Research article

Effectiveness of Nutrition Counseling and Exercise Program in Community Dwelling Older Adults with Sarcopenia

Chadaporn Onma[1], Noppawan Piaseu[2]*, Jintana Sirivarasai[3], Sirasa Ruangritchankul[4]

[1] Master of Science Program in Nutrition, Faculty of Medicine Ramathibodi Hospital and Institute of Nutrition, Mahidol University, Bangkok, Thailand.

[2] Division of Community Health Nursing, Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

[3] Nutrition unit, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

[4] Division of Geriatric Medicine, Department of Internal Medicine, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

ABSTRACT

With Thailand's rapidly aging population, sarcopenia has emerged as a significant health concern among community-dwelling older adults. This quasi-experimental study aimed to investigate the effectiveness of a nutrition counseling and exercise program among community-dwelling older adults with sarcopenia. The sample consisted of 27 participants recruited from the service area of Ramathibodi Hospital, Bangkok. The 8-week intervention included personalized nutritional counseling, meal planning, and resistance training, with health outcomes assessed pre- and post-intervention. Descriptive statistics were used to analyze demographic characteristics and clinical variables, including weight, waist circumference, body mass index (BMI), calf circumference, muscle mass, handgrip strength, gait speed, Mini Nutritional Assessment (MNA), energy, and protein intake. Paired t-tests were used to compare pre- and post-test outcomes. Results indicated significant improvements ($p < 0.001$) in nutritional intake, with mean daily energy increasing from 796.83±253.77 kcal to 925.50±222.10 kcal ($p < 0.001$), and mean protein intake rising from 29.15±8.86 g to 39.39±8.51 g ($p < 0.001$). Nutritional status, measured by the Mini Nutritional Assessment (MNA), improved substantially, with the proportion of participants in normal nutritional status increasing from 48.1% to 81.5%. Furthermore, anthropometric indicators and muscle performance tests demonstrated favorable changes following the intervention. This study highlights the importance of integrating nutrition counseling with resistance exercise for improving dietary intake, nutritional status, and functional outcomes among older adults with sarcopenia. The findings support the value of community-based interventions in promoting healthy aging and preventing functional decline, underscoring the need for future research to inform evidence-based practice guidelines.

Keyword : Sarcopenia, Older Adults, Nutrition Counseling, Resistance Exercise

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*Corresponding author's email: noppawan.pia@mahidol.ac.th

บทความวิจัย

ประสิทธิผลของโปรแกรมการให้คำปรึกษาด้านโภชนาการและการออกกำลังกาย ในผู้สูงอายุที่มีภาวะมวลกล้ามเนื้อน้อยในชุมชน

ชฎาพร อ่อนมา[1], นพวรรณ เปียซื่อ[2]*, จินตนา ศิริวราศัย[3], ศิรสา เรืองฤทธิ์ชาญกุล[4]

[1] หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาโภชนศาสตร์ โครงการร่วมคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี และสถาบันโภชนาการ มหาวิทยาลัยมหิดล

[2] สาขาวิชาการพยาบาลสุขภาพชุมชน โรงเรียนพยาบาลรามาธิบดี คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

[3] สาขาวิชาโภชนศาสตร์ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

[4] สาขาวิชาเวชศาสตร์ผู้สูงอายุ ภาควิชาอายุรศาสตร์ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

