research Article

### Parental Feeding Style and Paternal Involvement with Dietary Diversity among Young Children Aged 6 – 24 Months in Malaysia.

Nurzalinda Zalbahar<sup>1\*</sup>, Nurul Balquis Azlan<sup>1</sup>, Nur Amalina Amirullah<sup>1</sup>, Norhasmah Sulaiman<sup>1</sup>

<sup>1</sup>Universiti Putra Malaysia

#### ABSTRACT

Dietary quality among infants and young children is important for their growth and development. Thus, this study determines the maternal factors, feeding style, paternal involvement and dietary diversity among young children 6 – 24 months in Malaysia. In this cross-sectional study, parents of children under 24 months were invited to complete questionnaire via Google Forms. Mother's educational level, age and BMI, monthly household income, child feeding style, food fussiness, food security and husband involvement data were collected. Minimum dietary diversity (MDD) was measured and defined as the consumption of more than or equal to five of eight food groups including breast milk in the past 24 hours. Of 181 children, 15.5% unmet the MDD. Maternal age ( $r = -0.166$ ,  $p = 0.027$ ), maternal BMI ( $r = -0.153$ ,  $p = 0.039$ ), husband involvement ( $r = 0.330$ ,  $p < 0.001$ ), perceived responsibility on child feeding ( $r = -0.183$ ), concerns about the child's weight ( $r = -0.336$ ) and monitoring the child's intake (-0.293), were significantly associated with MDD ( $p < 0.001$ ). Logistic regression analysis shows that paternal involvement increases the odds of MDD by 2.14 (95% CI: 1.29 – 3.55). Conversely, older maternal age (0.89; 95%CI: 0.81 – 0.99) and monitoring feeding (0.183; 95%CI: 0.05 – 0.63) were associated with a lower likelihood of achieving MDD among the children. Active paternal involvement in child feeding may improve MDD, however older maternal age and increased monitoring of a child's food intake might negatively impact MDD among young children.

**Key words:** dietary diversity; feeding style; paternal involvement

\* Correspondence: nurzalinda@upm.edu.my

## F05: Research Article

### Factors Influencing Ultra-Processed Food Consumption Within Vulnerable Populations: A Scoping Review

Rina Chomawati<sup>1\*</sup>, Digna Niken Purwaningrum<sup>2</sup>

<sup>1</sup> Postgraduate Program of Public Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia,

<sup>2</sup> Department of Biostatistics, Epidemiology, and Population Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia

#### ABSTRACT

Consumption of ultra-processed food by vulnerable populations can lead to negative health outcomes such as obesity, diabetes, and other non-communicable diseases. Limited access to nutritious food causes those facing food insecurity to consume more ultra-processed foods, which poses health risks across various vulnerabilities and income levels. This study aims to identify factors influencing ultra-processed food consumption within vulnerable populations. This study used the Arksey and O'Malley framework, complying with the JBI guidance for scoping reviews. Eligibility criteria were considered based on the Population, Concept, and Context approach. Include peer-reviewed articles published after 2013, with full text available in English, and studies conducted in all income levels of countries. Ten articles identified in the review showed that the higher consumption of ultra-processed food was more prevalent among children (60%), followed by adolescents (30%) and mothers (10%). Children in the complementary feeding stage typically consume ultra-processed foods because they are affordable, convenient, and quick to prepare. As children progress through elementary and high school, they tend to have an uncontrolled intake of ultra-processed foods, particularly when they are away from home, using screens, and eating alone. Additionally, mothers experience difficulties in accessing local food sources due to increasing prices. Ultra-processed food is often chosen due to accessibility, availability, and affordability rather than nutritional needs, leading to poor dietary choices among vulnerable populations.

**Key words:** ultra-processed food, consumption, vulnerable

\* Correspondence: rinachomawati@mail.ugm.ac.id

## F06: Research Article

### Nutritional Challenges among Adolescents: Examining the Effects of Ultra-Processed Foods and Sugar-Sweetened Beverages

Rahayu Indriasari<sup>1\*</sup>, Rebecca Naya<sup>1</sup>, Resky Ayu Glori<sup>1</sup>, Laksmi Trisasmitta<sup>2</sup>, Safrullah Amir<sup>1</sup>

<sup>1</sup> Departement of Nutrition Science, Faculty of Public Health/Hasanuddin University

<sup>2</sup> Hasanuddin University

#### ABSTRACT

Overnutrition is a major concern among adolescents in Indonesia, with the consumption of ultra-processed foods (UPFs) and sugar-sweetened beverages (SSBs) contributing to weight gain and increased body fat. These products are high in calories, sugar, and fat but low in nutrients. This study investigates the relationship between UPFs and SSBs consumption and the nutritional status of adolescents in an urban high school. A cross-sectional study was conducted with 196 students selected through proportional random sampling. Anthropometric measurements were taken using Tanita scales and a stadiometer. Nutritional status was categorized into normal, overnutrition, and undernutrition based on BMI/A index. Food consumption was assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Data analysis involved chi-square and Fisher's exact tests. The study revealed that 37.2% of adolescents were overnourished, 7.1% undernourished, and the rest had normal nutritional status. UPFs consumption primarily included instant noodles, frozen meatballs, and sausages, while bottled tea, sweetened tea, and powdered beverages were the most commonly consumed SSBs. Higher UPFs consumption was associated with overnutrition ( $p < 0.05$ ), but no significant relationship was found between the frequency of UPFs or SSBs consumption and overnutrition ( $p > 0.05$ ). Adolescents at the study site had high intake of UPFs and SSBs. Although UPFs consumption was linked to overnutrition, SSBs consumption did not show a significant impact on nutritional status. It is recommended that adolescents limit their consumption of UPFs and SSBs, and that schools play an active role in promoting healthier food choices.

**Key words:** adolescent, ultra processed food, sugary sweetened beverage, overnutrition

\* Correspondence: rahayu.indriasari@unhas.ac.id

## F07: Research Article

### Online Food Delivery Habits and Body Image Are Associated with Percent Body Fat but Not BMI among Nutrition Students in Indonesia

**Nurzakiah<sup>1\*</sup>, Safrullah Amir<sup>1</sup>, Marini Amaliah Mansur<sup>1</sup>, Putri Risya Azzahra<sup>1</sup>, Sitti Rahmadani<sup>1</sup>, Hizwa Arianing Dyah Arief<sup>1</sup>**

<sup>1</sup> Department Nutrition Science Study Program, Public Health Faculty, Hasanuddin University

#### ABSTRACT

Non-communicable diseases (NCDs) are on the rise globally, with obesity being a significant risk factor. The habit of consuming online food delivery (OFD) contributes to increasing obesity rates. Additionally, a negative body image can lead to unhealthy eating behaviors, further resulting in obesity. This study aims to investigate the association between OFD habits and body image with body fat percentage and body mass index (BMI). This cross-sectional study was conducted among nutrition students at the Faculty of Public Health, Hasanuddin University, involving a total sample of 160 participants selected through systematic random sampling. OFD habits and body image were assessed, and body fat percentage was measured using the InBody 270 Bioelectrical Impedance Analysis (BIA). The study found significant relationships between OFD habits and negative body image with body fat percentage ( $P<0.05$ ). Respondents who used OFD had a higher proportion of obesity compared to those who did not (86.2% vs. 69.4%). Additionally, those with a negative body image had a higher body fat percentage compared to those with a positive body image. However, different results were observed when correlating with BMI, where respondents with a negative body image had a lower proportion of obesity compared to those with a positive body image (23.3% vs. 32.8%). The habit of consuming OFD and body image are more closely related to body fat percentage as both directly affect the body's fat composition. On the other hand, BMI may not show the same relationship as it does not differentiate between weight from fat and weight from muscle.

**Key words:** online food delivery, percent body fat, BMI, body image, non-communicable diseases

\* Correspondence: nurzakiah@unhas.ac.id

## F08: Research Article

### Examining the Pervasiveness and Characteristics of Unhealthy Food Ads on Indian Television Targeting Children

**Naveen Kumar<sup>1\*</sup>, Naresh Kumar Sharma<sup>2</sup>, Vijay Pal Singh<sup>3</sup>, Tilakavati Karupaiah<sup>4</sup>, Gild Ong Rick<sup>4</sup>,  
Bridget Kelly<sup>5</sup>, Sally Mackay<sup>6</sup>**

<sup>1</sup>Chitkara University, Punjab, 140401, India,

<sup>2</sup> Amity Institute of Biotechnology, Amity University Rajasthan, Jaipur, 303002, India,

<sup>3</sup> CSIR-Institute of Genomics & Integrative Biology (CSIR-IGIB), New Delhi-110025, India,

<sup>4</sup> School of Biosciences, Faculty of Health & Medical Sciences, Taylor's University, Malaysia,

<sup>5</sup> Early Start, School of Health and Society, University of Wollongong, Wollongong, New South Wales, Australia,

<sup>6</sup> School of Population Health, Faculty of Medical and Health Sciences, University of Auckland, New Zealand

#### ABSTRACT

Unhealthy food marketing plays a pivotal role in driving demand for unhealthy products, worsening associated health concerns. While studies on child-targeted marketing of unhealthy foods are mainly from developed countries, research in developing countries like India is scarce. The objective of this study is to document the extent of unhealthy food advertising on Indian television and identify the persuasive marketing strategies employed to promote such products. We recorded television programs following the International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support protocol from India's top three channels, totaling 432 hours over three months, covering both weekdays and weekends to identify food advertisements (ads). WHO nutrient profile model (NPM) for the South-East Asian region (WHO-SEARO) and Western Peripheral Region (WHO-WPRO) were utilized to categories the permitted or not-permitted status of food advertisements. Our findings revealed that of all ads ( $45.2 \pm 13.19$ ),  $9.31 \pm 5.97\%$  promoted food products. The ratio of permitted to not-permitted food ads was 1:2.75 according to WHO-SEARO NPM and 1:16.8 according to WHO-WPRO NPM, indicating a very high prevalence of not-permitted food ads. Not-permitted food products were consistently advertised throughout all recording hours, irrespective of peak and non-peak viewing times. The rate of not-permitted food ads was higher on weekends compared to weekdays considering the leisure time of children and parents. These findings emphasize the urgent need for stricter regulations on unhealthy food advertising towards children in India by policymakers.

**Key words:** food advertising, unhealthy foods, television marketing, persuasive strategies, children's advertising

\* Correspondence: nkft87@gmail.com

## F09: Research Article

### Food Environment Transformations and Policy Landscape in Zambia: A Qualitative Inquiry of the Ongoing Nutrition Transition

**Peter Yiga<sup>1\*</sup>, Pui Yee Tan<sup>1</sup>, Stephen Whitfield<sup>2</sup>, Christian Chomba<sup>3</sup>, Caitlin shannon<sup>4</sup>,  
Andrea Menefee<sup>4</sup>, Yun Yun Gong<sup>1</sup>**

<sup>1</sup> School of Food Science and Nutrition, Faculty of Environment, University of Leeds, UK

<sup>2</sup> School of Earth and Environment, Faculty of Environment, University of Leeds, UK,

<sup>3</sup> Agricultural Consultative Forum, Lusaka, Zambia,

<sup>4</sup> Care International Zambia and USA

#### ABSTRACT

Zambia is experiencing a nutrition transition. The study aimed to explore the policy makers' perception of the food environment. The 18 key informant interviews were conducted. Interview guide was based on food environment framework. Transitions, existing and potential policies were explored. Interviews were transcribed and analysed thematically. Transitions include decreasing diversity of healthier foods and increasing cheap unhealthy foods due to mono-agricultural subsidies and mushrooming fast-food chains. Supermarkets have increased, but offer largely unhealthier options displayed in prominent locations, fresh foods are limited and exotic. Wet markets are the main source for fresh foods but suffer infrastructural/food safety challenges. Aggressive unhealthier food marketing targeting children has increased, cultivating norms associating unhealthy foods with high social class. There are limited policy strategies aimed at transitions. Key focus is nutrition education using food based dietary guidelines. Perceived potential strategies include public-private partnerships to incentivise healthier foods across the chain (diversified primary production and reformulation), zoning policies limiting establishing and advertising unhealthy foods around schools and integrating dietary guidelines in curriculum. Others are nudging supermarkets to include seasonal indigenous and healthier options in prominent locations, and government led procurement preconditions to promote healthier indigenous foods in school canteens and public events. Multisectoral platforms to visualise cross-sectoral externalities is noted as key facilitator. Due to the economic investment policies, industry is viewed as strong and potential impediment if dialogues are not established. Current policy landscape is on bottom-up approaches. However, a combination with top-down approaches encompassing key dialogues with the food industry are needed.

**Key words:** nutrition transitions, food environment transformations, food environment policies, Zambia

\* Correspondence: p.yiga@leeds.ac.uk

## F10: Research Article

### Association between Morningness and Chrono-Nutrition among Young Malaysian Female Adults

**Su Pei Wen<sup>1</sup>, Satvinder Kaur<sup>1\*</sup>, Janice Tay Ee Fang<sup>1</sup>, Yee-How Say<sup>2</sup>, Siti Sabariah<sup>3</sup>**

<sup>1</sup> *UCSI University*,

<sup>2</sup> *Sunway University*

<sup>3</sup> *Universiti Teknologi MARA*

#### ABSTRACT

Young adults face various health challenges due to poor eating habits and the transition to university life, one of which is changes in the sleep-wake cycle, significantly influenced by chrono-nutrition habits. Therefore, this study aimed to determine the relationship between morningness and chrono-nutrition habits among female university students. This cross-sectional study recruited 702 female university students aged between 18 to 25 years from three universities. A self-administered questionnaire was distributed to assess sociodemographic background, chrono-nutrition habits using the Chrono Nutrition Questionnaire. Meanwhile, morningness was determined using SCRAM Questionnaire. Only 36% of participants reported a higher likelihood of morningness in their circadian phase. High breakfast skipping (66%) prevalence was found, and three quarter (75%) had a tendency of late evening eating and short evening latency (54%) for weekends. Morningness was positively associated with increased breakfast frequency ( $b = 0.220$ ,  $p = 0.010$ ). Later evening eating during weekend was associated with reduced morningness ( $b = -2.039$ ,  $p < 0.001$ ) among students. Meanwhile, shorter weekend eating latency was associated with morningness ( $b = -1.886$ ,  $p < 0.001$ ). Breakfast skipping and late evening eating habits were prevalent among the subjects, with reduced morningness significantly associated with increased evening eating and shorter eating latency on weekends. Future longitudinal and intervention studies focused on regular breakfast consumption and promoting morningness in improving female health.

**Key words:** chrono-nutrition, morningness, young female, breakfast skipping, evening eating

\* Correspondence: satvinderkaur@ucsiuniversity.edu.my

## F11: Research Article

### Determinants of Stunting among Children Aged 0-3 Years: A Cross-Sectional Study in Peninsular Malaysia

Norhasmah S.<sup>1\*</sup>, Nurzalinda Z.<sup>1</sup>, Nur Amalina A.<sup>1</sup>, Nurul Balquis A.<sup>1</sup>

<sup>1</sup> Department of Nutrition, Faculty of Medicine & Health Science, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

#### ABSTRACT

Stunting occurs due to chronic malnutrition over a long period. Stunted children experience disruptions in physical growth and cognitive development. In Malaysia, the National Health and Morbidity Survey (NHMS) 2022 reported that the percentage of stunting among children under five years old has risen to 21.2%. This study aims to identify factors influencing stunting using the height-for-age (HAZ) indicator for children aged 0–3 years. This was a cross-sectional study involving mothers with children aged 0–3 years. Respondents were recruited from four zones in Peninsular Malaysia. The questionnaire covered sociodemographic, anthropometric measurements, breastfeeding and complementary feeding, child's dietary diversity (MDD), child's eating behaviors, involvement in feeding, and women's empowerment. The data were analyzed using Pearson correlation and multiple linear regression, with the significance level set at  $p < 0.05$ . A total of 419 mothers completed the questionnaire. About 25.1% of children were stunted. Mother's age ( $r=-0.146$ ,  $p<0.005$ ), part-time work ( $r=0.111$ ,  $p<0.05$ ), marital status ( $r=0.118$ ,  $p<0.05$ ), mother's height ( $r=0.134$ ,  $p<0.05$ ), birth weight ( $r=0.188$ ,  $p<0.001$ ), complementary feeding ( $r=-0.208$ ,  $p<0.001$ ), MDD ( $r=0.265$ ,  $p<0.001$ ), fussy eating ( $r=0.114$ ,  $p<0.05$ ), and husband involvement ( $r=0.225$ ,  $p<0.001$ ) were significantly associated with HAZ. Mother's age, birth length, dietary diversity, and legal empowerment were factors contributing to the HAZ of the children (Adjusted  $R^2=0.219$ ,  $F=4.282$ ,  $p<0.001$ ). This study provided insights into factors that potentially contribute to stunting among children. Therefore, focusing on women's empowerment is essential to improve child nutrition.

**Key words:** stunting, children, women empowerment, nutritional status

\* Correspondence: norhasmah@upm.edu.my

## F12: Research Article

### Study of Nutritional, Chemical, and Microbiological Properties, and in Vitro Effects on Blood Sugar Control of Freeze-Dried Banana Blossoms

**Nichaphat Chotiprakornkul<sup>1\*</sup>, Wilawan Sintuprapa<sup>1</sup>, Sunee Nitisinprasert<sup>1</sup>, Paiboon Tunsagool<sup>1</sup>,  
Morrakot Suwannakarn<sup>2</sup>, Bandhita Wanikorn<sup>1\*</sup>**

<sup>1</sup> Kasetsart University, Thailand

<sup>2</sup> Chulabhorn Chalermpakiet Medical Center, Thailand

#### ABSTRACT

The prevalence of ischemic heart disease (IHD) is currently growing. The majority of cases are related to type 2 diabetes, which is caused by lifestyle choices such as consuming a high-sugar and high-carbohydrate diet that elevates blood sugar levels. Previous research has demonstrated the nutritional and chemical benefits of banana blossoms (BB), including their antioxidant and blood sugar-lowering properties. However, the nutritional value of banana blossoms can degrade due to quick oxidation after harvest. Freeze-drying is an efficient preservation process that prevents oxidative damage while maintaining the nutritional integrity of the banana blossom. In this study, freeze-dried banana blossom powder (FBP) was evaluated for its chemical composition and the presence of pathogenic microorganisms, as well as its bioactive compound content, antioxidant activity, and antihyperglycemic activity through alpha-amylase and alpha-glucosidase inhibition tests. The FBP was high in soluble and insoluble dietary fiber, while also meeting pathogen safety criteria. It exhibited a high total phenolic content ( $38.66 \pm 2.37$  mg GAE/g) and antioxidant activity ( $4.69 \pm 0.15$  mg TE/g). Additionally, it showed significant inhibitory effects on alpha-glucosidase and alpha-amylase enzymes, with  $IC_{50}$  values of  $0.35 \pm 0.09$   $\mu$ g/mL and  $0.05 \pm 0.00$   $\mu$ g/mL, respectively. These findings indicate that banana blossoms have significant promise as a functional ingredient in foods and nutraceuticals, particularly for controlling blood sugar levels and reducing oxidative stress.

**Key words:** Banana blossom, freeze drying, nutrition, antioxidant activity, antihyperglycemic activity

\* Correspondence: fagibtw@ku.ac.th

## F13: Research Article 0077

### The Effect of *Arthrosipa Platensis* Carotenoid Extract on Fish Oil Stability to Photooxidation During Storage

Andrew Nathanael<sup>1</sup>, Siti Ari Budhiyanti<sup>1\*</sup>

<sup>1</sup> Universitas Gadjah Mada

#### ABSTRACT

Fish oil is a source of omega-3 fatty acid, especially docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), which play an important role in growth and preventing degenerative diseases in humans. Omega-3 fatty acids are highly susceptible to oxidation, especially photooxidation. Photooxidation has a rapid oxidation rate and produces reactive singlet oxygen. Carotenoids from *Arthrosipa platensis* can function as Singlet Oxygen Quencher and produce more stable products. This study aims to determine the effect of the addition of *A. platensis* carotenoid extract on the oxidative stability of fish oil in photooxidation treatment at 4000 lux during storage period. This study consisted of two treatments, namely the addition of antioxidant and storage. Antioxidants consisted of 200, 400 and 600 ppm of *A. platensis* carotenoid extract, control, and 150 ppm BHT and storage treatment (dark and light storage). Observations were made weekly for 4 weeks. The experimental design was a completely random design with three replications. The analysis included peroxide number, anisidine number, total oxidation number, antioxidant activity, and total carotenoid content. The peroxide value, anisidine value, and total oxidation increased during 4 weeks of storage, but the carotenoid content and antioxidant activity decreased. The best treatment was fish oil with the addition of 600 ppm *A. platensis* extract, because it had lower values of anisidine value, peroxide value, and total oxidation compared to 200 ppm, 400 ppm, and BHT 150 ppm. The best treatment was fish oil with *A. platensis* carotenoid extract of 600 ppm with dark storage.

**Key words:** carotenoids, *Arthrosipa platensis*, fish oil, antioxidant, photooxidation

\* Correspondence: sitabudhiyanti@ugm.ac.id

## F14: Research Article

### Evaluation of Physicochemical Properties and Children's Consumers Preference of Fish Galantine Added with *Arthrosphaera Platensis* for School Supplementary Feeding Program

Mohammad Khosidil Haq<sup>1</sup>, Indun Dewi Puspita<sup>1\*</sup>, Latif Sahubawa<sup>1</sup>, Amir Husni<sup>1</sup>

<sup>1</sup> Universitas Gadjah Mada, Indonesia

#### ABSTRACT

The diversification of fish product for school supplementary feeding program is the best way to increase the fish consumption and to prevent the incidence of under nutrition among school-aged children. We proposed the product of fish galantine added with *Arthrosphaera platensis*. This study aims to determine the best ratio of *A. platensis* granules and breadcrumb-milk batter in fish galantine formula, in term of physico-chemical properties and consumers preference. Fish galantine in this study utilizes meat from the trimming process from the frozen fish fillet industry. The treatment of the ratio of *A. platensis* granules and breadcrumb-milk batter is expected to increase the nutritional value and children's consumer preference. This research design uses a one-factor Completely Randomized Design (CRD) with 4 treatments of the ratio of *A. platensis* granules and breadcrumb-milk batter, namely 0:60; 5:55; 10:50; 15:45 (g) and t-test to know differences of treatments. The results showed that the best ratio treatment was fish galantine with a ratio of *A. platensis* granules and bread-milk batter 5:55 (P1). This ratio had a significant effect ( $P<0.05$ ) on physico-chemical properties, reducing ash content, and increasing fat, protein, and beta-carotene content as well as reducing cooking loss and increasing the hardness. The ratio of *A. platensis* granules and bread-milk flour batter 5:55 decreased children's preference for the appearance parameter of fish galantine. Child consumers can accept fish galantine products well. The RDA contribution of 100 g of fish galantine with the addition of *A. platensis* to children's protein requirement was 24%, fat 13%, carbohydrates 15%, beta-carotene content 2% and total energy 280 kcal.

**Key words:** *Arthrosphaera platensis*, children's consumer preference, fish galantine

\* Correspondence: indun\_dp@ugm.ac.id

## F15: Research Article

### Addition of Pandan Leaf Powder Increases Antioxidant Activity and Consumer Acceptance of *Sargassum Cristaefolium* Seaweed Tea

Sekar Ayuning Tyas<sup>1</sup>, Amir Husni<sup>1\*</sup>

<sup>1</sup> Universitas Gadjah Mada, Indonesia

#### ABSTRACT

*Sargassum cristaefolium* has bioactivity so it has the potential as a functional food, such as seaweed tea. Seaweed tea has a weakness: a fishy smell that consumers do not like. This study aims to determine the effect of adding pandan leaf powder on antioxidant activity and consumer acceptance of *S. cristaefolium* seaweed tea. The treatments used in this study were variations of adding pandan leaf powder as much as 0, 10, 20, 30, and 40%. Tests conducted included the content of water, total phenol, antioxidant activity using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) methods, hedonic test, and quantitative descriptive analysis (QDA) analysis. The results showed that adding pandan leaf powder affected total phenol, antioxidant activity, consumer acceptance level, and aroma perception. However, adding pandan leaf powder did not affect the water content. The best treatment was the addition 40% of pandan leaf powder with a characteristic: water content of  $4.26 \pm 0.23\%$ , total phenol content of  $7.55 \pm 0.03$  mg GAE/g, DPPH inhibition of  $68.38 \pm 0.44\%$ , FRAP values of  $24.27 \pm 0.26$  mM/g, the hedonic values for color, aroma, and taste were  $4.15 \pm 0.70$ ,  $4.36 \pm 0.62$ , and  $4.09 \pm 0.64$ ; QDA values with dominant aromas of fishy, pandan, burnt which have intensities 0.10, 14.61, and 0.09, respectively. The adding pandan leaf powder can increase antioxidant activity and consumer acceptance level of *S. cristaefolium* seaweed tea.

**Key words:** *Sargassum cristaefolium*, seaweed tea, pandan, antioxidant, sensory

\* Correspondence: a-husni@ugm.ac.id

## F16: Research Article

### Perception, Knowledge, Attitudes and Practices on Body Weight Management and Its Relationship with Physical Activity among University Students

Siti Nuraisyah Mohd Rosli<sup>1</sup>, Norlida Mat Daud<sup>1\*</sup>

<sup>1</sup> Universiti Kebangsaan Malaysia

#### ABSTRACT

Obesity cases among young adults have increased significantly in the past years. It is important to investigate their perception and knowledge, attitude and practice (KAP) on body weight management. Moreover, KAP studies on this matter are still scarce in Malaysia. This study aimed to determine the perception and KAP of body weight management among the university students. Additionally, since body weight is also related to physical activity levels (PAL), its relationship with KAP was also accessed. A total of 377 subjects (normal body mass index=110, overweight=141, obese=126) filled up KAP questionnaires on body weight management and International Physical Activity Questionnaires. Body composition was measured using Omron Bioelectrical Impedance. The results showed that the perception ( $63.4\pm10.1\%$ ) and KAP scores ( $K=74.8\pm3.7\%$ ,  $A=61.9\pm6.4\%$ ,  $P=56.5\pm7.8\%$ ) were at moderate levels and significantly different ( $p<0.05$ ) between BMI classifications. Normal weight subjects had a significantly higher ( $p<0.05$ ) perception, attitude and practice scores compared to other groups. However, their knowledge was significantly lower ( $p=0.012$ ) than the overweight group. The PAL among the normal weight group were in the moderate category ( $940\pm725.5$  MET-minutes/week) and significantly higher compared with the overweight ( $702\pm540.3$  MET-minutes/week) and obese ( $644.0\pm582.2$  MET-minutes/week) groups. Only practice scores had a significant positive correlation with PAL ( $r=0.119$ ,  $p=0.021$ ), the rest were not significant ( $p>0.05$ ). In conclusion, perception, KAP and PAL play an important role in managing body weight among university students.

**Key words:** perception, knowledge, attitude and practice, body weight, physical activity

\* Correspondence: norlida.daud@ukm.edu.my

## F17: Research Article 0015

### Red Palm Oil Intervention Improves Nutritional Status of Vitamin A-Deficient Rural Schoolchildren

**Tan Pei Yee<sup>1</sup>, Radhika Loganathan<sup>1</sup>, Yvonne Lim Ai-Lian<sup>2</sup>, Kanga Rani Selvaduray<sup>1</sup>**

<sup>1</sup> Product Development and Advisory Services Division, Malaysian Palm Oil Board, No. 6, Persiaran Institusi, Bandar Baru Bangi, 43000, Kajang, Selangor, Malaysia,

<sup>2</sup> Department of Parasitology, Faculty of Medicine, Universiti Malaya, 50603, Kuala Lumpur, Malaysia

#### ABSTRACT

This study aims to investigate the effects of red palm oil (RPO)-enriched biscuit supplementation on the nutritional status, ocular status and soil-transmitted helminth (STH) infections of children with vitamin A deficiency (VAD). In a double-blinded randomised controlled trial, 651 schoolchildren (8-12 years old) with VAD from 10 rural primary schools in Malaysia participated. The experimental group (n=334) received RPO-enriched biscuits, while the control group (n=317) received palm oil (PO)-enriched biscuits for 6 months. Screening revealed a high prevalence of VAD (20.6%), malnutrition (53.4%), xerophthalmia (42.7%) and STH infections (54.5%) among the subjects. Following 6-month supplementation, both groups showed significant improvements in retinol and retinol-binding protein levels, while only the experimental group exhibited significant improvements in  $\alpha$ - and  $\beta$ -carotene levels, haematological indices, iron status, reduced inflammation, and a lower reinfection rate of *Ascaris lumbricoides*. A significantly higher prevention rate of xerophthalmia was also observed in the experimental group compared to the control group. The findings suggest that 6-month supplementation of RPO-enriched biscuits improved the nutritional, ocular and STH infections of vitamin A-deficient primary schoolchildren. Therefore, incorporating RPO into national nutritional intervention programmes is recommended to enhance the health status of vitamin A-deficient or malnourished children.

**Key words:** vitamin A deficiency, red palm oil, nutritional status, soil-transmitted helminth, xerophthalmia

\* Correspondence: tpyee0417@gmail.com

## F18: Research Article

### The Evaluation of Training Programs for Community Health Worker in Monitoring Toddler Growth and Development in Yogyakarta, Indonesia

Dini Tri wahyuni<sup>1\*</sup>, Ayudiva Rizky Anugraheni<sup>2</sup>

<sup>1</sup> Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

<sup>2</sup> Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada; Indonesia

#### ABSTRACT

Monitoring growth and development is crucial for identifying and addressing disorders early, thereby facilitating timely interventions. Community health worker plays a significant role in overseeing toddler growth and development at integrated health posts. However, technical errors in managing these health posts have been observed, leading to decreased data validity. To address these issues, it is essential to implement training programs focused on enhancing the knowledge and skills of community health workers in growth and development monitoring. The training program was conducted from February to May 2024, covering key topics such as anthropometric measurements, infant and young child feeding practices, developmental screening, and plotting and completing growth charts in the Maternal and Child Health (MCH) handbook. The evaluation was conducted in June 2024 using the Center of Excellence (CoE) instrument, with data collected from integrated health posts selected through convenience sampling. The evaluation was conducted at 17 selected integrated health posts. Post-training assessments indicated that 90% of the community health workers demonstrated proficiency in skills and knowledge related to anthropometric measurements. However, the performance in other areas was found to be suboptimal: only 54% of the community health workers effectively plotted growth charts in the MCH handbook, 35% demonstrated an adequate understanding of infant and young child feeding education, and merely 11% were proficient in developmental screening. The training program aimed to improve community health worker skills and knowledge in monitoring toddler growth and development. Improvements were noted only in anthropometric measurements and other areas remained inadequate. To address these gaps, periodic, targeted training sessions should be implemented to ensure that content is effectively tailored to the needs of specific participants.

**Key words:** toddler, community health worker, integrated health post, growth, development

\* Correspondence: dini.tri wahyuni@mail.ugm.ac.id

## F19: Research Article

### **GEMILANG: Best Practices in Health Worker-Community Collaboration to Reduce Anemia in Stunted Toddlers in Sleman, Indonesia**

**Khalisa Khairani<sup>1\*</sup>, Azmia Naufala Zahra<sup>1</sup>**

<sup>1</sup> Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

#### **ABSTRACT**

Data from the Gamping 1 Public Health Center showed that 24% of stunted toddlers suffered from anemia in 2022. This alarming situation prompted the launch of the GEMILANG program, an iron supplementation intervention targeting stunted toddlers under five with anemia. The program aims to reduce the prevalence of anemia in these toddlers through collaboration between health workers, community members, and health cadres. This study examines whether this collaborative effort decreases anemia in stunted children. The program's effectiveness was assessed by evaluating improvements in anemia status during the intervention period and changes in stunting status in the subsequent year. A mean difference test was conducted to identify significant improvements in anemia status. Field observations were carried out to assess the program's implementation. In 2022, following the intervention, 23 out of 30 stunted toddlers with anemia showed significant improvement, recovering from anemia with a significant increase in hemoglobin levels ( $p<.001$ ) and overcoming stunting by the end of the year. Key factors contributing to the program's success include active community involvement in nutrition education, regular monitoring, and social support, all of which were implemented by various stakeholders. Collaboration among health workers, health cadres, and the community in the GEMILANG program has proven effective in reducing anemia among stunted toddlers. Strengthening the roles of all members is crucial to ensuring the program's sustainability.

**Key words:** collaboration, stunting, anemia, iron supplementation, Indonesia

\* Correspondence: khalisa.khairani@mail.ugm.ac.id

## F20: Research Article

### Unveiling the Effectiveness of the 'Care-Nutri' Programme among Caregiver-Child Dyads of the Urban Poor in Malaysia

Chek Lok Poh<sup>1</sup>, Gan Wan Ying<sup>1\*</sup>, Norhasmah Sulaiman<sup>1</sup>, Chin Yit Siew<sup>1</sup>

<sup>1</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia

#### ABSTRACT

Caregivers' knowledge, attitudes and practices (KAP) regarding child nutrition have significant impacts on children's dietary intake and quality, ultimately determining their nutritional status. Intervention is needed for urban poor who are at high risk of undernutrition. This randomized controlled trial aimed to evaluate the effectiveness of 'Care-Nutri' programme in improving caregivers' nutrition-related KAP and children's dietary practices among urban poor. Caregiver-child dyads from six public low-cost flats in Kuala Lumpur were randomly assigned into intervention group (IG; n=37) or control group (CG; n=37). The IG participated in 'Care-Nutri' programme for one month. The CG received all materials after study period without intervention. Data were collected at baseline (T0), immediate after programme (T1) and 3-month follow-up (T2), using a validated self-administered questionnaire. The Generalized Linear Mixed Model was used, controlling for mother's employment status. Significant main effects of group-time interactions were found for knowledge, attitude, diet quality (DQ), energy, carbohydrate and protein intakes. The IG showed significant improvement in knowledge, attitude, DQ scores, energy, protein, and fat intakes (coefficient=5.60, 8.65, 10.48, 264.08, 14.10, 13.49) at T1, and in knowledge, DQ scores, energy and carbohydrate intakes at T2 (coefficient=3.78, 8.15, 272.80, 30.93) compared to the CG. These findings indicate that the intervention was effective in improving caregivers' knowledge and attitudes, as well as children's dietary practices. Extending the 'Care-Nutri' programme to more urban poor communities could effectively address the high risk of undernutrition by reaching a larger population.

**Key words:** nutrition programme, caregivers, child nutrition

\* Correspondence: [wanying@upm.edu.my](mailto:wanying@upm.edu.my)

## F21: Research Article

### Factors Influencing Compliance with Weekly Iron-Folic Acid Supplementation among Adolescent Girls in Medan Deli, North Sumatra

Asma Rizkiyani<sup>1\*</sup>, Aulia Rahmadini Saputri<sup>1</sup>, Khairani Fauziah<sup>1</sup>

<sup>1</sup> Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

#### ABSTRACT

Anemia continues to be a pressing public health concern among adolescent girls in Indonesia, with prevalence rates rising from 37.1% in 2013 to 48.9% in 2018. To combat this, the government has initiated Iron Tablet Supplementation (TTD) programs. However, adherence to the supplementation regimen remains suboptimal among the target demographic. This study aims to evaluate compliance with TTD and identify barriers to consistent consumption among adolescent girls in the Medan Deli Primary Health Care area. This cross-sectional design involved 187 adolescent girls selected via purposive sampling. Data collection was conducted using questionnaires designed to assess compliance with iron tablet supplementation, reasons for non-compliance, and associated factors. Additionally, anthropometric measurements were obtained to evaluate the participants' nutritional status. Only 13.9% of adolescent girls adhered to the recommended weekly iron tablet supplementation. The predominant reasons for non-compliance were the unpleasant odor (44.9%) and taste (65.2%) of the tablets, as well as forgetfulness (48.7%). Additionally, a substantial proportion of the participants (72%) were found to be anemic, underscoring the urgent need for enhanced intervention strategies. The low compliance with iron tablet supplementation observed in this study underscores a significant challenge in combating anemia among adolescent girls. Targeted health education, including the use of social media platforms is needed to address sensory-related issues like unpleasant taste and odor. Reformulating iron supplements into more acceptable forms, such as syrups or effervescent tablets, and implementing enhanced monitoring strategies are crucial to improve adherence and effectively address anemia.

**Key words:** anemia, iron tablet compliance, adolescent girls, nutritional intervention

\* Correspondence: asmarizkiyani@mail.ugm.ac.id

## F22: Research Article

### The Relationship between Family Support and Subjective Well-Being of Diabetes Mellitus Patients at the Sangkrah Health Center

**Anisa Catur Wijayanti<sup>1\*</sup>, Widya Galih Puspita<sup>1</sup>, Nur Riqqah Maulita<sup>1</sup>**

<sup>1</sup> Universitas Muhammadiyah Surakarta, Indonesia

#### ABSTRACT

A person who has been diagnosed with diabetes will experience functional changes in the body that can have a negative impact on emotions and cause stress, and depression that can worsen the condition of the disease. Diabetics' negative view of all psychological problems is an indication of subjective well-being that functions to control themselves to carry out prevention and control efforts. This study aims to analyze the relationship between family support and the subjective well-being of diabetics. This study is a cross-sectional study with a sample of 125 diabetics at the Sangkrah Health Center, Surakarta. The sampling technique uses purposive samples and the data collection technique uses interviews and questionnaires using questionnaires. Data analysis uses the Chi-Square statistical test. The results of the study showed that there was a relationship between family support and subjective well-being of diabetics ( $p$  value = 0.001). The importance of family support in improving the subjective well-being of patients so that it is necessary to provide education health workers to family members of diabetics to be able to provide support to patients.

**Key words:** diabetes mellitus, family support, subjective well-being

\* Correspondence: anisa.wijayanti@ums.ac.id

## F23: Research Article

### Assessing the Impact of the Integrated Child Health Check-up (ICHC) Program on Early Detection of Nutritional and Developmental Issues in Yogyakarta

Dean Salsabila Rihadatulaisi Falahudin<sup>1\*</sup>

<sup>1</sup> Postgraduate Program of Public Health; Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada , Yogyakarta, Indonesia

#### ABSTRACT

Early detection of child growth and development initiatives has arisen in Yogyakarta. In this regard, many programs have been developed, including the Integrated Child Health Check-up (ICHC) program at Mlati 2 Public Health Center. This program aims to enhance early detection and prevention of health issues in children. It focuses on identifying nutritional and health problems at an early stage, providing appropriate interventions, and raising awareness among parents and caregivers about the importance of child health. This study utilized an observational design with a quantitative approach. The subjects were 6-month-old infants who attended Mlati 2 Public Health Center in Sleman District. Interviews and observations were conducted using the ICHC medical examination form, which assesses family caregiving patterns, growth, development, and clinical issues in children. Throughout the ICHC, out of 45 infants who underwent the examination, 35.5% were identified with growth disorders, while 17.7% showed signs of developmental delays and 13.3% with clinical issues. Furthermore, through the ICHC, 60% of infants required educational counseling on nutrition and received guidance on developmental stimulation for the next stage of growth as an early intervention. Additionally, some infants were referred to the hospital for further examination. The Integrated Child Health Check-up (ICHC) program has shown to be a valuable tool for the early detection and prevention of nutritional and developmental issues in children. It identified growth and developmental disorders, provided targeted interventions, and offered counseling on nutrition and developmental stimulation.

**Key words:** early detection, nutritional issues, integrated child health check-up (ICHC)

\* Correspondence: deansalsabila17@gmail.com

## F24: Research Article

### Evaluating the Effectiveness of a Nutrition Program in Reducing Anemia Among Adolescent Girls in Yogyakarta, Indonesia

**Khairani Fauziah<sup>1\*</sup>, Asma Rizkiyani<sup>1</sup>, Aulia Rahmadini Saputri<sup>1</sup>**

<sup>1</sup> Postgraduate Program in Public Health, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia

#### ABSTRACT

Anemia is a common nutritional health issue in Indonesia, particularly among adolescent girls. The most common cause is iron deficiency, but other factors like poor nutrition, infections, and chronic diseases also contribute. In Yogyakarta, the "nutrition program" program aims to reduce anemia among adolescent girls through iron supplementation, nutritional education, and physical activity interventions. This study aim to evaluate the effectiveness of the nutrition program in Yogyakarta. The evaluation of the "nutrition program" program in the Gedongtengen Health Center area was conducted using qualitative methods, specifically interviews with nutrition health officials. Data collection involved interviews as the main component, supported by program observations and analysis of anemia screening results among adolescent girls. Based on the interview results, significant challenges in program implementation were identified, including low adherence to the consumption of an iron-folic acid supplement.) due to taste and odor issues, and a lack of monitoring of adolescent girls. Despite various efforts, anemia prevalence remains high, indicating the need for more effective intervention strategies. The "nutrition program" program has been implemented in all schools in the Gedongtengen Health Center area, although the activities are carried out separately and adherence to an iron-folic acid supplement. consumption among adolescent girls remains low. This is evidenced by the remaining stock of an iron-folic acid supplement and the continued presence of anemia among adolescent girls after the pre-intervention period.

**Key words:** anemia, adolescent girls, iron supplementation, nutritional education, Yogyakarta, public health intervention

\* Correspondence: khairanifauziah@mail.ugm.ac.id

## F25: Research Article

### Factors Associated with Stress During Pregnancy in the First Trimester of Pregnancy: A Preliminary Finding of the MYBIOTA Cohort Study

Shiang Yen Eow<sup>1\*</sup>, Ling Jun Lee<sup>1</sup>, Wan Ying Gan<sup>1</sup>, Su Peng Loh<sup>1</sup>, Yit Siew Chin<sup>1</sup>,  
Leslie Thian Lung Than<sup>2</sup>

<sup>1</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

<sup>2</sup> Department of Medical Microbiology, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

#### ABSTRACT

Stress during pregnancy of pregnant women affects the physical and mental developments of both mothers and their children. Excessive stress exposes pregnant women to higher risk for pregnancy-related complications. This study examined the factors associated with stress during pregnancy among pregnant women in the first trimester of pregnancy. A total of 71 pregnant women aged 20-42 years old recruited from a private clinic in Kajang, Selangor, Malaysia were given a self-administered questionnaire to provide information on their sociodemographic background, food security, nausea and vomiting, constipation, physical activity level, and stress during pregnancy. The readings of their body mass index and blood pressure level were derived from their body weight and height recorded during their clinic visit. The mean score of stress during pregnancy was  $14.14 \pm 4.61$ . The prevalence of high stress, moderate stress, and low stress among pregnant women in this study was 1.4%, 59.2%, and 39.4%, respectively. Multiple linear regression analyses showed that nausea and vomiting was significantly associated with stress during pregnancy among pregnant women ( $\beta = 0.493$ ,  $p < 0.05$ ). Psychological support from the healthcare professionals and family member during prenatal care is crucial in ensuring proper stress management among pregnant women.

**Key words:** stress during pregnancy, first trimester, pregnant women, nausea and vomiting

\* Correspondence: cescvin423@hotmail.com

# Abstract

## Poster Presentation (PP)

**The 2nd Southeast Asia Public  
Health Nutrition Conference  
(2nd SEA-PHN)**

## PP01: Research Article

### Effectiveness of Anthocyanin-Rich Red-Pigmented Rice on Cardiometabolic Health in Malaysian Adults with Type 2 Diabetes

Jun-Hao Lim<sup>1</sup>, Catriona Kar-Yuen Ong<sup>2</sup>, Yu-Qiong Chin<sup>3</sup>, Cordelia Kheng-May Lim<sup>1</sup>, Sreelakshmi Sankara Narayanan<sup>2</sup>, Yuh-Fen Pung<sup>4</sup>, Faiz Daud<sup>5</sup>, Wickneswari Ratnam<sup>6</sup>, Zulfitri Azuan Mat Daud<sup>1</sup>, Tilakavati Karupaiah<sup>2\*</sup>

<sup>1</sup>Department of Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia,

<sup>2</sup>School of Biosciences, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, Selangor, Malaysia,

<sup>3</sup> School of Food Studies and Gastronomy, Faculty of Social Sciences and Leisure Management, Taylor's University, Subang Jaya, Selangor, Malaysia,

<sup>4</sup> Division of Biomedical Science, Faculty of Science and Engineering, University of Nottingham Malaysia, Semenyih, Selangor, Malaysia,

<sup>5</sup> Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia,

<sup>6</sup> Department of Biological Sciences and Biotechnology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

#### ABSTRACT

Cardiovascular diseases (CVD) remain the leading cause of death among Type 2 Diabetes (T2D) patients. High glycemic index (GI) white rice is known to increase CVD risk, whereas pigmented rice, with its low GI and antioxidant properties, holds therapeutic potential. This study evaluates the effects of substituting white rice with anthocyanin-rich, red-pigmented rice (UKMRC9) on cardiometabolic parameters in T2D patients. This was a 24-week, multicenter, open-label, parallel-group, randomized controlled trial involving 101 Malaysian adult T2D patients. Eligible participants, who were habitual white rice consumers with poorly controlled T2D, were randomly assigned to either UKMRC9 (treatment) or white rice (control) group. Assessments were conducted at baseline, 12<sup>th</sup> and 24<sup>th</sup> weeks. Generalized estimating equations were employed to compare changes in study parameters over time between treatment and control groups based on intention-to-treat analysis. Significant and progressive reductions (all  $p<0.05$ ) in adiposity indices, glycemic markers, insulin resistance, and the 10-year CVD risk were observed in the treatment group from baseline to the 12<sup>th</sup> and 24<sup>th</sup> week of intervention. Conversely, the control group showed no significant changes in these parameters ( $p>0.05$ ). The effect of UKMRC9 on 10-year CVD risk reduction was significantly mediated by glycemic markers ( $S/E = -2.978, p=0.024$ ). At least 40g/d (raw weight) of UKMRC9 was required for its optimal cardiometabolic effects. Substituting white rice with UKMRC9 significantly improves cardiometabolic parameters in T2D patients, suggesting its potential as an effective staple food for diabetes management.

**Key words:** pigmented rice, cardiometabolic risk, type 2 diabetes

\* Correspondence: tilly\_karu@yahoo.co.uk

## PP02 : Research Article

### The Antioxidant Content of White Mulberry Leaf Extract and Their Potential as Nephroprotective Effects in *In-Vivo* Study

Ahmad Fauzi<sup>1,2</sup>, Nurina Titisari<sup>3</sup>, Mohd. Hezmee Mohd. Noor<sup>4</sup>, Hazilawati Hamzah<sup>1</sup>, Azrina Azlan<sup>5,6\*</sup>

<sup>1</sup> Department of Veterinary Pathology and Microbiology, Faculty of Veterinary Medicine, Universiti Putra Malaysia UPM, Serdang 43400, Selangor, Malaysia;

<sup>2</sup> Department of Veterinary Clinical Pathology, Faculty of Veterinary Medicine, University of Brawijaya, Malang East Java 65141, Indonesia;

<sup>3</sup> Department of Veterinary Physiology, Faculty of Veterinary Medicine, University of Brawijaya, Malang East Java 65141, Indonesia;

<sup>4</sup> Department of Veterinary Preclinical Sciences, Faculty of Veterinary Medicine, Universiti Putra Malaysia UPM, Serdang 43400, Selangor, Malaysia;

<sup>5</sup> Department of Nutrition, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia;

<sup>6</sup> Laboratory of Halal Science Research, Halal Products Research Institute, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor

#### ABSTRACT

Numerous studies have suggested that mulberry leaves contain bioactive components that exhibit therapeutic activities but still lack evidence demonstrating their therapeutic effects in preventing kidney injury. This study presents the antioxidant properties and preclinical efficacy of an ethanol-extracted white mulberry leaf (WML) in relation to the amelioration of kidney injury. The antioxidant properties were assessed by quantifying the total phenolic content (TPC) through the Folin Ciocalteu method and the total flavonoid content (TFC) through an aluminium chloride colourimetric method. Kidney injury in mice model was induced using unilateral ureteral obstruction (UUO) method, followed by treatment for 14 days according to groups, which received 125 mg/kg of WML (dose was based on previous toxicity study) or 15 mg/kg of enalapril as a control-positive drug. At the end of the study, blood samples were assessed for haematological changes; the urine sample was analysed for urine protein creatinine ratio (UPCr), and the kidney sample was examined for histology. UPCr test was conducted to determine urinary protein levels associated with kidney damage. In WML, TPC (10.93 mg of GAE per g of DW and TFC (256.67 mg of QE per g of DW) indicate high antioxidant properties. Administration of WML demonstrated significantly improved anaemia and leukocytosis ( $p < 0.05$ ) in the UUO-induced mice. The WML treatment improved kidney function by reducing UPCr levels and preventing glomerulonephritis and cellular infiltration in UUO-induced mice. The findings indicate that the WML exhibits significant antioxidant activity, effectively mitigating kidney injury in UUO-induced mice. This offers potential for the development of novel nephroprotective treatments.

**Key words:** white mulberry leaf, haematology, UPCr, histology.

\* Correspondence: tilly\_karu@yahoo.co.uk

## PP03 : Research Article

### Look-Up Tables for Weight and Height Estimation in Clinical Practice

Tran Chau Quyen<sup>1\*</sup>, Nghiem Nguyet Thu<sup>1\*</sup>, Tran Quang Binh<sup>1</sup>, Tran Thanh Duong<sup>1</sup>, Lam Quoc Hung<sup>1</sup>

<sup>1</sup>National Institute of Nutrition

#### ABSTRACT

Weight and height are crucial parameters for evaluating nutritional status and determining medication dosages. However, many elderly individuals are unable to undergo conventional measurements due to mobility constraints. Consequently, weight and height estimation equations have been developed and validated using anthropometric data from Vietnamese geriatrics, proving feasible for use in clinical practice. The estimation equations for weight and height were developed and validated according to established protocols. Look-up tables for weight estimation were created based on mid-arm circumference (MAC) and calf circumference (CC) for both genders. Height estimation relied on knee height (KH) and age for men, while for women, it involved KH and age or KH and humerus length (HL), using Microsoft Excel. All MAC, CC, KH and LH were rounded to 0 or 0.5 cm. Five technical look-up tables with technical procedures were devised. These include the "Weight estimation look-up table for men using mid-arm circumference and calf circumference," and "Weight estimation look-up table for women using mid-arm circumference and calf circumference", "Height estimation look-up table for men using age and knee height", "Height estimation look-up table for women using age and knee height", and "Height estimation look-up table for women using humerus length and knee height". The generated look-up tables provide non-invasive methods for assessing Vietnamese geriatrics in clinical settings, offering reliable alternatives for assessing nutritional status and medication dosing when traditional methods are impractical.

**Key words:** weight, height, estimation, circumference, elderly

\* Correspondence: nighiem.nguyetthu@gmail.com

**PP04 : Research Article****Postoperative Nutritional Changes and Anthropometric Measures in Cancer Patients: A Prospective Study in Vietnam**

**Tran Chau Quyen<sup>1</sup>, Bui Thi Kim Hue<sup>1\*</sup>, Nguyen Thi Loan<sup>1</sup>, Tran Thi Nam<sup>1</sup>, Bui Vinh Quang<sup>1</sup>, Le Van Thanh<sup>1</sup>, Ha Thi Kim Hao<sup>1</sup>, Le Thi Le Quyen<sup>1</sup>**

<sup>1</sup> Hanoi Oncology hospital, Vietnam

**ABSTRACT**

Early recovery following surgery is crucial for cancer patients as it allows them to undergo subsequent treatments. Malnutrition is a prevalent issue among cancer patients and adversely impacts treatment outcomes. However, data on nutrition continuous monitoring postoperative in Vietnam is still limited. This study aimed to identify the anthropometric and dietary changes in postoperative cancer patients. This prospective, observational study collected patients  $\geq 18$  years old, indicated surgery and waiting for operation from May to July 2020. Their weight, height, mid arm circumference (MAC) and calf circumference (CC) were measured according to standard procedures. The 24 hours dietary recalls were collected from preoperative day (D0) until the 7th day (POD7), using food images. The Patient generated subjective global assessment (PG-SGA) also performed preoperatively based on hospital records, clinical examination and personal interview. A total of 145 patients (102 females), mean aged  $50 \pm 13.7$  were included. Gastrointestinal cancer patients were at highest risk of malnutrition according to PG-SGA classification. The BMI and CC decreased significantly at POD3. Dietary intake covers  $> 80\%$  of the energy and  $> 75\%$  of the protein requirement, but gradually decreased from the POD1 to POD7. Muscle preserved in cancer patients undergoing surgery did not only depend on protein and energy intake. Dietary intakes before and after surgery should be monitored in order to intervene immediately to reduce malnutrition rates postoperatively.

**Key words:** operation, malnutrition, dietary intake, muscle loss, calf circumference.

\* Correspondence: buithikimhue010695@gmail.com

## PP05 : Research Article

### Food Insecurity Prevalence among Hemodialysis Patients in Pahang, Malaysia

**Sarah Muneera Karami<sup>1</sup>, Nor Azwani Mohd Shukri<sup>1</sup>, Wan Azdie Mohd Abu Bakar<sup>1</sup>,  
Norhasmah Sulaiman<sup>2</sup>, Roselawati Mat Ya<sup>3\*</sup>**

<sup>1</sup> Department of Nutrition Sciences, Kulliyyah of Allied Health Sciences, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia

<sup>2</sup> Department of Nutrition, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

<sup>3</sup> Department of Community Medicine, Kulliyyah of Medicine, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia

#### ABSTRACT

Food insecurity involves the lack of physical and economic access to sufficient, safe, and nutritious food that meets an individual's dietary needs. End-stage renal disease (ESRD) patients undergoing hemodialysis should follow specific dietary guidelines, but food insecurity can hinder their compliance. This cross-sectional study aimed to identify the food insecurity prevalence and its determinants among hemodialysis patients in the Kuantan, Pekan, and Jengka districts of Pahang, Malaysia. A total of 287 adults aged 22 to 81 years who had been on regular hemodialysis treatment for at least three months prior to the study were involved. The food security status was determined using the Malay Food Insecurity Experience Scale. The determinants of food insecurity were assessed using validated, interviewer-administered questionnaires on demographic and socioeconomic background, physical and economic access to food, disease/treatment-related factors, and dietary factors. The data were statistically analyzed using the Fisher Exact test and one-way ANOVA test. Based on the food security status, about one-third of the hemodialysis patients were categorized as food insecure, where 16.4%, 9.4%, and 5.6% were mildly food insecure, moderately food insecure, and severely food insecure, respectively. Significant associations were found between food security status and age ( $p=0.013$ ), marital status ( $p=0.021$ ), monthly income ( $p=0.027$ ), number of shops available ( $p=0.021$ ), and affordability to buy food ( $p<0.001$ ). This study found a remarkable prevalence of food insecurity among hemodialysis patients in Pahang, Malaysia. Their food security status was associated with certain demographic and socioeconomic factors, as well as physical and economic access to food.

**Key words:** determinants, end-stage renal disease, food insecurity, hemodialysis, Malay Food Insecurity Experience Scale

\* Correspondence: rosematy@iium.edu.my

## PP06 : Research Article

### Effects of Inulin on Metabolic Parameters in Sprague Dawley Rats Fed with High-Fat Diets

Thanyaporn Musan <sup>1</sup>, Nathamon Kosoltanapiwat <sup>2</sup>, Amornrat Aroonnual <sup>1</sup>, Kansuda Wunjuntuk <sup>3</sup>,  
Pattaneeya Prangthip <sup>2\*</sup>

<sup>1</sup> Department of Tropical Nutrition and Food Science, Faculty of Tropical Medicine, Mahidol University, Thailand

<sup>2</sup> Department of Microbiology and Immunology, Faculty of Tropical Medicine, Mahidol University, Thailand

<sup>3</sup> Department of Home Economics, Faculty of Agriculture, Kasetsart University, Thailand

#### ABSTRACT

Obesity, defined as a BMI  $\geq 25$  kg/m<sup>2</sup>, is a major public health issue that raises the risk of hypertension and cardiovascular diseases. Globally, obesity affects approximately 650 million adults and 340 million children, with notable increases in Thailand from 2012 to 2018. The researcher is interested in fiber to help reduce fat in the blood, helps the digestive system to function normally. This study investigates the effects of inulin, a fermentable fiber, on metabolic health parameters in rats fed a high-fat diet. Inulin, made up of fructosyl units, supports digestive health and may impact lipid metabolism and glucose regulation. Rats were divided into three groups: a control group (N), a high-fat diet group (HF), and a high-fat diet group supplemented with inulin (HF-IN). The experimental design included three phases: adaptation, induction, and treatment. Key parameters measured were blood glucose levels, liver function, renal function, lipid profiles, antioxidant activity, and cytokine levels. The HF-IN group exhibited a weight gain of 24%, slightly better than the HF group's 25%, though this difference was not statistically significant. Inulin supplementation reduced liver enzyme levels, suggesting potential liver protection. High-fat diet rats showed decreased creatinine clearance, indicating renal impairment. While inulin lowered blood glucose in some conditions, its overall impact on antioxidant capacity and cytokine levels was inconsistent. In conclusion, inulin demonstrates potential health benefits related to obesity, particularly in liver function and glucose level, but further research is warranted to clarify its effects on metabolic health.

**Key words:** obesity, high-fat diet, fiber, inulin, prebiotic, probiotic

\* Correspondence: pattaneeya.pra@mahidol.edu

## PP07 : Research Article

### The Comparison of Sweet, Fatty and Salty Food Consumption between Generation X and Generation Y in Queen Sirikit Heart Center of the Northeast

Sarochin Sompongpun<sup>1\*</sup>, Aranya Udomvech<sup>1</sup>

<sup>1</sup>*Nutrition unit, Queen Sirikit Heart Center of the northeast*

#### ABSTRACT

There is a worldwide increase in non-communication disease among people in Thailand. When considered in food consumption, it is known that the consumption of sweet, fatty and salty food is linked with a higher risk of obesity and non-communication disease. According to the health check-up report from Queen Sirikit Heart Center of the Northeast in 2022. It was shown that 32.86 percent (256 persons) were classified as obesity. The study found that generational differences play an important role in the consumption of sweet, fatty and salty food. Therefore, this study aims to compare the consumption of sweet, fatty and salty food between Generation X and Generation Y. This cross-sectional study collected data from 98 participants by an online questionnaire (Google Form) over a 2 months period, from July 2022 to August 2022. The data was validated and statistical analysis was conducted using IBM SPSS statistics version 28, with a p-value of less than 0.05 considered statistically significant. The 98 participants, 34.7 percent were generation X and 65.3 percent were generation Y. The study discovered a significantly higher risk of consuming sweet food ( $p=0.008$ ) and fatty food ( $p=0.031$ ) in generation Y. As same as salty food, though the difference is not statistically significant. The consumption of fatty food in generation Y is average 10.36 out of 15, which considered as high level of risk. Generation Y had a significantly higher risk of consuming sweet and fatty foods compare to generation X, while the difference in salty food consumption was not statistically significant.

**Key words:** generation, food consumption, sweet fatty and salty

\* Correspondence: [saroso@kku.ac.th](mailto:saroso@kku.ac.th)

## PP08 : Research Article

### Nutrition Status and Dietary Intakes in Hemodialysis Patients at ViMUT-Theptarin Hospital

Werawat Wannasaksri<sup>1</sup>, Bunyarin Chakriyanugul<sup>1</sup>, Annapan Jantawan<sup>1</sup>, Kamonwan Damrattanamani<sup>1</sup>,  
Weena Huttakornwirya<sup>1</sup>, Nattamon Jirawattanawong<sup>1</sup>, Natchana Pathomnetikul<sup>1</sup>,  
Suthasinee Phanomthirakiat<sup>1</sup>, Kewalin Wattanawiroon<sup>1</sup>, Patnapa Srichomchey<sup>1\*</sup>

<sup>1</sup>Center of Nutrition and Dietetics, ViMUT-Theptarin Hospital, Bangkok, Thailand

#### ABSTRACT

Nutritional assessment is crucial for identifying patients at risk of malnutrition. The Malnutrition Inflammation Score (MIS) is a tool used for hemodialysis patients to assess their nutritional status. This study aimed to explore the relationship between nutritional status and dietary intakes in hemodialysis patients. A retrospective study was conducted at the Hemodialysis Unit of ViMUT-Theptarin Hospital, Bangkok, Thailand, collecting data from January 2021 to June 2024. Nutritional status was assessed using the MIS and categorized into class A, B, and C. Dietary intakes using the 24-hour recall was conducted by a registered dietitian. The significant differences were expected at p-value < 0.05. Seventy-nine patients were classified into class A, B, and C as 17, 31, and 31, respectively. Body mass index (BMI) differed significantly between class A and C, but not between class A and B. Energy intake per day was significantly higher in class A than in class C, but similarly with class B. No significant differences were found between the 3 classes in energy intake per kg dry body weight (E/BW), protein intake per day, and protein intake per kg dry body weight (P/BW). Although E/BW and P/BW are similar across all classes, caution should be placed when interpreting these values in class C, as lower body weight (as indicated by a lower BMI) may inflate these ratios. Further studies on weight changes and dietary intake in this class are warranted.

**Key words:** dietary intakes, hemodialysis, malnutrition inflammation score, nutritional status

\* Correspondence: psrichomchey@gmail.com

**PP09 : Research Article****Association between Socioeconomic Status and Nutrient Adequacy of Karen School-Aged Children in Sangkhlaburi District, Kanchanaburi Province, Thailand**

**Sueppong Gowachirapant<sup>1</sup>, Prapa Kongpunya<sup>1</sup>, Sinee Chotiboriboon<sup>1</sup>, Nattapach Thongkam<sup>1</sup>,  
Wantanee Kriengsinyos<sup>1</sup>, Pattamaporn Joompa<sup>1\*</sup>**

<sup>1</sup>*Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom 73170, Thailand*

**ABSTRACT**

Nutrient inadequacy remains crucial for all ages, including school-aged children (SAC), especially those living in remote areas. Several socioeconomic factors have been associated with adequacy of nutritional intake. This study aimed to investigate the association of the socioeconomic status of the Karen SAC's households with their dietary nutrient adequacy. Under the Climate Change Resilience of Indigenous Socio-Ecological Systems (RISE) project conducted in the two Karen villages in Laiwo Subdistrict, Sangkhlaburi District, Kanchanaburi Province, 50 healthy SAC (6-12 Y) were randomly sampled to assess dietary intake using a single-day 24-hour dietary recall. The nutrient adequacy ratios (NAR) for 12 selected nutrients and the mean adequacy ratio (MAR) were calculated. Adequate nutrient intake was defined as NAR and MAR  $\geq 0.70$ . The head of SAC's household administered the socioeconomic questionnaire. More than half of SAC with an average age of  $9.7 \pm 2.0$  years old achieved adequate nutrient intake of overall selected nutrients (MAR  $\geq 0.70$ ), especially energy, protein, vitamin B1, vitamin B2, and niacin (NAR  $\geq 0.70$ ). However, some of them insufficiently received calcium, iron, zinc, vitamin A, vitamin C, vitamin B6, and vitamin B12. Some socioeconomic factors, including family system, household poverty, and household size were associated with adequate intake of all selected nutrients and some micronutrients, including vitamin A, vitamin B2, and niacin (all  $p < 0.05$ ). The Karen SAC still faces inadequate intake of some crucial micronutrients. Understanding the socioeconomic status of their household may support the strategies to improve the nutritional status of SAC.

**Key words:** nutrient adequacy, socioeconomic status, school-aged children, indigenous people, micronutrients

\* Correspondence: pattamaporn.joo@mahidol.ac.th

**PP10 : Research Article****Estimation of Breast Milk Intakes from 24-Hour Dietary Recall****Pornpan Sukboon<sup>1</sup>, Tippawan Pongcharoen<sup>1\*</sup>, Sutthida Sukshapsri<sup>1</sup>, Pattanee Winichagoon<sup>1</sup>**<sup>1</sup> *Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom, Thailand***ABSTRACT**

Gold standard method for assessing breast milk (BM) intake is the dose-to-mother isotope dilution (DTM), not appropriate for population studies. This study estimated breast milk intakes from 24-hour dietary recalls using published algorithms. Data of infants aged 6-17 months old from a longitudinal study on energy expenditure were used. Mothers reported duration of each breastfeeding (BF) occasion, and number of feeds by 24-hour dietary recalls. Age-group specific algorithms (Briefel, 2010) were used to calculate BM intakes per day. BM intakes from a global systematic review by WHO were used as benchmarks (Rios-Leyvraz, 2023). Descriptive statistics on total daily BM intakes, and energy intakes from BM are presented. BM intakes between direct BF vs expressed BM were compared using Mann-Whitney U test. P-value <0.05 was considered significant. Estimated BM intakes were underestimated compared with that from global average intakes for all age groups. Maternal recalls on duration of each BF was variable, and might not reflect actual suckling. On average, BM provided 62.7, 45.0, 32.6 and 27.3% of total daily energy intakes for each 3-month age groups, respectively. No significant differences in the amount of BM intakes by BF provision method among the two younger age groups, but significant for the older age groups. BM intakes using published algorithms tended to be lower than the global average of BM intakes for children aged 6-17 months. BM provided lesser energy intakes as child's age increases. Direct BF vs expressed milk or combination was inconsistently significantly differences.

**Key words:** breast milk intake, 24-hour dietary recall, estimation algorithm, 6-17 months old infants

\* Correspondence: tippawan.pon@mahidol.ac.th

## PP11 : Research Article

### Correlation Between Dietary Diversity, Fermented Food Intake, and Blood Glucose Control in Patients with Type 2 Diabetes

Annisa Rizky Maulidiana<sup>1\*</sup>, Anisa Wahyuni<sup>1</sup>, Annisa Mayang Soliha<sup>1</sup>, Olivia Anggraeny<sup>1</sup>,  
Catur Saptaning Wilujeng<sup>1</sup>

<sup>1</sup> Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia

#### ABSTRACT

Fermented foods are widely recognized for their health benefits and have become an integral part of diets across many cultures, including Indonesia. Incorporating a diverse range of foods into the daily diet can help control blood glucose levels, which may be beneficial for diabetes management. This study aimed to investigate the relationship between local fermented food consumption, dietary diversity, and blood glucose control in diabetic patients. A cross-sectional survey was conducted with thirty outpatients with type 2 diabetes mellitus from private clinics in Lampung, Indonesia. Body mass index was performed to evaluate nutritional status. Dietary intake was assessed using a 24-hour recall and a semi-quantitative food frequency questionnaire to determine patterns of fermented food consumption and individual dietary diversity scores (IDDS). Fasting blood glucose (FBG) levels were measured monthly over a three-month period and averaged. The majority of respondents were classified as obese class 1 (66.7%) and had uncontrolled FBG (63.3%). The mean IDDS was moderate,  $5.23 \pm 2.83$ . The most frequently consumed food groups included starchy staples, other fruits and vegetables, legumes, nuts and seeds, and fish and seafood. On average, respondents consumed 5 to 6 types of fermented foods over the past three months, with soybean tempeh being the most commonly consumed. Significant positive correlations were observed between fermented food consumption ( $r = 0.696$ ;  $p < 0.001$ ), food diversity ( $r = 0.649$ ;  $p < 0.001$ ), and FBG control. This study suggests that a diverse diet, including adequate consumption of fermented foods, may benefit diabetes management. Incorporating a variety of foods could improve blood glucose control in diabetic patients.

**Key words:** blood glucose control, diabetes, dietary diversity, fasting blood glucose, fermented food

\* Correspondence: annisarizky@ub.ac.id

## PP12 : Research Article

### The Relationship between Macronutrient Intake, Metabolic Profiles, and Wound Severity in Diabetic Foot Ulcer Patients

Anggun Rindang Cempaka<sup>1\*</sup>, Kanthi Permaningtyas Tritisari<sup>1</sup>, Ayuningtyas Dian Arestiningsih<sup>1</sup>,  
Rowan Laili Dwi Puspita Rini<sup>1</sup>, Armavia Nisrina<sup>1</sup>, Sheila Sabina Fadiyatus Zahroh<sup>1</sup>

<sup>1</sup>Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, East Java, Indonesia

#### ABSTRACT

Nutrition and metabolic management play a critical role in treating diabetic foot ulcers (DFU). However, the relationship between these factors and wound severity is not fully understood. This study aimed to explore the relationship between macronutrient intake, metabolic profiles, and wound severity in DFU patients in the Malang Raya area. This cross-sectional study involved 34 DFU patients from the Malang Raya area. The Wagner classification was used to assess wound severity. Macronutrient intake was recorded using a validated Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) based on dietary patterns over the past 3 months. Metabolic profile data, including blood glucose, HbA1C, and serum albumin, were obtained from venous blood vessels, while blood pressure measurements were collected using a digital sphygmomanometer. Spearman correlation analysis was performed to evaluate the relationship between macronutrient intake, metabolic profile, and wound severity. The Kruskal-Wallis test analyzes the differences in dietary intake and metabolic profiles across varying wound severities. Higher carbohydrate intake was found to be positively correlated with greater wound severity ( $r=0.469$ ,  $p=0.005$ ), whereas serum albumin levels were negatively correlated with wound severity ( $r=-0.640$ ,  $p<0.001$ ). The Kruskal-Wallis test confirmed significant differences in energy intake ( $p=0.048$ ), carbohydrate intake ( $p=0.044$ ), and serum albumin ( $p=0.006$ ) across different levels of wound severity. Patients with more severe wounds tended to have higher carbohydrate intake and lower serum albumin levels. The study highlights significant correlations between macronutrient intake, metabolic profiles, and wound severity in DFU patients. These findings underscore the importance of tailored nutritional and metabolic management in improving wound outcomes and managing diabetic foot ulcers effectively.

**Key words:** diabetic foot ulcer, macronutrient intake, metabolic profile, wound severity

\* Correspondence: cempakaanggun@ub.ac.id.

## PP13 : Research Article

### Formation of Vegetable and Fruit Eating Behavior Using the Theory of Planned Behavior Approach in Adolescents in Suburban Areas in Indonesia

Nikmah Utami Dewi<sup>1</sup>, Ali Khomsan<sup>2</sup>, Cesilia Meti Dwiriani<sup>2</sup>, Hadi Riyadi<sup>2</sup>, Ikeu Ekayanti<sup>2</sup>,  
Diah Ayu Hartini<sup>3</sup>

<sup>1</sup> Tadulako University, <sup>2</sup> IPB University, <sup>3</sup>Health Polytechnic of Palu

#### ABSTRACT

The behavior of adolescents in Indonesia who eat vegetables and fruits is still low. Eating behavior is influenced by various factors, one of which is shown through the Theory of Planned Behavior. This study aimed to identify the formation of adolescent eating behavior in suburban areas based on the Theory of Planned Behavior. The study was conducted from October 2021 to February 2022 in Palu City-Indonesia. Three hundred ninety-five adolescents aged 15-17 who lived in suburban areas were randomly selected. Adolescents were interviewed using a validated questionnaire to obtain information about attitude, subjective norms, control behavior, and intention (Cronbach's alpha>0.70). The behavior of eating vegetables and fruits was assessed using a food frequency questionnaire and two 24-hour food recalls to obtain diet quality. Path analysis involved components of the Theory of Planned Behavior, nutritional literacy, and diet quality. Eating vegetables and fruits in adolescents is formed from subjective norms directly associated with eating behavior without going through intention. The eating fruit behavior has a direct relationship to diet quality but not to vegetables. Functional Nutritional Literacy is negatively related to subjective norms and the behavior of eating vegetables and fruits. In contrast, Critical Nutritional Literacy is positively related to the same path. Intervention efforts to change adolescents' eating of vegetables and fruits, especially in urban areas, need to pay attention to the flow of behavioral changes related to the process of forming adolescent eating behavior. Essential people who influence adolescent subjective norms, such as friends and family, should be involved.

**Key words:** adolescence, eating behavior, nutrition literacy, theory of planned behavior

\* Correspondence: nikmah@untad.ac.id

**PP14 : Research Article****Dietary Patterns and its Association to Overweight & Obesity among  
Filipino Adults: ENNS 2018-2019****Ma. Lilibeth P. Dasco<sup>1</sup>, Ma. Evette B. Misagal<sup>1\*</sup>, Apple Joy D. Ducay<sup>1</sup>**<sup>1</sup> *Department of Science and Technology – Food and Nutrition Research Institute***ABSTRACT**

Overweight and obesity have been steadily increasing throughout the years and these are influenced by several factors, especially dietary intake. Limited studies in the country exist about dietary patterns and their association with overweight and obesity. This study determined the association between dietary patterns and overweight/obesity among Filipino adults, 20 years old and above. The study utilized the 2018 and 2019 Expanded National Nutrition Survey (ENNS) data and included 79,530 adults. Principal Component Analysis (PCA) was used to identify dietary patterns specific to the adult population. Logistic regression analyses were performed to assess the association between the different dietary pattern scores and overweight/obesity with adjustment for potential confounders. Three major dietary patterns were identified through PCA: 1) meat, poultry, and sugar and syrups pattern (MPSP); 2) rice and fish pattern (RFP) and 3) vegetable pattern (VP). Adults consuming an RFP (highest tertile) are more likely residing in rural areas. Respondents in the highest tertile of MPSP are more likely to be from the rich and richest wealth quintiles. MPSP and RFP were associated with higher odds of overweight/obesity [highest-tertile adjusted odds ratio (AOR) 1.12, 95% CI: 1.04-1.20; AOR: 1.18, 95% CI: 1.11-1.27, respectively]. Dietary patterns characterized by MPSP and RFP are associated with overweight/obesity. Identifying dietary patterns is important to capture the complexity of the overall diet and interactions of nutrients, whether these promote health or increase the risk of chronic diseases. Moreover, the findings will serve as a basis for nutrition education strategies targeting vulnerable adults.

**Key words:** adults, dietary patterns, diet quality, obesity, overweight

\* Correspondence: misagalevette@gmail.com

## PP15 : Research Article

### Assessment of Food Consumption Knowledge Among Hemodialysis Patients: A Cross-Sectional Study in Sakon Nakhon Province, Thailand

Bowornjit Maytharit<sup>1</sup>, Sineenart Chautrakarn<sup>1</sup>, Jukkrit Wungrath<sup>1\*</sup>

<sup>1</sup> Faculty of Public Health, Chiang Mai University, Chiang Mai, Thailand

#### ABSTRACT

Chronic kidney disease (CKD) is a significant public health issue globally, with hemodialysis (HD) serving as a crucial treatment for end-stage renal disease (ESRD) patients. Malnutrition is a common problem among HD patients, affecting their health outcomes. This study aimed to evaluate the level of food consumption knowledge among HD patients in Sakon Nakhon province, Thailand. This cross-sectional analysis included ESRD stage 5 patients undergoing HD at hemodialysis units in Sakon Nakhon province. A sample size of 131 participants was calculated using G\*Power software, considering a power of 0.80, an alpha of 0.05, and an effect size of 0.50. Stratified random sampling was employed to select participants from different HD units to ensure representativeness. A food consumption knowledge questionnaire was used to assess dietary knowledge, with scores categorized as high, moderate, or low. The mean knowledge score was 14.08, indicating an overall high understanding of dietary requirements among HD patients. Additionally, 61.07% of participants demonstrated a high level of food consumption knowledge, 36.64% had a moderate level, and only 2.29% had a low level, highlighting the need for targeted educational interventions. The study revealed that most HD patients had a good level of food consumption knowledge, highlighting the importance of incorporating it into HD care. Improving dietary knowledge can help manage malnutrition and enhance the quality of life for HD patients.

**Key words:** hemodialysis, food consumption, knowledge

\* Correspondence: jukkrit.w@cmu.ac.th

## PP16 : Research Article

### Association Between Maternal Dietary Habit with Postpartum Depression Among Malaysian Mothers

Noor Fairuzi Suhana Yahya<sup>1</sup>, Nur Islami Mohd Fahmi Teng<sup>1\*</sup>, Norsham Juliana<sup>2</sup>

<sup>1</sup> Centre of Dietetics Studies, Faculty of Health Science, Universiti Teknologi MARA, Selangor, Malaysia

<sup>2</sup> Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, Negeri Sembilan, Malaysia

#### ABSTRACT

Postpartum diet is crucial for maternal well-being, but traditional postpartum practices in Malaysia strongly influence maternal diets, and their impact on postpartum depression (PPD) remains unclear. This study aims to assess maternal postpartum diet and their relation to PPD. A cross-sectional study (n=351) was conducted among Malaysian postpartum mothers in Selangor. The Malay version of the Confinement Practice Questionnaire and the Edinburgh Postnatal Depression Scale (EPDS) were used to assess traditional postpartum dietary habits and measure PPD symptoms. The results showed that 90% of mothers agreed white rice could be consumed during the postpartum period, while noodles like "egg noodles" or "laksa" were commonly avoided. Seafood, beef and certain fish were the most avoided proteins (>70%), but most mothers consumed leafy (83.5%) and non-leafy vegetables (76.7%). Cooking oil (77.2%) were largely prohibited but garlic was the most prescribed (83.2%). Plain water was highly consumed (83.2%), whereas fruit juice (77.2%) and coffee (81.2%) were avoided. Mothers who consumed prohibited fruits (AOR = 1.979; 95% CI 1.084, 3.614; p=0.026) or black pepper (AOR = 2.081; 95% CI 1.194, 3.628; p=0.010) were reported twice as likely to develop PPD, while those who drank less or no plain water had nearly 5 times the risk (AOR = 4.736; 95% CI 2.551, 8.793; p<0.001). Traditional postpartum dietary practices, particularly the consumption of prohibited fruits and black pepper, were significantly associated with an increased risk of PPD. Ensuring proper hydration and re-evaluating traditional dietary restrictions may reduce PPD risk in postpartum mothers.

**Key words:** traditional postpartum practice, maternal dietary habit, postpartum depression, maternal well-being, diet restriction

\* Correspondence: nurislami@uitm.edu.my

## PP17 : Research Article

### Triple Burden of Malnutrition in Southeast Asian Children 0.5-12 Years Old (SEANUTS II)

Ilse Khouw<sup>1</sup>, Nadja Mikulic<sup>1</sup>, Rini Sekartini <sup>2\*</sup>, Bee Koon Poh<sup>3</sup>, Nipa Rojroongwasinkul<sup>4</sup>,  
Nga Thuy Tran<sup>5</sup>, Anke Schlatmann<sup>1</sup>, Cécile M. Singh-Povel<sup>1</sup>, Nanda de Groot<sup>1</sup>

<sup>1</sup> FrieslandCampina, 3818 LE Amersfoort, The Netherlands

<sup>2</sup> Faculty of Medicine, Universitas Indonesia, Jakarta 10430, Indonesia

<sup>3</sup> Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia

<sup>4</sup> Institute of Nutrition, Mahidol University, Nakhon Pathom 73170, Thailand

<sup>5</sup> National Institute of Nutrition, Hanoi 100000, Vietnam

#### ABSTRACT

Malnutrition in children remains a global issue. Effective interventions require understanding current nutritional status and intake. The South East Asian Nutrition Surveys II (SEANUTS II), conducted in Indonesia, Malaysia, Thailand, and Vietnam, provides comprehensive data on anthropometrics, nutritional status, and intake of children aged 0.5-12 years. Children from rural and urban areas were recruited via multistage cluster sampling. We assessed the prevalence of stunting, underweight, overweight, and obesity. Blood samples from a subsample were analyzed for hemoglobin, ferritin, retinol, B12, and 25-hydroxy vitamin D. Nutrient intake of vitamin D and calcium was assessed via a one-day 24-hour dietary recall. Of the 13,933 children recruited, 12,943 were analyzed. In Indonesia, stunting (25%) and underweight (19% for children under 5) were most prevalent. Overweight/obesity was highest in Malaysia (18%), Thailand (23%), and Vietnam (23%), especially among older children. Anemia affected 12-18% of children in all countries, with Indonesia having the highest prevalence of anemia and iron deficiency (20% for children under 4). Vitamin D insufficiency was high in all countries (25-31%) except Thailand (5%). Vitamin B12 and A deficiencies were low (0-8%). Over 70% of children did not meet recommended intakes for vitamin D and calcium. SEANUTS II highlights the triple burden of malnutrition in Southeast Asian children, with undernutrition, overnutrition, and micronutrient deficiencies coexisting. Many children do not meet recommended intakes for vitamin D and calcium. These findings are essential for planning and reviewing nutritional public health programs in this region.

**Key words:** malnutrition, Southeast Asia, children

\* Correspondence: rsekartini@yahoo.com

## PP18 : Research Article

### Regional Disparities in the Nutritional Quality of Street Food in Thailand: A Comparative Analysis of Bangkok and Ubon Ratchathani

Paphawarin Muksombat<sup>1</sup>, Rewadee Chongsuwat<sup>1</sup>, Chanchira Phosat<sup>1\*</sup>

<sup>1</sup> Department of Nutrition, Faculty of Public Health, Mahidol University

#### ABSTRACT

Street food constitutes a vital component of Thailand's food culture, providing affordable and readily accessible meals to a substantial portion of the population. However, the nutritional quality of street food may vary across different settings, particularly between the capital city and upcountry regions. This study aimed to compare the nutritional composition of street food sold in diverse environments, focusing on Bangkok and Ubon Ratchathani, a major upcountry region. A cross-sectional survey was conducted on 64 widely consumed street food items, consisting of 47 samples from Bangkok and 19 from Ubon Ratchathani, to evaluate their macronutrient, fiber, sodium, and caloric content. The results were then compared against the Thai Recommended Dietary Intake (Thai RDI). The findings indicated that over 95% of street food samples from Bangkok provided less than 30% of the Thai RDI for energy, carbohydrates, protein, fat, and fiber, while 10.6% of samples exceeded the sodium recommendations for a single meal. In contrast, street food samples from Ubon Ratchathani exhibited a broader distribution, with 31.6% surpassing 65% of the Thai RDI for sodium, and many falling within 31% to 65% of the Thai RDI for fat and protein. In conclusion, the results highlight significant regional differences in the nutritional profiles of street foods, with items from Ubon Ratchathani containing higher levels of calories, fat, and sodium compared to those from Bangkok. These findings underscore the need for targeted public health interventions to promote healthier street food choices across various regions of Thailand.

**Key words:** street food, nutrients, nutrition quality, macronutrients, dietary intake

\* Correspondence: chanchira.pho@mahidol.ac.th

**PP19 : Research Article****Association Between Dietary Intake and Obesity in a Young Adult Population in Perak, Malaysia**

**Divya Sivapregas<sup>1</sup>, Manahil Bineid<sup>2</sup>, Eddy Cheah Seong Guan<sup>3</sup>, Annaletchumy Loganathan<sup>3</sup>, Phoon Lee Quen<sup>3</sup>, Karani Santhanakrishnan Vimaleswaran<sup>2</sup>, Anto Cordelia Tanislaus Antony Dhanapal <sup>3\*</sup>**

<sup>1</sup> Faculty of Science, Universiti Tunku Abdul Rahman (UTAR), Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia

<sup>2</sup> Hugh Sinclair Unit of Human Nutrition, Department of Food and Nutritional Sciences, Institute for Cardiovascular and Metabolic Research (ICMR), and Institute for Food, Nutrition and Health (IFNH), University of Reading, Reading RG6 6AH, UK

<sup>3</sup> Nutrigenetics and Nutrigenomics Research and Training Unit (N2RTU), Centre for Biomedical and Nutrition Research (CBNR), Universiti Tunku Abdul Rahman, Jalan Universiti, Bandar Barat, Kampar 31900, Malaysia

**ABSTRACT**

Obesity is a growing public health issue among young adults in Malaysia, influenced by dietary patterns and inadequate nutrient intake. This study investigated the association between dietary intake and obesity among young adults in Perak. A cross-sectional study of 300 young adults aged 18-25 from four tertiary institutions in Kampar and Ipoh, Perak, was conducted using multi-stage sampling. Socio-demographic profiles and nutritional anthropometric measurements were collected, and the Asian-Pacific Body Mass Index cutoff points were used to classify overweight/obesity (OW/OB). Dietary intake was assessed using the Food Frequency Questionnaire (FFQ), and data were analyzed using independent t-tests and logistic regression. Among participants, 34.0% (Men: 15.3%; Women: 18.6%) were OW/OB. Women exceeded the recommended intake for total energy ( $12\%, p=3.87\times10^{-3}$ ), carbohydrates ( $16\%, p=8.86\times10^{-8}$ ), proteins ( $18\%, p=5.20\times10^{-14}$ ), and fats ( $8\%, p=1.47\times10^{-12}$ ), while men exceeded the recommended intake for carbohydrates ( $11\%, p=1.27\times10^{-3}$ ) and fats ( $8\%, p=5.1\times10^{-4}$ ). Women also had low iron ( $<60\%, p=1.87\times10^{-14}$ ) and zinc ( $<75\%, p=1.30\times10^{-19}$ ) intake. Higher carbohydrate (OR=1.007, 95% CI: 1.003-1.010,  $p=3.5\times10^{-5}$ ), fat (OR=1.025, 95% CI: 1.004-1.047,  $p=0.020$ ), and calcium (OR=1.003, 95% CI: 1.001-1.005,  $p=0.013$ ) intakes were associated with higher obesity risk. Vitamin D (OR=0.894, 95% CI: 0.845-0.947,  $p=1.22\times10^{-4}$ ) and vitamin A (OR=0.997, 95% CI: 0.995-0.999,  $p=0.002$ ) were inversely associated with obesity after adjusting for gender, ethnicity, and family income. The study found significant associations between high carbohydrate, fat, and calcium intakes with increased obesity risk among young Malaysian adults, while vitamins A and D had protective effects.

**Key words:** obesity, dietary intake, macronutrients, micronutrients, young adults, Malaysia

\* Correspondence: antoc@utar.edu.my

**PP20 : Research Article****Infant and Young Child Feeding (IYCF) Practices and Body Composition:  
A Cross-sectional Study of Thai Infants Aged 6-8 Months**

Yaowalak Rooppat<sup>1\*</sup>, Tippawan Pongcharoen<sup>1</sup>, Pattanee Winichagoon<sup>1</sup>, Pornpan Sukboon<sup>1</sup>,  
Sutthida Sukshapsri<sup>1</sup>, Pimnapanut Sridonpai<sup>1</sup>, Kunchit Judprasong<sup>1</sup>, Phornthip Thappratum<sup>1</sup>,  
Wanabhorn Tongchom<sup>2</sup>

<sup>1</sup> Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom, Thailand

<sup>2</sup> Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

**ABSTRACT**

Infant and young child feeding (IYCF) practices play a critical role in the growth and nutritional status of young children. This study determined how variations in feeding practices may influence key measures of nutritional status and body composition. IYCF practices of 57 Thai infants aged 6 to 8 months were assessed following WHO guidelines. Weight and height were measured, and Z-scores for weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) were calculated based on WHO growth standards. Body composition was measured using the doubly labeled water method. Independent t-tests were used to analyze differences between groups meeting and not meeting minimum dietary diversity (MDD), meal frequency (MMF), and acceptable diet (MAD) criteria. Of the infants, 66.7% and 79.1% of infants met the criteria for MDD and MMF, while only 49.1% met the MAD. Infants who met MDD had significantly lower WAZ and WHZ compared to those who did not (-0.44 vs. 0.18,  $p < 0.016$ ; -0.22 vs. 0.43,  $p < 0.013$ ). Infants meeting MMF showed a higher percentage of fat-free mass compared to those who did not (75.7% vs. 71.5%,  $p < 0.026$ ), and had lower fat mass percentage and fat mass index (24.3% vs. 28.5%,  $p < 0.045$ ; 4.14 vs. 4.99 kg/m<sup>2</sup>,  $p < 0.029$ ). Infants who met the criteria for MDD and MMF had lower weight and body fat compared to those who did not. Further investigation is needed to fully understand how IYCF practices influence infant weight and body fat.

**Key words:** IYCF practices, body fat, doubly labeled water, infants

\* Correspondence: too.yaowalak@gmail.com

**PP21 : Research Article****Healthy Eating Index among Obese and Non-Obese Adolescent:  
A Case Study at Depok City, Indonesia****Muhammad Nur Hasan Syah<sup>1</sup>, Utami Wahyuningsih<sup>2</sup>, Ibnu Malkan Bakhrul Ilmi<sup>2</sup>, Rana Nurfitri<sup>2</sup>**<sup>1</sup> *Indonesia Health Workforce Council*<sup>2</sup> *Nutrition Study Program, Universitas Pembangunan Nasional Veteran Jakarta, Indonesia***ABSTRACT**

Indonesia is predicted to increasing the incidence of triple burden malnutrition (TBM) in the future. Undernutrition and overnutrition can result from inadequate dietary intake. Adolescence is a critical period for addressing nutritional problems. This study aims to examine the differences in the Healthy Eating Index between obese and non-obese adolescents in Depok City, Indonesia. The research was a cross-sectional study design, with a sample size of 164 and randomly selected based on the age of 15-17 years. The Healthy Eating Index was determined using a score of Balanced Nutrition Index (BNI) 3-60 (An Indonesian local base index for balanced Nutrition) with score  $> 50$  categorized as good. The Body Mass Index (BMI) score according to age was used to determine obesity (z-score  $\geq 2$ ). The study found that 10.4% of adolescents were obese, with a higher number of obese boys compared to girls. The majority of boys had a lower BNI score, and 17.3% of them were obese. On the other hand, 100% of the girls had a good BNI score, but 5.6% were still found to be obese. There was no difference in BNI scores between obese and non-obese adolescents, although some obese adolescents had a lower BNI score. The study concludes that both obese and non-obese adolescents with a lower BNI score were more prevalent than those with a good BNI score. The relationship between the Healthy Eating Index and obesity needs further investigation as part of efforts to address the triple burden of malnutrition (TBM) in Indonesia.

**Key words:** healthy eating index, adolescent nutrition, balanced nutrition, nutritional guideline

\* Correspondence: anca.gizi@gmail.com

## PP22 : Research Article

### Analyzing Nutritional- and Warning-Related Infographics in Thailand

Thanya Suwankhajit<sup>1</sup>, Kanoknop Phati-amorn<sup>1</sup>, Saranya Honghimaphan<sup>1</sup>, Napat Palivanich<sup>1</sup>, Rarisara Seksuntisakul<sup>1</sup>, Natasha Abhisinha<sup>1</sup>, Channitcha Tangkana<sup>1</sup>, Tumnoon Charaslertrangsi <sup>2\*</sup>

<sup>1</sup> Undergraduate Program in Biological Sciences, Mahidol University International College, Nakhon Pathom, Thailand

<sup>2</sup> Science Division, Mahidol University International College, Nakhon Pathom, Thailand

#### ABSTRACT

Adequate nutrient intake are required to promote good health, growth, and maintenance of our bodies. Since the nutritional messages could influence the consumers' perception to become health conscious, the public sector frequently disseminate infographics to educate the public, using social media channels. Thus, this study examined the nutritional and warning messages collected from the infographics communicated by the Bureau of Food Safety Extension and Support (BFSES), Ministry of Public Health, Thailand. Infographics issued between January 1st - December 31st, 2022, were acquired from the official BFSES Facebook page (<https://www.facebook.com/profile.php?id=100011416496383>). Descriptive analysis was performed to determine the frequency and the major nutritional and health warning messages. Among the 99 infographics analyzed, results showed that 25/99 (25.3%) were nutrition related infographics, while 47/99 (49%) were warnings-related infographics. Balanced and complete nutrition showed up the most (12/25, 48.0%), followed by promoting low fat consumption (6/25, 24%), low sugar intake (5/25, 20%), low sodium intake (4/25, 16%). Encouraging high fiber and high protein consumption were also presented (3/25, 12% each). Warning messages of dietary-related diseases also appeared on infographics, which include diabetes (1/25, 4%), hyperlipidemia (1/25, 4%), lung disease (1/25, 4%), and cardiac disease (1/25, 4%), where the key preventions message focused on avoiding too much fatty, sweet, and salty food. It should be noted that the main mission of BFSES focused on food safety rather than health promotion. In conclusion, the present study determined the frequency of occurrence and identified key nutritional messages as communicated by a governmental organization in Thailand. Rather than a specific consumption practice, most messages emphasized having a complete and balanced diet.

**Keywords:** infographics, nutritional messages, conscious consumption, health warning, Thailand

\* Correspondence: tumnoon.cha@mahidol.ac.th

## PP23 : Research Article

### The Evaluation of the Thailand 5-Year National Plan of Action for Nutrition (NPAN) 2019 - 2023 During the Second Half of the Plan 2022 – 2023

Narttaya Ungkanavin<sup>1\*</sup>, Kunlanant Senkham<sup>1</sup>, Passakorn suraphad<sup>1</sup>, Onwara Dejsakulkrai<sup>1</sup>,  
Warinda Da-am<sup>1</sup>

<sup>1</sup> Ministry of Public Health, Thailand

#### ABSTRACT

This research aimed to evaluate Thailand 5-Year National Plan of Action for Nutrition (NPAN) 2019-2023 during the second half of the plan 2022-2023. The mixed methods used with quantitative and qualitative are based on the CIPP Model (Context, Input, Process, Product). Weighted scoring system is applied with 3-level: high, moderate, low. The interpretation of the average score categorized into 3 ranges: 1.00-1.66(satisfactory), 1.67-2.33(moderate), 2.34–3.00 (excellent). Content analysis was conducted based on questionnaires from 38 relevant agencies. Results found that health outcomes of Thai population have not met the targets. In children aged 0–5, stunting, wasting, and obesity were higher than the targets 11.6, 6.2, and 8.5% respectively. 46.8%, of adults aged 18–59 had a normal BMI and the HALE was 68.3 years. However, 90% of project performance achieved the goals, reflecting strong alignment with the plan. The most projects in 3 plans achieved "excellent" Plan 1, (knowledge development and management): Project on behavior change, food and nutrition indicators, and simplified nutrition labels all received excellent scores (3.00). This reflects that factors context, input, process and product contributed to success. Plan 2 (food education integration in food chain): Project on nutrition policy received highest score (3.00), emphasizing government's leadership in policymaking. Plan 3 (national food and nutrition databases): Projects on developing nutrition monitoring system receiving highest score (2.75). There were limitations of budget and resources. Five policy recommendations have been suggested such as prioritizing development of nutrition knowledge, promoting health literacy, creating supportive environments for good nutrition, and ensuring effective coordination for future well-being in Thailand.

**Key words:** evaluation, National Plan of Action for Nutrition, Thailand

\* Correspondence: narttaya.ung@gmail.com

**PP24 : Research Article****Evaluation of Different Anthropometric Indices and Their Associations with Elevated Blood Pressure among Malaysian Adolescents****Wan Ying Gan <sup>1\*</sup>, Karthikah Radakrishnan<sup>1</sup>, Joyce Ying Hui Tee<sup>1</sup>, Siti Fathiah Mohamed<sup>1</sup>**<sup>1</sup> *Universiti Putra Malaysia***ABSTRACT**

A global rise in hypertension among adolescents, including in Malaysia, has been observed. Early detection and treatment are crucial to reduce the associated risks and long-term consequences. Anthropometric indices have been used to predict hypertension. This cross-sectional study compared the predictive ability of seven anthropometric indices: BMI-for-age z-score (BAZ), waist circumference (WC), waist-to-height ratio (WHtR), conicity index (C-index), a body shape index (ABSI), body roundness index (BRI), and triponderal mass index (TMI), in identifying elevated blood pressure (BP) among adolescents aged 13 to 17 years in Selangor, Malaysia. A total of 934 respondents (41.4% boys and 58.6% girls) from three randomly selected schools were recruited. Data on socio-demographic background, physical activity, and sleep quality were collected through self-administered questionnaires, and measurements of weight, height, waist circumference, and blood pressure were taken. The prevalence of elevated BP was 19.6%, with WC (AOR=1.274, 95% CI=0.746, 2.176) and TMI (AOR=1.310, 95% CI=1.219, 1.407) were significantly associated with elevated BP. WC had the highest predictive power (AUC=0.767, 95% CI=0.735, 0.800) compared to other indices, suggesting that it is the best index for predicting high BP among adolescents. The cut-off values for WC were found to be 71.12 cm for males and 74.27 cm for females. These findings suggest that WC is a valuable indicator for assessing the risk of high BP in adolescents.

**Key words:** adolescents, anthropometric indices, BMI-for-age z-score, blood pressure, waist circumference

\* Correspondence: [wanying@upm.edu.my](mailto:wanying@upm.edu.my)

## PP25 : Research Article

### A Consensus on Health Impact of Caesarean Section Related Dysbiosis and Strategies to Restore Gut Microbiota

Ngamphaiboon Jarungchit<sup>1</sup>, Aw Marion Margeret<sup>2</sup>, Subramanian Raman<sup>3</sup>, Sotha Keth Lysotha<sup>4</sup>,  
Nguyen Nhi<sup>5</sup>, Cheah Fook Choe<sup>6</sup>, Dutta Soumitra<sup>7</sup>, Amin Chirag<sup>8</sup>, Wanapirak Chanane<sup>9</sup>,  
Visuthranukul Chonnikant<sup>1</sup>, Chongsrisawat Voranush<sup>1</sup>

<sup>1</sup> Department of Paediatrics, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand., <sup>2</sup>Department of Paediatrics, Yong Loo Lin School of Medicine, National University of Singapore, Singapore, <sup>3</sup>Fetal Medicine & Gynaecology Center, Petaling Jaya, Malaysia, <sup>4</sup>Cambodian Society of Gynecology and Obstetrics, Phnom Penh, Cambodia, <sup>5</sup>Obstetrics and Gynecology Center, Tam Anh General Hospital, Ho Chi Minh City, Vietnam, <sup>6</sup>Department of Paediatrics, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia, <sup>7</sup> Department of Paediatrics, Intensivist Bhagirathi Neotia Woman and Child Hospital, New Town, Kolkata, India, <sup>8</sup> Amin's Hospital for Women, Ahmedabad, Gujarat, India, <sup>9</sup> Department of Obstetrics and Gynecology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand.

#### ABSTRACT

Caesarean-section deliveries (CSD) impact the establishment of gut microbiota, with caesarean-born infants exhibiting a microbiota composition more akin to skin flora rather than maternal vaginal microbiota which linked to long term health impacts including increased risks of allergies, asthma, and obesity. This current work evaluates the association of CSD with infant gut microbiota and identifies strategies for restoring gut microbiota in CSD-born infants. A modified Delphi method was used to build consensus among a panel of 11 experts in the fields of paediatrics and obstetric and gynaecology from six South and Southeast Asian countries. The process included identifying a corpus of statements for evaluation, three iterative rounds of questionnaires and a virtual meeting to gather and refine expert opinions. Feedback from all rounds was incorporated into the final consensus document. Consensus was defined as high when agreement was  $\geq 75\%$ , moderate when 55-74% and low when  $< 55\%$ . Experts unanimously agreed that CSD had a significant impact on infant gut microbiota colonisation, with high consensus on the crucial role of *Bifidobacterium* and *Lactobacillus* in healthy gut development. Moderate consensus on the first 3–4 months of life representing a critical window for correcting gut dysbiosis. Consensus was high for the following strategies to address dysbiosis: exclusive breastfeeding and/or the potential use of combination of prebiotic (scGOS/IcFOS) with probiotic (*B. breve* M-16V) preferred over prebiotic alone. Strategic early-life interventions, including breastfeeding and the use of synbiotic supplementation are important interventions to mitigate potential adverse health outcomes associated with CSD.

**Key words:** Caesarean section deliveries (CSD), gut microbiota, dysbiosis, symbiotic, *Bifidobacterium breve*, breastfeeding, Delphi method

\* Correspondence: ngamphaiboon\_j@yahoo.com

## PP26 : Research Article

### Association Between Burnout and Eating Behaviors Among Thai Nutrition and Dietetics Practitioners

Tithita Chinthanakorn<sup>1</sup>, Thanit Vinitchagoon<sup>2</sup>, Phenphop Phansuea<sup>2,\*</sup>

<sup>1</sup>Master of Science Program in Nutrition and Dietetics (International Program), Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand

<sup>2</sup>Food and Nutrition Academic and Research Cluster, Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand

#### ABSTRACT

Burnout can trigger coping mechanisms like emotional eating, potentially affecting weight status. Among healthcare professionals, nutritionists and dietitians face a heightened risk of burnout. Given the limited research in Thailand, this study aims to explore the prevalence of burnout and overweight/obesity among Thai nutrition and dietetics practitioners and examine whether eating behavior patterns vary with different levels of burnout and weight status. An online cross-sectional study, conducted from July to August 2024, involved 483 participants stratified by geographical region and recruited via snowball sampling. Data were collected through questionnaires assessing demographic characteristics, burnout levels (using the Thai version of the Maslach Burnout Inventory – General Survey), eating behaviors (using the Thai Eating Style Scale), and self-reported weight and height. Descriptive statistics and Pearson's chi-squared test were used for statistical analysis. Among the 483 nutrition and dietetics practitioners, 42% experienced burnout, while 52% were classified as overweight or obese. The most common burnout type was low professional efficacy (71%), followed by cynicism (60%) and emotional exhaustion (54%). Regardless of weight status, participants experiencing burnout exhibited higher rates of external eating and emotional eating but lower rates of restrained eating ( $p < .001$ ). These results highlight the impact of burnout on coping-related eating behaviors across weight categories. Burnout and overweight/obesity are prevalent among Thai nutrition and dietetics practitioners and are linked to various coping-related eating behaviors. These findings underscore the need for mental health support to address burnout, promote healthier eating behaviors, and improve weight management in this essential healthcare workforce.

**Key words:** burnout, dietitians, eating behaviors, health, obesity

\* Correspondence: phenphop.ph@gmail.com

## PP27 : Research Article

### Handgrip Strength Is Related to Higher Blood Pressure on Pre-Elderly and Elderly

Adhila Fayasari<sup>1\*</sup>, Anis Febri Nilansari<sup>1</sup>, Margala Juang Bertorio<sup>1</sup>

<sup>1</sup> PGRI Yogyakarta University

#### ABSTRACT

Handgrip strength (HGS) is a widely recognized marker of overall muscle function and a strong predictor of clinical outcomes such as future disability, mobility and mortality, especially in elderly populations. Previous studies have suggested conflicted relationship between HGS and increased blood pressure (BP). This study aims to examine the association between HGS and BP levels in pre-elderly and elderly populations. A cross-sectional study was conducted on pre-elderly and elderly outpatient at Wirosaban Hospital, Yogyakarta, Indonesia. HGS was measured using a hand dynamometer, while BP was recorded using a standard sphygmomanometer. Adherence to healthy behavior (PATUH) and DASH-like questionnaire were measured. BMI will be calculated from measured height and weight. Data were analyzed by correlation and multiple regression, with  $\alpha 5\%$ . Adherence to healthy behavior was 64,5% and to DASH-like diet was 75%. The study found no significant relationship between HGS and BP. But, in elderly group with lower HGS had notably higher systolic and diastolic BP compared to those with higher HGS. Regression analysis revealed that lower HGS was associated with a higher risk of uncontrolled blood pressure, after adjusting for confounders like age and BMI. Reduced HGS is linked to higher BP and an increased risk of high blood pressure the elderly. Maintaining DASH-like diet adherence and muscle strength may be crucial in mitigating hypertension risk and comorbidity in older adults.

**Key words:** DASH diet, elderly, handgrip strength, hypertension, malnutrition

\* Correspondence: adhila@upy.ac.id

**PP28 : Research Article****Risk Factors of Non-Communicable Diseases among Thai Karen Population in Sangkhlaburi District, Kanchanaburi Province: A Cross-Sectional Study**

Pattamaporn Joompa<sup>1</sup>, Sinee Chotiboriboon<sup>1</sup>, Prapa Kongpunya<sup>1</sup>, Nattapach Thongkam<sup>1</sup>,  
Wantanee Kriengsinyos<sup>1</sup>, Sueppong Gowachirapant<sup>1\*</sup>

<sup>1</sup> Institute of Nutrition, Mahidol University

**ABSTRACT**

Non-communicable diseases (NCDs) are the predominant cause of death worldwide, over 80% of these deaths occurred in low-and-middle income countries including Thailand. Although several risk factors that lead to NCDs are preventable, health surveillance for indigenous peoples in Thailand is scarce. This study aimed to investigate the risk factors of NCDs among Pwo Karen population living in Sangkhlaburi district, Kanchanaburi province. Venipuncture was performed in 282 Karen participants from 2 villages, Koh Sadueng (KSD) and Sanephong (SNP) village, for measuring blood sugar and lipid profile consist of total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triglycerides (TG) using automated lipid analyzer. Hyperglycemia and dyslipidemia indicators were identified based on World Health Organization (WHO) definition. The study population comprised of 59 school-aged children (SAC), 183 adults and 40 elderly people. Mean age of each subgroup were  $9.5 \pm 1.9$ ,  $41.1 \pm 10.8$ , and  $67.0 \pm 7.5$  years old, respectively. Overall, between 2 villages, prevalence of hyperglycemia was indistinguishable ( $p > 0.05$ ), 4.0% in KSD and 4.4% in SNP. For lipid abnormalities, a comparable percentage of high TC (~40.0%) and high LDL (~30.0%) were observed ( $p > 0.05$ ). In addition, participants in SNP showed higher problem of low HDL and high TG (50.5% and 30.2%), when compared with KSD (35.0% and 19.0%) ( $p < 0.05$ ). High prevalence of metabolic risk factors among this Karen population was reviewed, this might be due to urbanization that increase accessibility to modern foods. Therefore, health monitoring and nutrition education in indigenous peoples should be considered in the national health surveillance program.

**Keywords:** non-communicable diseases, Karen, indigenous people, hyperglycemia, dyslipidemia

\* Correspondence: sueppong.gow@mahidol.ac.th

**PP29 : Research Article****Influence of Energy Intake and Energy Expenditure on Infants' Body Weight  
and Body Fat**

**Tippawan Pongcharoen<sup>1\*</sup>, Pattanee Winichagoon<sup>1</sup>, Pornpan Sukboon<sup>1</sup>, Sutthida Sukshapsri<sup>1</sup>,  
Pimnapanut Sridonpai<sup>1</sup>, Kunchit Judprasong<sup>1</sup>, Phorntip Thappratum<sup>1</sup>, Yaowalak Rooppat<sup>1</sup>,  
Wanabhorn Tongchom<sup>2</sup>**

<sup>1</sup> *Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom, Thailand*

<sup>2</sup> *Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand*

**ABSTRACT**

Understanding the interplay between energy intake and expenditure is crucial for assessing their impact on infant growth and adiposity. This study investigates how these factors influence body weight and body fat in infants. A cohort of 52 Thai infants (24 boys and 28 girls) was assessed at two developmental stages: 6 months (aged 6-8.9 months) and 12 months (aged 12-14.9 months). Energy intake was measured using three non-consecutive 24-hour dietary recalls, while total energy expenditure (TEE) and body composition were assessed with doubly labeled water. The influence of energy intake and TEE at 6 and 12 months on body weight, weight-for-age Z score (WAZ), and body fat at 12 months was analyzed using multiple linear regression, adjusting for covariates. At 12 months, energy intake and body weight or WAZ at 6 months were associated with body weight and WAZ ( $\beta$  0.01 kcal, 1 kg, and 0.8 SD;  $p<0.05$ ). However, TEE at 6 and 12 months and energy intake at 6 months were not associated with body weight or WAZ. Furthermore, neither energy intake nor TEE at any time point was significantly associated with body fat percentage at 12 months. While energy intake at 12 months and earlier body weight or WAZ influence body weight and WAZ, early energy intake and TEE do not show a clear link to body fat at 12 months. Research with longer follow-up is needed to fully understand how the dynamics of energy intake and expenditure affect long-term growth in infants.

**Key words:** energy intake, total energy expenditure, body fat, doubly labeled water, infants

\* Correspondence: tippawan.pon@mahidol.ac.th

## PP30 : Research Article

### Factors Influencing Street Food Selection Among Groups with Different Weight Statuses

Sontaya Boonlaun<sup>1</sup>, Rewadee Chongsuwat<sup>1</sup>, Chanchira Phosat<sup>1\*</sup>

<sup>1</sup>Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand

#### ABSTRACT

Street food has become increasingly popular and may serve as a primary food source in contemporary society. Identifying the factors that affect street food selection, especially among high-risk health groups, is crucial for creating effective nutritional health promotion strategies. This study aims to investigate the determinants of street food selection among individuals with varying health statuses. A cross-sectional study involving 404 consumers was conducted to explore the relationship between body mass index, sociodemographic factors, and street food consumption. Comparisons were made among underweight, normal weight, overweight, and obese groups. Significant differences were found across these groups regarding gender, age, waist circumference, marital status, type of accommodation, monthly income, dietary expenses, and frequency of street food consumption ( $p<0.05$ ). Over half of the overweight and obese participants did not express nutritional concerns regarding selected street food ( $p<0.05$ ). The study also identified significant positive correlations between the frequency of street food consumption and factors such as ease of access, and perceived food prices ( $p<0.05$ ). However, no positive correlation was found between consumption frequency and factors related to proper nutrition, nor were significant associations observed with gender, weight, or education. These findings suggest that street food selection, influenced more by accessibility and economic factors than by nutritional considerations, could contribute to the rising prevalence of obesity and related health issues. The results emphasize the need for public health strategies focused on modifying food environments and encouraging healthier dietary practices to combat the growing obesity epidemic.

**Key words:** street food, street food consumption, food selection, weight, obese

\* Correspondence: chanchira.pho@mahidol.ac.th

**PP31 : Research Article****Chrono-Obesity Connect: Unraveling the Impact of Obesity on Chrononutrition  
Habits Among Adults in Brunei Darussalam****Syahirah Marshidi<sup>1\*</sup>, Satvinder Kaur<sup>1</sup>, Hui Chin Koo<sup>2</sup>, Vaidehi Ulaganathan<sup>1</sup>, Munawwarah Tarif<sup>3</sup>**<sup>1</sup> *Department of Food Science with Nutrition, Faculty of Applied Sciences, UCSI University, Kuala Lumpur, Malaysia*<sup>2</sup> *Department of Bioscience, Faculty of Applied Sciences, Tunku Abdul Rahman University College, Kuala Lumpur*<sup>3</sup> *Health Promotion Centre, Ministry of Health Brunei***ABSTRACT**

With current lifestyle constantly around the clock has contributed to a rise in obesity which desynchronizes the body's biological clock, leading to irregular meal timing that contributes to health-related issues. Therefore, exploring the biological clock is now a crucial approach to tackling health-related issues. This study examines whether obesity is associated with chrononutrition habits among adults in Brunei Darussalam. A longitudinal case-control study was conducted among adults aged 18 to 59 years, followed up every 6 months for 1.5 years. Cases were overweight/obese, controls were normal body mass index (BMI). Chrononutrition habits were assessed using the Chrononutrition Profile Questionnaire (CP-Q), focused on breakfast skipping, nighttime snacking, and largest meal. Socio-demographic data, anthropometric measurements, and BMI were collected. Chi-square was used to analyze differences in chrononutrition habits and percent distribution. At baseline (n=754), cases were likely to skip breakfast than controls (56.0% vs 45.0%, p=0.003), with significant persistent trends across three subsequent follow-ups (65% vs 19%, p<0.001; 68.5% vs 0%, p=0.003; 57.3% vs 0%, p<0.001). At follow-ups, nighttime eating was frequent among cases than controls (94.1% vs 81.5%, p<0.001; 94.1% vs 86.8%, p=0.003; 95.0% vs 75.3%, p<0.001). Consequently, at 1st and 2nd follow-up, dinner was prominently consumed as largest meal by cases than controls with 90.6% vs 89.9%, p<0.001 and 97.3% vs 80.3%, p<0.001. Obesity is significantly associated with poor chrononutrition habits among Brunei's adults, with overweight/obese more prevalent on breakfast skipping, nighttime eating, and dinner consumed as largest meal. Further longitudinal studies to explore public health interventions improving meal timing and minimize obesity risks in Brunei Darussalam.

**Key words:** chrononutrition, obesity, case control, BMI, longitudinal study, Brunei Darussalam

\* Correspondence: satvinderkaur@ucsiuniversity.edu.my

## PP32 : Research Article 0111

### Association Between School Environment and Body Mass Index of Selected Secondary School Students

Shashikala <sup>1\*</sup>, Yap Siang Yi <sup>1</sup>

<sup>1</sup> Department of Food Science and Nutrition, Faculty of Applied Sciences, UCSI University, Kuala Lumpur, Malaysia

#### ABSTRACT

Childhood obesity have become one of the public health issues. The poor dietary behaviour and low physical activity level significantly associated with the prevalence of obesity. School environment is one of the factors that influences adolescent's weight status. Hence, this study aimed to determine the relationship between school environment and weight status among adolescents. This was a cross-sectional study with a total of 322 adolescents participated from 2 selected secondary schools. The data was collected by using self-administered questionnaire which consist of sociodemographic characteristics, whole school environmental mapping, eating habits, food frequency questionnaire (FFQ) and physical activity. Anthropometric measurement such as weight and height were taken. The proportion of female (50.6%) and male (49.4%) was about the same with majority being Chinese (89.1%). The most common food and beverage consumed by the adolescents were white rice (14%) and water (33%). Most of the adolescents were physically inactive (62.1%). The mean BMI was  $19.87 \pm 3.92$ . The correlation between weight status and the food habit of eating a cake or a dessert at meals was found to be correlated ( $r=0.135$ ,  $p=0.009$ ). Furthermore, an inverse relationship was found between weight status and the habit of drinking 8 glasses of water daily ( $r=-0.127$ ,  $p=0.003$ ). Adolescents who often eat a cake or a dessert at meals tend to have higher BMI and adolescents who drinks 8 glasses of water daily tend to have lower BMI. In future study, a detailed data on dietary and nutrient intake should be collected.

**Key words:** adolescents, secondary school, school environment, weight status

\* Correspondence: shashikala@ucsiuniversity.edu.my

**PP33 : Research Article****Exploring the Link between Anemia Prevalence and Prenatal Care among  
Filipino Pregnant Mothers****Frances Pola S. Arias <sup>1\*</sup>, Glenda P. Azana<sup>1</sup>, Ma. Lynell V. Maniego<sup>1</sup>**<sup>1</sup> *Food and Nutrition Research Institute***ABSTRACT**

Prenatal care plays a vital role in the well-being of a pregnant woman and her unborn child. In the Philippines, significant progress was observed in the reduction of maternal anemia prevalence in the last two decades. This study assessed the relationship between anemia prevalence and prenatal care service utilization among Filipino pregnant mothers. Secondary analysis of the 2018-2019 and 2021 Expanded National Nutrition Survey (ENNS) pooled data of 1269 pregnant women was done. The information obtained include anemia status, anthropometric assessment, socio-demographic profile, and dietary assessment. Descriptive, chi-square and multiple logistic regression analyses were done using Stata version 16.0. Findings show that the percentage of non-anemic pregnant women who availed prenatal check-up was higher compared to the anemic mothers although the difference was not statistically significant. Likewise, the percentage of non-anemics and anemics taking micronutrient supplements were not significantly different. The mean intake for poultry and other vegetables were significantly higher among non-anemics as compared to the anemic pregnant mothers, however, the proportion meeting the nutrient requirements was not significantly different between the two groups. The study demonstrated that prenatal care service utilization between anemic and non-anemic pregnant women have shown minimal disparities. This could suggest that well-functioning health services were equitably provided to both groups, supporting the decline in the country's anemia prevalence over the past two decades. However, anemia as a public health significance still persists so additional efforts on nutrition education and community-level awareness are necessary to address the underlying causes of anemia effectively.

**Keywords:** anemia, pregnant, prenatal care

\* Correspondence: francesarias\_24@yahoo.com

**PP34 : Research Article****Development of high-energy and high-protein snacks (Hi OVO CHICKY)  
for Patients with Renal Replacement Therapy**

**Khataleeya Kaewkoon<sup>1</sup>, Thanattha chaimongkol<sup>1</sup>, Rinrada Talearnngkul<sup>1</sup>,  
Petehmanee Thongjang<sup>1</sup>, Kajeepan Keawsot<sup>1\*</sup>**

<sup>1</sup>*Nutrition Department of Phyathai 2 Hospital, Bangkok, Thailand*

**ABSTRACT**

End-stage renal disease patients receiving hemodialysis (ERSD on HD) have been shown in numerous studies to be malnourished. At the Phyathai 2 Hospital hemodialysis center, it was found that 92% and 81% of patients, respectively, consumed insufficient energy and protein. Additionally, 43% of patients took oral nutrition supplements but remained inadequate due to their dislike of the taste and the high cost. These patients prefer Thai snacks for their soft and crispy texture. The objective is to develop high-energy and protein snacks for ESRD on HD by developing Thai custard and crispy rice. Develop the recipe by selecting protein from egg whites, egg white powder, and chicken breast. Calculate the nutritional value using the program INMUCAL-Nutrient v.4 and analysis in the laboratory. Then, evaluate the satisfaction (5-point hedonic scale) in the general population before adjusting the recipe for 26 patients. Thai custard contains 215 kcal of energy, 10 g of protein, 264 mg of potassium, 55 mg of phosphorus, and 254 mg of sodium. Crispy rice contains 293 calories, 8 g of protein, 84 mg of potassium, 28 mg of phosphorus, and 273 mg of sodium per serving. According to ESRD HD patients' satisfaction, Thai custard was favored at a medium-high level, while crispy rice was preferred highly. Thai custard and crispy rice contain twice and four times, respectively, as much protein as similar products on the market. In further study, clinical studies are recommended. The product can serve as a model for other malnourished patient groups.

**Key words:** Thai custard, crispy rice, high energy and protein snack, snack for patients with renal replacement therapy

## PP35 : Research Article

### Development of Fresh Noodle from Wheat Flour, Chickpea and Irradiated Jackfruit Flour Supplemented with Water Meal

Natchaya Jewsuwan<sup>1</sup>, Piraya choksakulkeat<sup>1</sup>, Suteera vatthanakul<sup>1\*</sup>

<sup>1</sup> Faculty of Science and Technology, Thammasat University

#### ABSTRACT

Noodles are a widely popular food, however generally has low nutritional value, leading to problems related to nutrient deficiencies. This aim to enhance essential nutrients in noodle products. In this study, fresh noodles were developed to enhance their nutritional value using a base of grains by adjusting the ratio between chickpea flour and irradiated jackfruit seed flour at three levels: 1:1, 1:2, and 1:3. Dietary fiber was supplemented with water meal powder at two levels: 5% and 10%. It was found that increasing the ratio of irradiated jackfruit seed flour and decreasing the ratio of chickpea flour tended to increase cooking yield, decrease cooking loss, and increase noodle tensile strength. Conversely, increasing the amount of dried water meal powder reduced the color values ( $L^*$ ,  $a^*$ , and  $b^*$ ), decreased cooking yield, increased cooking loss, and reduced noodle tensile strength. The noodles had low fat content and high protein and dietary fiber content of 0.3 grams, 18.38 grams, and 29.12 grams, respectively. This affected a decrease in the porosity of the internal structure of fresh noodles due to the increase in the protein matrix around the starch granules, affected the water-holding capacity, and led to a more uniform surface structure of the noodles. Sensory evaluation revealed that noodles with a chickpea flour to irradiated jackfruit seed flour ratio of 1:3 and 5% dried water meal powder received the highest overall preference scores. This study indicates that fresh noodles enriched with water meal powder and chickpea flour can be developed into a healthy food option that is well accepted by consumers

**Key words:** fresh noodles, microstructure, scanning electron microscopy, water meal

\* Correspondence: emmesuteera@gmail.com

## PP36 : Research Article 0056

### Intake24 Malaysia Malay Language (Intake24 My-Malay), a Web-Based Dietary Assessment Tool for Multiethnic Population

**Nurul Natasha Osman<sup>1\*</sup>, Shaleen Tho Rajasegaram<sup>1</sup>, Nik Nur Izzati Nik Mohd Fakhruddin<sup>1</sup>, Nur Suraiya Abu Hassan Shaari<sup>2</sup>, Emma Foster<sup>1</sup>, Jessica Watterson<sup>1</sup>, Amutha Ramadas<sup>1\*</sup>, Ng Choonming<sup>1</sup>**

<sup>1</sup> Monash University Malaysia

<sup>2</sup> Universiti Teknologi Mara

#### ABSTRACT

A population's dietary data is crucial in the development of food and nutrition-related policies. Numerous tools are available, with 24-hour diet recall (24DR) being the most commonly used method to assess dietary intake. The study aims to develop a Malay version of Intake24 Malaysia and validate it against traditional 24DR. The study will be conducted in two parts: 1) Development of Intake24 MY-Malay 2) Validation of the system. Part 1 includes a) building a food list containing multiethnic cuisines and commercial foods, b) system translation into the national language, Malay language, c) portion references development such as guide images, as-served images and standard portions and d) creating a nutrient composition database by compilation and recipe calculation process. Part 2 will be conducted via a few steps: a) Photograph validation - validating the portion images with Malaysian adults b) Pilot testing - to refine the system usability and language aspect c) Single meal validation - validating against direct observation d) Relative validation - validating the system against traditional 24DR. Intake24 MY-Malay will be a comparable dietary assessment tool to be used against 24DR for the country's multiethnic population. The available food portion references will help the population estimate the food portion. Additionally, the automatic linking of the nutrient composition with the multiethnic dish data will minimize the time to process the population's dietary intake. The validation phase will also help refine the system. Intake24 MY-Malay is a way forward to conducting a sizable, cost-effective dietary survey, especially in multiethnic settings.

**Keywords:** web-based, 24 hour dietary recall, multiple pass method, multiethnic population, Intake24 Malaysia

\* Correspondence: amutha.ramadas@monash.edu

**PP37 : Research Article****Preparation of Cream Cheese from Rice Bran Wax Organogel****Preedaporn Sirimangkalakorn<sup>1\*</sup>, Supathra Lilitchan<sup>1\*</sup>, Kornkanok Aryusuk<sup>2</sup>**<sup>1</sup>*Department of Nutrition, Faculty of Public Health, Mahidol University, Bangkok, Thailand*<sup>2</sup>*Division of Biochemical Technology, School of Bioresources and Technology, King Mongkut's**University of Technology Thonburi (KMUTT), Bangkok, Thailand***ABSTRACT**

Cream cheese is widely used in both savory and sweet culinary applications. Traditional cream cheese can contain up to 60 percent fat, with 50 percent of that being saturated fat. Multiple studies have shown that consuming a high-fat diet raises the risk of chronic diseases. Substituting milk fat with vegetable oil in cream cheese improves its fat composition. Therefore, this study aims to replace the fat in cream cheese by using a blended oil of rice bran oil (RBO), *camellia oleifera* seed oil (CSO), and perilla seed oil (PSO), combined in appropriate ratios and incorporated into an organogel. The objective of this study is to create an organogel cream cheese with reduced fat content and lower saturated fatty acids. The study examines the physicochemical properties and nutritional value of the blended oil organogel cream cheese product in comparison to full-fat commercial cream cheese (CO). The study found that the organogel cream cheese had lower firmness and spreadability compared to commercial cream cheese, making it easier to apply and spread. It contains less than half the total fat of the commercial formula, resulting in lower energy content. The results suggest that blended oil organogels can serve as a fat substitute in cream cheese products, providing less energy. However, to increase firmness, it is recommended to either change the type of organogelator or increase the amount used. The reason for choosing RBW as the organogelator in this study is that previous studies have shown it provides a firmness and spreadability similar to full-fat commercial cream cheese.

**Key words:** organogel, cream cheese, blended oil, rice bran wax

\* Correspondence: supathra.lil@mahidol.ac.th, preedaporn.ratta@gmail.com

**PP38 : Research Article****Development of a Nutrient-Dense Popsicle from Tempe and Pineapple for Supporting Energy and Protein Intake in Stunted Children in Indonesia**

**Adelya Desi Kurniawati<sup>\*</sup>, Belvana Alrizqi, Fanny Fauri Salsabillah Surya, Audrey Kinanti Fadhillah, Gumiang Lintang Insani, Rahma Micho Widyanto, Olivia Anggraeny**

*Nutrition Department, Faculty of Health Sciences, Universitas Brawijaya, Malang, Indonesia*

**ABSTRACT**

The prevalence of stunting in Indonesia reached 21%, which is considered high according to WHO standards. Addressing this health issue, stunted children require nutrient-dense foods, particularly those high in energy and protein. This study aims to develop a high-energy, protein-rich popsicle made from tempe, pineapple, and pineapple peel juice as an interlude food for stunted children. This study was conducted with a completely randomized design (CRD) method with five formulations, comparing different ratios of pineapple, tempe, and pineapple peel juice, F1 (100:0:0), F2 (75:10:15), F3 (50:20:30), F4 (25:30:45), and F5 (0:40:60). The final product was then analyzed for chemical characteristics (proximate composition, energy, antioxidant activity, and Vitamin C content) and organoleptic properties (color, taste, aroma, texture, and overall appearance). Statistical analysis revealed significant differences ( $p<0.05$ ) in protein, fat, moisture, ash, energy, and vitamin C levels among the formulations, while carbohydrate content was insignificant. The best formulation based on chemical characteristics was F5, accounting for 194.45 Kcal energy, 7.92% protein, 4.5% fat, 28.31% carbohydrates, 57.25% moisture, and 0.84% ash. Additionally, it supplies 32.12 mg/100g, and antioxidant activity recorded at IC50 score 417.6 ppm. However, the popsicle's acceptability test showed that the panelists accepted F3 as the most accepted formulation. One serving size popsicle (50 g) of F3 contributes 45.67% of the daily energy and provides 198% of the daily protein needs from snacks (15% of daily need), suggesting that the final product could be a beneficial alternative snack for undernourished children requiring high energy and protein support.

**Key words:** popsicle, tempe, pineapple, stunting

\* Correspondence:adel.kurniawati@ub.ac.id

## PP39 : Research Article

### Characteristics of Edible Film Chitosan-CMC Enriched with Arthrosira Platensis with a Combination of Sorbitol and PEG-400 Plasticizer

Apriyana Tri Maryani<sup>1</sup>, Prihati Sih Nugraheni <sup>1\*</sup>

<sup>1</sup> Fisheries Department, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia

#### ABSTRACT

Edible film with the addition of Arthrosira platensis is purposed to improve the antioxidant properties. Arthrosira platensis doesn't affect the physical characteristic of edible film with the glycerol as plasticiser, except for elongation that still under the JIS standart for edible film. This research aims to replace the glycerol with sorbitol and PEG-400 in chitosan-CMC-Arthrosira platensis edible film and evaluate its physical characteristics. Plasticizer has function to increase elongation of edible film because of its ability to reduce hydrogen bonds in the film. The combination two types of plasticizers were based on our previous study which showed that sorbitol could reduce the greatest hydrogen compared to other plasticizers (glycerol and PVA), meanwhile PEG 400 increase elongation at low concentrations. The edible film formula used is 2% chitosan, 0,5% CMC, 2% Arthrosira platensis with a volume ratio of 10:1:1 then added with 2% sorbitol and PEG 400 with varying concentrations (0%, 0,1%, 0,2%, 0,3%, 0,4%, and 0,5%). The edible film characteristics observation include elongation, tensile strength, thickness, viscosity, solubility, water content, antioxidant activity, and functional group, and pH analysis. The addition of 2% sorbitol plasticizer and 0,2% concentration of PEG-400 produces edible film meets with all parameters in JIS standards and has 12,63% of antioxidant activity. Chitosan-CMC Edible film enriched with Arthrosira platensis has potential to be used as food packaging especially for food with high fat content.

**Key words:** edible film, chitosan, CMC, Arthrosira platensis, sorbitol, PEG 400, plasticizer

\* Correspondence: nugrahenips@ugm.ac.id

## PP40 : Research Article

### Natural Colorant from *Ulva Lactuca* to Increase Antioxidant and Dietary Fiber in Glutinous Rice Cakes (Mochi)

Afiza Atra<sup>1</sup>, Anindha Radistya Putri<sup>1</sup>, Nurfitri Ekantari <sup>1\*</sup>

<sup>1</sup> Fisheries Department Faculty of Agriculture, Universitas Gadjah Mada

#### ABSTRACT

*Ulva Lactuca* (sea lettuce) is a macroalgae that is one of the green algae. Its green color is derived from chlorophyll, a naturally occurring coloring component. Sea lettuce has dietary fiber (28.4%) and phenols, which are strong antioxidants. This study aims to determine the maximum concentration that customers desire, which also to ascertain the sensory, physical, and functional characteristics of mochi fortified with *Ulva* flour. *Ulva lactuca* flour is prepared by soaking for nine hours in 1% NaOCl and oven drying for 4 hours at 70°C. The percentages of *Ulva lactuca* flour added to the total flour were 0%, 1.5%, 3%, 4.5%, and 6%. Dietary fiber, antioxidant, color and moisture content were determined. Customer acceptance and mochi characteristics were also evaluated. Adding *Ulva* flour to mochi dough can increase green color, decrease moisture content ( $p<0,05$ ), increase antioxidants to 35,79%, and increase dietary fiber to 6.73%. Customers preferred mochi wrappers with 3% *Ulva lactuca* flour added, and the addition did not differ from mochi without fortified ( $p>0,05$ ). However, mochi with filling (75% peanuts; 25% sugar) might add up to 4.5%. When the mochi containing 3% *Ulva* flour was chewed, the fishy aftertaste of *Ulva* emerged but could be covered by the nutty flavor between 16.5 and 18.6 seconds. To ensure that *Ulva lactuca* is well-received by consumers and develops into a natural dye and functional component in mochi, its recommended addition rate is 3%.

**Keywords:** antioxidant, mochi, natural dye, dietary fiber, *Ulva lactuca*

\* Correspondence: nurfitri@ugm.ac.id

## PP41 : Research Article

### Enhancing Spinach Noodles with Blanched and Irradiated Jerusalem Artichoke Powder

Tikumporn Ninprapai, Charida Pakasap, Krittiya Khuenpet\*

*Department of Food Science and Technology, Faculty of Science and Technology, Thammasat University, Rangsit Center, Khlong Nueng, Khlong Luang, Pathum Thani 12120*

#### ABSTRACT

Spinach noodles still require improvements in both texture and functionality. Adding dietary fiber from Jerusalem artichoke (JA) might enhance these qualities. The objectives of this research were to examine effects of blanching and gamma irradiation on properties of Jerusalem artichoke powder (JAP), and to evaluate impact of adding pretreated JAP on quality of spinach noodles. Sliced JA were divided into two groups: non-blanching (NB) and blanched (B). All samples were dried and milled into JAP. The JAP samples were either non-irradiated (NI) or gamma irradiated at 2.5 kGy (I2.5). The treated JAP was assessed for its quality properties, such as color, water holding capacity, and water swelling capacity. The selected JAP was then added into spinach noodles formulation at 0%, 5%, 7.5%, and 10% to evaluate its impact on noodle quality containing color, cooking yield, cooking loss, cooking time and tensile strength. Blanching and gamma irradiation decreased lightness ( $L^*$ ) and increased redness ( $a^*$ ) and yellowness ( $b^*$ ) of JAP. Both treatments improved water-holding and water-swelling capacities of JAP. In spinach noodles, the addition of B-I2.5 at 7.5% maintained acceptable cooking yield and reduced cooking time, while it affected noodle color. The addition of NB-I2.5 at 5% preserved the light green color of spinach noodles, increased cooking yield, and did not significantly affect cooking time. Blanching and gamma irradiation improve properties of JAP, making it a suitable additive for spinach noodles. The study recommended using 7.5% B-I2.5 for achieving optimal quality, while 5% NB-I2.5 was suggested as an option for better color retention.

**Key words:** blanching, gamma irradiation, Jerusalem artichoke, spinach noodle

\* Correspondence: krittiya23@tu.ac.th

**PP42 : Research Article****Quality Change and Iron Retention During Storage of Ferrous Fumarate  
-Fortified Cookies**

**Anantita Sangsuriyawong<sup>1</sup>, Panitnart Kanjanatiwat<sup>2</sup>, Sueppong Gowachirapant<sup>1</sup>,  
Nicole Stoffel<sup>3</sup>, Nattapol Tangsuphoom<sup>1\*</sup>**

<sup>1</sup> *Institute of Nutrition, Mahidol University, Nakhon Pathom, Thailand*

<sup>2</sup> *Flowfolk Co., Ltd., Phrae, Thailand*

<sup>3</sup> *St. Hilda's College, University of Oxford, Oxford, United Kingdom*

**ABSTRACT**

Iron deficiency is a moderate public health problem in Thailand. Cookies are suitable vehicle for micronutrient fortification, particularly iron. This study aims to develop and evaluate the storage stability of iron-fortified cookies. Iron fortification was done by homogeneously mixing ferrous fumarate with butter cookie dough. Quality parameters including color, texture profile, water activity, nutritional composition, and microbiological quality of iron-fortified cookies were determined against unfortified cookies. Sensory acceptability was evaluated by 50 females aged 24–49 years using a 5-point hedonic face scale. Changes in quality of cookies packed in aluminum-foil bags during storage at retail ambient condition were evaluated every 2 weeks for 2 months. Iron fortification did not affect any quality parameters, but color and iron content, of cookies. Color values ( $L^*$ ,  $a^*$ ,  $b^*$ ) of the fortified cookies were slightly lower than control, while iron content increased from 0.60 to 116.40 mg/100 g. Both cookies were equally accepted by the panel, with scores of 3.72–4.32 for all sensory attributes. During storage, quality parameters of fortified and unfortified cookies similarly changed, i.e., moisture content and water activity increased, whereas hardness decreased with storage time. Both stored samples passed microbiological quality standards. For fortified cookies, iron content gradually decreased to 97.02 mg (83% retention) at the end of 8th week. Based on the 1st order reaction kinetic, estimated half-life of iron in fortified cookies was 31.5 weeks. Ferrous fumarate could be fortified in cookies as an alternative to iron supplementation for mild-anemic persons.

**Key words:** cookies, iron, ferrous fumarate, food fortification, storage stability

\* Correspondence: nattapol.tng@mahidol.ac.th

**PP43 : Research Article****Eight-Week Vitamin D3-Fortified Fruit Drink Supplementation Improves 25(OH)D and Ferritin Concentrations in Malaysian Women with Low Iron Stores**

**Nursyafiqah Aqilah Suhaimi<sup>1</sup>, Salma Faeza Ahmad Fuzi <sup>1\*</sup>, Su Peng Loh<sup>1</sup>, Norhafizah Ab Manan<sup>2</sup>, Nurzalinda Zalbahar<sup>1</sup>, Muhammad Najib Mohamad Alwi<sup>3</sup>**

<sup>1</sup> Department of Nutrition, Universiti Putra Malaysia, Selangor, Malaysia

<sup>2</sup> Department of Public Health, Cyberjaya University College of Medical Sciences, Selangor, Malaysia

<sup>3</sup> International Medical School, Management and Science University, Selangor, Malaysia

**ABSTRACT**

Few RCTs have examined the effect of vitamin D fortification on both vitamin D and iron status biomarkers, as most studies have focused primarily on supplementation. This 8-week double-blind RCT was aimed to assess the effect of consumption of a 4000 IU vitamin D3-fortified fruit drink on vitamin D and iron status biomarkers in a total of 45 low iron stores women with mean  $\pm$  SD age of 25.3  $\pm$  4.6 years. Healthy, non-pregnant/lactating subjects were recruited, excluding those who had donated blood in the past 6 months, regularly consumed supplements, or had gastrointestinal/iron disorders. Subjects were randomly assigned to the intervention (n=22) or placebo groups (n=23), where 25-hydroxyvitamin D [25(OH)D], serum ferritin, high sensitivity C-reactive protein, and full blood counts indices concentrations were measured at baseline, interim, and post-intervention, with the intervention effects assessed by mixed-model repeated measures ANOVA. The 8-week intervention not only significantly improved 25(OH)D concentrations ( $\Delta$  76.42  $\pm$  30.15 nmol/L vs  $\Delta$  -1.19  $\pm$  10.72 nmol/L,  $p=0.001$ ) but also led to a substantial increase in serum ferritin levels ( $\Delta$  2.20  $\pm$  4.16  $\mu$ g/L vs  $\Delta$  -0.32  $\pm$  3.44  $\mu$ g/L,  $p=0.048$ ) in the intervention group compared to placebo group. A moderate correlation observed between changes in 25(OH)D and ferritin concentrations ( $r=0.378$ ,  $p=0.017$ ) might potentially have contributed to enhanced iron stores. Continued exploration into vitamin D fortification could offer a valuable tool improving not only iron status, but also vitamin D levels, particularly in at-risk groups.

**Key words:** anemia, iron status, vitamin D supplementation, vitamin D fortification

\* Correspondence: salmafazea@upm.edu.my

## PP44 : Research Article

### Cross-Sectional Study: Is the Performance of Health Cadres in Handling Stunting Influenced by Internal Characteristics?

**Kusuma Estu Werdani<sup>1\*</sup>, Sudrajah Warajati Kisnawaty<sup>1</sup>, Ayu Khoirotul Umaroh<sup>1</sup>, Yeni Indriyani<sup>1</sup>**

<sup>1</sup> *Universitas Muhammadiyah Surakarta*

#### ABSTRACT

Health cadres play an essential role in handling stunting in Indonesia. However, measuring the performance of health cadres in handling stunting still needs to be done. This study aims to analyze the relationship between the characteristics of health cadres (employment status, length of service as a cadre, knowledge about stunting, attitude towards stunting, participation in health training) and health cadres' performance in handling stunting. This research method is observational, with a cross-sectional approach involving 65 cadres as respondents—bivariate analysis using the Chi-square Test and multivariate analysis with Logistic Regression with  $\alpha = 0.05$ . The results showed that only length of service as a cadre influenced the performance of health cadres ( $p$ -value = 0.017, OR = 4.394, 95%CI = 1.309 - 14.750). Other variables (employment status, knowledge about stunting, attitude towards stunting, participation in health training) showed no influence on health performance in handling stunting at the Pacitan Health Center, East Java, Indonesia. Further research is recommended to analyze external factors of health cadres that may influence their performance in handling stunting.

**Key words:** stunting, attitude, health knowledge, health cadre

\* Correspondence: [kusuma.werdani@ums.ac.id](mailto:kusuma.werdani@ums.ac.id)

## PP45 : Review Article

# A Systematic Literature Review of the Effectiveness of the Role of Health Cadres in Reducing the Risk of Cardiovascular Disease in Lower-Upper-Middle-Income Countries

Ayudiva Rizky Anugraheni <sup>1\*</sup>, Dini Triwahyuni<sup>2</sup>

<sup>1</sup> Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia

<sup>2</sup> Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Indonesia

## ABSTRACT

Cardiovascular diseases rank as the leading cause of death from non-communicable diseases (NCDs). Uncontrolled hypertension is a significant risk factor for the development of cardiovascular diseases. Controlling high blood pressure is a crucial aspect of preventing hypertension-related complications. One effective strategy for managing hypertension, improving public accessibility to healthcare facilities, and reducing treatment costs is by empowering and involving the community to participate in healthcare services actively. The present literature review aimed to synthesize the effective role of cadres in controlling hypertension, especially in lower-to-upper-middle-income countries. A literature search was performed using the PubMed electronic database with the keywords "hypertension AND community health worker." The inclusion criteria include studies published between 2015 and 2020, focusing on experimental and observational research conducted in lower- to upper-middle-income countries. The findings indicate that the role of cadres contributed to reductions in blood pressure (n=8), improvements in the proportion of controlled hypertension (n=4), and increased medication adherence (n=3). Additionally, three studies reported lifestyle changes, while two found no significant lifestyle changes. The involvement of community health workers can yield positive outcomes in hypertension management in lower-to-upper-middle-income countries.

**Key words:** cadres, hypertension, cardiovascular disease, lower and middle income

\* Correspondence: ayudiva.r@mail.ugm.ac.id

## PP46 : Research Article

### The Relationship between Respondent Characteristics and Knowledge on the Fulfillment of the Feasibility of Community Clean Water Sources Spring Flow

Rezania Asyfiradayati <sup>1\*</sup>, Arvita Ningtyas<sup>1</sup>, Wulan Sari Alam<sup>1</sup>, Jenita Berlian N<sup>1</sup>

<sup>1</sup> Universitas Muhammadiyah Surakarta, Indonesia

#### ABSTRACT

The people of Indonesia still use wells as a source of clean water. In fulfilling clean water, public knowledge about the feasibility of clean water sources has a very important role, because if public knowledge is low, it will have an impact on the selection/attitude in meeting the needs of clean water sources and vice versa. This study is quantitative research that aims to determine the relationship between age, gender, and education with knowledge of the feasibility of fulfilling the feasibility of clean water sources in the spring flow community. This type of research uses an analytical observational design with a Cross Sectional approach. The sample used in this study was 116 respondents. The variables in this study consist of independent variables, namely respondent characteristics (age, gender, and education) and bound variables, namely knowledge of the feasibility of clean water sources in the Cokro Spring flow community. The research analysis used was univariate analysis and bivariate analysis. The statistical test used in this study is a chi-square test with a confidence level of 95% with a significant level of  $p < 0.05$ . The results of the chi-square test showed a p-value of  $< 0.05$  which means that there are a relationship between the characteristics of the respondents (age, gender, and education) with knowledge of the fulfilments of the feasibility of clean water sources in the Cokro Spring community. Relationship between the characteristics of the respondents (age, gender, and education) with knowledge of the fulfilments of the feasibility of clean water

**Key words:** clean water, gender, education, knowledge, age

\* Correspondence: ra123@ums.ac.id

**PP47 : Research Article****Assessing Complementary Feeding, Minimum Dietary Diversity, Child's Eating Behaviour, and Nutritional Status of Children 0-3 Years Old in Peninsular Malaysia**

**Nur Amalina Amirullah<sup>1\*</sup>, Nurzalinda Zalbahar Zabaha<sup>1</sup>, Nurul Balquis Azlan<sup>1</sup>,  
Norhasmah Sulaiman<sup>1\*</sup>**

<sup>1</sup> Department of Nutrition, Universiti Putra Malaysia

**ABSTRACT**

Previous studies showed inadequate dietary intake posed a risk factor for malnutrition in children. Insufficient dietary intake hinders growth process, resulting in underweight, stunting, or wasting. This study was conducted to determine the nutritional status of children aged 0-3 years old (prevalence of underweight, stunting, wasting, and overweight/obesity). Other aspects investigated include complementary feeding practices, minimum diet diversity and food fussiness. This cross-sectional study involved mothers with children aged 0-3 years. The questionnaire gathered data on household characteristics, the child's sociodemographic details (gender, age, gestational age), anthropometric measurements (weight (kg) and length/height (cm)), complementary feeding practices, minimum diet diversity (MDD), and the child's eating behavior. The data were subjected to descriptive analysis. A total of 419 mothers participated in the study. Most of the children were female (70.9%), while 29.1% were male. Most respondents were Malay (93.1%), followed by Chinese (4.5%) and Indians (1.4%). Most mothers in the study had secondary education (52.3%). Among the children, 25.1% were stunted, 12.6% were underweight, 4.4% were wasted, 4.8% were overweight, while 2.2% were obese. A majority (53.5%), of the respondents started complementary feeding at 7 months of age, and most (87%) achieved the MDD. But most of the children had high food fussiness (78.6%). A child's nutritional quality will influence their health status in later years. This study describes the complementary feeding, dietary diversity, food fussiness, and nutritional status of children aged 0-3 years. Further analyses can be conducted to understand how these aspects could potentially affect the nutritional status of children.

**Key words:** children, dietary diversity, food fussiness, nutritional status

\* Correspondence: norhasmah@upm.edu.my

## PP48 : Research Article

### **Nutrigame: A Mobile Game Application to Promote Healthy Eating, Water Intake, and Physical Activity among Schoolchildren**

**Nur Suraiya Abu Hassan Shaari<sup>1\*</sup>, Noor Syuhada Safain<sup>1</sup>, Siti Fadzilah Mat Noor<sup>2</sup>,  
Muhammad Irfan Mohamad Nazarudin<sup>2</sup>**

<sup>1</sup> *Universiti Teknologi MARA*

<sup>2</sup> *Universiti Kebangsaan Malaysia*

#### **ABSTRACT**

Healthy eating and physical activity are essential for schoolchildren's psychological and cognitive development. Ensuring optimal growth requires providing the body with the necessary energy and nutrients. Hence, developing educational tools for childhood is crucial for fostering healthy eating habits and lifestyles. This study aims to develop and validate a nutrition education mobile game application for children aged 7 to 9 years that focused on nutrition, water intake, and physical activity. The study was conducted in two phases; Phase 1: the development of the modules and mobile game application based on literature reviews and Phase 2: content and face validation of the module and mobile game application. Validation was performed encompassing six aspects: two aspects related to content validity and another four to face validity. Nutrigame consists of 3 main sections; 1) Healthy eating and water intake in children, 2) Physical activity for children 3) Quiz. The game achieved I-CVI and S-CVI scores exceeding 0.78 and 0.80, respectively, indicating good content validity. The developed mobile game application demonstrates good content validity and holds potential in nutrition education for schoolchildren.

**Key words:** mHealth, nutrition education, physical activity, schoolchildren, mobile game application

\* Correspondence: [nursuraiya@uitm.edu.my](mailto:nursuraiya@uitm.edu.my)

## PP49 : Research Article

### Participation and Capacities of Indigenous Women and Youth in Sustainable Food System: A Case Study

**Sinee Chotiboriboon<sup>1</sup>, Pattamaporn Joompa<sup>1</sup>, Prapa Kongpunya<sup>1</sup>, Sueppong Gowachirapant<sup>1</sup>,  
Solot Sirisai<sup>2</sup>, Kritsada Boonchai<sup>3</sup>, Sasiwimon Chuangyanyong<sup>4</sup>, Wantanee Kriengsinyos<sup>1</sup>,  
Nattapach Thongkam<sup>1\*</sup>**

<sup>1</sup> Institute of Nutrition, Mahidol University, Nakhon Pathom, Thailand

<sup>2</sup> Retired academic of Mahidol University, Faculty of Liberal Arts, Thailand

<sup>3</sup> Local Development Institute, Bangkok, Thailand,

<sup>4</sup> Independent researcher, Bangkok Thailand

#### ABSTRACT

The sustainability of food systems is crucial for all populations facing climate change and economic crises. The involvement of women and youth is particularly vital for developing sustainable food systems, especially within indigenous communities. Women possess the knowledge and skills to manage food from production to consumption, while youth can bridge traditional knowledge with modern practices. Their participation in research on food systems, climate change, and socio-economic development is essential to understanding and managing sustainable food systems. Objectives: 1) To study the potential of women and youth participating in research. 2) To explore the existing community asset in food system management among women and youth. This qualitative research employs a case study approach, focusing on the Climate Change Resilience of Indigenous Socio-Ecological Systems (RISE) research project. The study uses participatory and non-participatory observation, along with content analysis, applying concepts of sustainable food systems and community capital. Indigenous women and youth (Pwo Karen) demonstrate the capability to research, such as the development of research tools, planning, and data collection, including presenting research findings at both community and national levels. Awareness of the food system situation among these groups enhances the potential for food system recovery. Capacity of women and youth to collaborate with public and private networks, coupled with food wisdom, contributes to sustainable food system management. Involving educational institutions, community leaders, and relevant agencies in engaging women and youth in research and development is key to achieving sustainable food systems.

**Key words:** participation and capacities, women and youth, indigenous people, sustainable food systems

\* Correspondence: nattapach.tho@mahidol.ac.th

## PP50 : Research Article

### Description of Stress among Non-Working Elderly in Desa Pucangan Sukoharjo

Sheena Ramadhia Asmara Dhani <sup>1\*</sup>, Sri Darnoto<sup>1</sup>, Yeni Indriyani<sup>1</sup>

<sup>1</sup> Universitas Muhammadiyah Surakarta

#### ABSTRACT

The imposition of age limits on job vacancies in Indonesia significantly contributes to the high unemployment rate among the elderly, which, in turn, exacerbates stress and mental health challenges within this demographic. There is gradual physical and psychological deterioration, where the decline in conditions can cause stress to some elderly people. Psychosocial problems in the elderly can include stress, anxiety and depression. The problem comes from several aspects, including changes in physical, psychological and social aspects. This study was conducted to describe stress levels among non-working elderly at a Village named Desa Pucangan Sukoharjo in one of Indonesian Province, Central Java. Methods of this research is a descriptive survey research. This study used the Depression Anxiety Stress Scale 42 instrument which was changed to 20 questions. Univariate analysis to find out and describe the description of each variable consisting of age, type of sex, physical stress and psychological stress. These data are displayed in the form of frequency distribution tables and percentages. The results showed that of the 71 elderly in this study, 57 elderly (80.3%) experienced mild physical stress. This study also found that of 71 elderly people in this study, 64 elderly (90.1%) experienced mild psychological stress. In conclusion, the results of this study get an overview of physical and psychological stress in the elderly at Desa Pucangan Surakarta.

**Key words:** non-working elderly, physical stress, psychological stress.

\* Correspondence: sra776@ums.ac.id

## PP51 : Research Article

### Personal Hygiene and Sanitation: Determinants and Implications for Public Health

**Yeni Indriyani <sup>1\*</sup>, Nurul Fadilah <sup>2</sup>, Sheena Ramadhia Asmara Dhani<sup>1</sup>**

<sup>1</sup> *Universitas Muhammadiyah Surakarta*

<sup>2</sup> *University of Kader Bangsa*

#### ABSTRACT

Good sanitation is a crucial factor in ensuring the safety of food consumed by the public. Inadequate personal hygiene practices among food handlers can increase the risk of disease transmission. This study aims to analyze the relationship between personal hygiene practices and predisposing factors such as knowledge, attitudes, gender, education, age, and economic status among food handlers in elementary school canteens. A quantitative method with a cross-sectional approach was used, involving observations and the distribution of questionnaires for data collection. The results indicate that knowledge, attitudes, gender, and education have a significant relationship with personal hygiene practices ( $p<0.05$ ), while age and economic status do not show a significant relationship ( $p>0.05$ ). In conclusion, improving education and awareness about the importance of sanitation and personal hygiene should be implemented in schools to enhance public health and prevent diseases.

**Key words:** personal hygiene, food handlers, sanitation

\* Correspondence: yi245@ums.ac.id

## PP52 : Research Article

### Pressure to Eat and Food as Reward: Two Common Child-Feeding Practices among Young Mothers in Yogyakarta, Indonesia

Digna Niken Purwaningrum <sup>1\*</sup>, Harumanto Sapardi<sup>2</sup>

<sup>1</sup> Departement of Biostatistics, Epidemiology, and Population Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

<sup>2</sup> The Center for Health Policy and Management; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

#### ABSTRACT

The parental approach to child feeding is believed to affect child eating patterns, subsequently influencing both the quantity and quality of nutritional intake among toddlers. This study aims to explore common child-feeding practices for toddlers in Yogyakarta, Indonesia. This qualitative study involved 33 mothers of toddlers from three districts in the Special Region of Yogyakarta, Indonesia. Data were collected through focus group discussions and in-depth interviews, and analyzed thematically to identify prevalent feeding practices and the underlying considerations. The findings highlight two prevalent feeding practices: parental pressure to eat and the use of food as a reward. Pressure to eat is driven by concerns about malnutrition and cultural norms prioritizing the completion of meals. Conversely, food as a reward is utilized by parents to encourage eating without exerting force, though it raises concerns about potential dependency and behavioral issues. Despite a strong desire among parents to adopt responsive feeding practices, there remains significant anxiety about the adequacy of their children's nutrition. Pressure to eat and food as a reward are the two predominant feeding practices among mothers of toddlers in Yogyakarta, with the primary motivation being the prevention of malnutrition. Nutrition education interventions are necessary to help parents understand and implement responsive feeding practices effectively.

**Key words:** child feeding practices, toddlers, pressure to eat, food as reward, Indonesia

\* Correspondence: digna.n.p@ugm.ac.id

## PP53 : Research Article

### BERAKSI: A Further Development of Aksi Bergizi to Promote Healthy Lifestyle for Adolescent in Rural Area of Yogyakarta, Indonesia

B.J. Istiti Kandarina<sup>1\*</sup>, Digna Niken Purwaningrum<sup>1</sup>, Dean Falahudin<sup>2</sup>, Mahran Sasmaja<sup>2</sup>,  
Anis Mutmainah<sup>2</sup>

<sup>1</sup> Departement of Biostatistics, Epidemiology, and Population Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

<sup>2</sup> Postgraduate Program in Public Health; Faculty of Medicine, Public Health, and Nursing; Universitas Gadjah Mada, Indonesia

#### ABSTRACT

Adolescent nutrition in Indonesia faces the dual challenge of undernutrition and rising obesity, affecting teens' growth and well-being. Addressing this requires education, better dietary practices, and improved access to nutritious food. This initiative focuses on promoting healthy lifestyle activities for adolescents within school settings. We adopted a school-based campaign for healthy lifestyles called Aksi Bergizi and tailored some components for rural areas. The three main activities included group exercise sessions, shared breakfasts, interactive talk shows, and social media-based dance competitions. The initiative was implemented in elementary and junior high schools in Gunung Kidul, Yogyakarta. Student participation at the research sites was notably high, supported by enthusiastic involvement from teachers and school committees. Group exercise sessions emerged as the most popular activity among adolescents. However, some students' breakfast choices did not meet balanced nutritional standards. The talk show format proved less effective in large classroom settings, where it tended to lack focus. Conversely, integrating dance, as a form of local cultural expression, holds significant potential for enhancing campaigns promoting healthy lifestyles. Campaigns aimed at improving healthy lifestyles among adolescents need to be tailored to the specific settings where they learn and live daily. Support from teachers and parents is crucial for adolescents to develop and maintain healthy habits.

**Key words:** adolescent nutrition, healthy lifestyle, school-based campaign, rural area

\* Correspondence: [istitik@ugm.ac.id](mailto:istitik@ugm.ac.id)

**PP54 : Research Article****Modification of Dietary Fat Consumption Behavior****“Replace Fat Intake with Fresh Fruit”**

**Pimnapanut Sridonpai<sup>1</sup>, Aree Prachansuwan<sup>1</sup>, Thanit Vinitchagoon<sup>1</sup>, Karaked Tongdonpo<sup>1</sup>,  
Nutthunyawadee Suksodkiew<sup>2</sup>, Wantanee Kriengsinyos<sup>1\*</sup>**

<sup>1</sup> *Human Nutrition Unit, Food and Nutrition Academic and Research Cluster, Institute of Nutrition,  
Mahidol University, Nakhon Pathom, Thailand*

<sup>2</sup> *Bachelor of Science Program (Biological Sciences), Mahidol University International College*

**ABSTRACT**

Hypercholesterolemia is a significant risk factor for coronary heart disease, a leading cause of death worldwide. Diets high in saturated fats and low in dietary fiber are among the contributing factors to this condition. Nutritional interventions that incorporate reflection strategies within nudge-based designs can effectively promote sustainable health behavior modification. This study aimed to evaluate the effect of a nudge-based intervention designed to encourage Thai adults with hypercholesterolemia to replace fat consumption with fresh fruits. In a 12-week parallel cluster-randomized trial, participants were assigned to either a control or a nudged-based intervention group. The intervention group received daily fresh fruits and infographic media during the first three weeks to stimulate behavior change, followed by continuous infographic support until week 12. Blood lipid profiles and eating behaviors were assessed at baseline, week 3, and week 12. The atherosclerosis index revealed that TC/HDL-C and LDL-C/HDL-C ratios in the intervention group decreased by 4% and 2%, respectively, while the control group showed increases of 2% and 6% ( $p<0.05$ ). Additionally, 71% of participants successfully replaced fat with fresh fruits. Those in the intervention group experienced a 15% greater reduction in LDL-C, non-HDL-C, and LDL-C/HDL-C values compared to the control group ( $p<0.05$ ). The use of an infographic nudge with reflection focused on the behavior “Replace Fat with Fresh Fruit” shows a promising trend in reducing atherosclerosis, which is closely linked to cardiovascular risk.

**Key words:** nudge with reflection, dietary behavior, hypercholesterolemia

\* Correspondence: wantanee.krieng@mahidol.ac.th

## PP55 : Research Article

### **Sports Nutrition Education Programm in Malaysian Sports Schools: A Novel Approach-Winning Meals Kachimeshi®**

**Haemamalar Karppaya<sup>1\*</sup>, Shashikala Sivapathy<sup>2</sup>, Mahenderan Appukutty<sup>3</sup>, Lau Chin Mun<sup>4</sup>,  
Phang Xiao Xuan<sup>4</sup>**

<sup>1</sup> *Arawin Nutrition and Health Consultancy*

<sup>2</sup> *Faculty of Applied Sciences, UCSI University, Kuala Lumpur, Malaysia*

<sup>3</sup> *Faculty of Sports and Recreation, Universiti Teknologi MARA, Shah Alam, Malaysia*

<sup>4</sup> *Ajinomoto (Malaysia) Berhad, Head Office, Bukit Jalil, Kuala Lumpur, Malaysia*

#### **ABSTRACT**

Winning Meals Kachimeshi is a Japanese approach that combines five elements of basic meals to create a balanced meal containing the amino acids and carbohydrates required for sports. In addition to the meals, athletes' nutrition awareness is raised with constant nutrition education via informative posters and digital information. The sports nutrition education program focuses on meal planning using 'winning meal components', which consist of staple foods, main dishes, side dishes, soups, and dairy products (milk and yoghurt) to create a balanced and nutritious meal for victory. This programme involved sports school athletes aged 11-18 years old from central, east coast and east Malaysia. The concept of Kachi (Winning) Meshi (meals) was based on the 5-Circle strategy that consists of rice (carbohydrate), meat and its product (protein), milk (protein), vegetable/fruit (fibre, mineral & vitamin), soup (fibre, carbohydrate/ protein, mineral & vitamin). The menu development involved consists of 6 stages (Stage 1: menu development; Stage 2: selection of menu; Stage 3: calorie calculation; Stage 4: confirmation by school sports dietitian; Stage 5: food sensory; and Stage 6: food serving. All meals were prepared according to the components of the winning meal, ensuring that the athletes received the necessary nutrition for their training. The meals were well received by the sports schools and the athletes involved, confirming the program's potential benefits and its positive impact on the athletes' performance.

**Key words:** sports nutrition, balanced lunch meal, sports school, adolescent athletes

\* Correspondence: k.haemamalar@gmail.com

**PP56 : Research Article****Food Intake During Celebrations among the Bugis in Tawau, Sabah, Malaysia****Kasram AB<sup>1</sup>, Ooi YBH<sup>2\*</sup>**<sup>1</sup> Faculty of Food Science and Nutrition, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia<sup>2</sup> Nutrition in Community Engagement Living Lab, Nutrition Programme, Faculty of Food Science and Nutrition, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia**ABSTRACT**

In many Southeast Asian communities, much traditional foods, particularly carbohydrates and meat are consumed during celebrations. We report a study conducted among the Bugis communities in Tawau town, eastern Sabah. A cross-sectional study using convenience sampling of 125 adult respondents was conducted. Semi-quantitative food frequency questionnaire was interviewer administered to quantify food intake during celebration for newborn, wedding, housewarming, funeral wake, and thanksgiving which last one day. Many foods consumed were not in the Malaysian Food Composition Database and were calculated from recipes. Results were expressed as servings of food groups; one serving of cereals and cereal products was 30 g carbohydrate, one serving of fruits and vegetables was 15 g carbohydrate, and one serving of poultry, fish, egg and meat was 14 g protein. Intake of cereals was significantly higher during newborn celebration (7.0 servings) compared to funeral wake (2.5 servings). Intake of traditional cakes was significantly higher during thanksgiving (7.5 servings) and newborn (7.3 servings) compared to wake (4.2 servings). Meat intake during thanksgiving was (11.6 servings) compared to wake (4.7 servings). However, intake of vegetables was only 1.1 servings, albeit significantly higher than wake (0.5 servings). Total energy intake was significantly higher during newborn (5247 kcal) and thanksgiving (5240 kcal) compared to wake (2427 kcal). Fat intake was significantly higher during thanksgiving (202.3 g) compared to wake (83.7 g). All  $p < 0.001$ . As celebrations occur often in this tightknit community, such intake levels may contribute to increased risk of diet related diseases.

**Keywords:** celebration food, Bugis, food intake**\*Correspondence:** yasmin@ums.edu.my

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