บทคัดย่อ

จากการที่ประเทศไทยก้าวเข้าสู่สังคมผู้สูงอายุอย่างรวดเร็ว ภาวะมวลกล้ามเนื้อน้อย (Sarcopenia) จึงกลายเป็นปัญหาสุขภาพที่สำคัญยิ่งในกลุ่มผู้สูงอายุที่อาศัยอยู่ในชุมชน การวิจัยกึ่งทดลองนี้มีวัตถุประสงค์เพื่อศึกษาประสิทธิผลของโปรแกรมการให้คำปรึกษาด้านโภชนาการและการออกกำลังกายในผู้สูงอายุที่มีภาวะมวลกล้ามเนื้อน้อยในชุมชน กลุ่มตัวอย่างจำนวน 27 คน ในเขตรับผิดชอบของโรงพยาบาลรามาธิบดี กรุงเทพมหานคร เข้าร่วมโปรแกรมเป็นเวลา 8 สัปดาห์ ประกอบด้วยการให้คำปรึกษาด้านโภชนาการรายบุคคล การวางแผนมื้ออาหาร และการออกกำลังกายแบบแรงต้าน โดยได้รับการประเมินภาวะสุขภาพทั้งก่อนและหลังการทดลอง การวิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนาเพื่ออธิบายลักษณะประชากรและผลลัพธ์ทางคลินิก ได้แก่ น้ำหนัก เส้นรอบเอว ดัชนีมวลกาย เส้นรอบวงน่อง มวลกล้ามเนื้อ แรงบีบมือ ความเร็วในการเดิน แบบประเมินภาวะโภชนาการ ปริมาณพลังงานและโปรตีนที่ได้รับ เปรียบเทียบความแตกต่างก่อนและหลังการทดลองด้วยสถิติ Paired t-test ผลการวิจัยพบว่า กลุ่มตัวอย่างมีปริมาณพลังงานและโปรตีนเฉลี่ยต่อวันเพิ่มขึ้น ($p < 0.001$) โดยพลังงานเฉลี่ยเพิ่มขึ้นจาก 796.83±253.77 kcal เป็น 925.50±222.10 kcal ($p < 0.001$) และโปรตีนเฉลี่ยเพิ่มขึ้นจาก 29.15±8.86 กรัม เป็น 39.39±8.51 กรัม ($p < 0.001$) นอกจากนี้ ภาวะโภชนาการ (MNA) อยู่ในเกณฑ์ปกติเพิ่มขึ้นจากร้อยละ 48.1 เป็น 81.5 พร้อมทั้งตัวชี้วัดทางกายภาพและสมรรถภาพกล้ามเนื้อพัฒนาขึ้นอย่างมีนัยสำคัญ ผลการวิจัยชี้ให้เห็นว่า การบูรณาการให้คำปรึกษาด้านโภชนาการร่วมกับการออกกำลังกาย แบบแรงต้าน ช่วยส่งเสริมพฤติกรรมการบริโภคและสมรรถภาพทางกายของผู้สูงอายุที่มีภาวะมวลกล้ามเนื้อน้อยได้อย่างมีประสิทธิภาพ ทั้งยังเน้นย้ำความสำคัญของการส่งเสริมสุขภาวะผู้สูงอายุในระดับชุมชนและการวิจัยเชิงประจักษ์เพื่อพัฒนาแนวปฏิบัติวิชาชีพอย่างยั่งยืน

คำสำคัญ: ภาวะมวลกล้ามเนื้อน้อย, ผู้สูงอายุ, การให้คำปรึกษาด้านโภชนาการ, การออกกำลังกายแบบแรงต้าน

*Corresponding author's email: noppawan.pia@mahidol.ac.th

INTRODUCTION

Thailand is currently undergoing a rapid demographic transition toward an aging society. In 2021, the number of older adults rose to 12.5 million, accounting for 19% of the total population, and this figure is projected to reach 20.5 million, equivalent to 31.4% of the population by 2040[1]. With advancing age, physiological and structural changes occur across multiple body systems, contributing to the development of sarcopenia. The prevalence of sarcopenia ranges from 11% to 50% among individuals aged 80 years and older, and up to 29% among community-dwelling older adults receiving healthcare services. In Asia, studies conducted in Korea reported weighted prevalence rates of 19.2% in men and 26.4% in women, with consistently higher rates observed among females. Important clinical determinants of sarcopenia include advancing age, anthropometric parameters such as stature, body weight, body mass index (BMI), waist circumference (WC), and skeletal muscle index (SMI), and fasting blood glucose levels[2]. Within Thailand, the prevalence of sarcopenia among elderly residents in Sattahip District, Chonburi Province was 48.3%, with 14.3% classified as severe[3]. Similarly, among community-dwelling older adults in Bangkok, the prevalence was 22.2%, with severe sarcopenia reported in 9.4%, and overall prevalence increasing with age in both sexes[4].

Sarcopenia, characterized by a progressive decline in skeletal muscle mass and strength, contributes to impaired mobility, diminished quality of life, and an increased likelihood of falls, hospital admissions, and prolonged rehabilitation. The condition predominantly affects individuals aged 60 years and above and is multifactorial in etiology, associated with a sedentary lifestyle, malnutrition, impaired anabolic responses to amino acids, and elevated levels of reactive oxygen species (ROS). At the pathophysiological level, sarcopenia involves selective atrophy of type II muscle fibers, loss of alpha motor neurons, reduction in functional motor units, slowed neural transmission, and impaired coordination of agonist–antagonist muscle groups. Collectively, these changes result in declines in both muscle fiber quantity and protein quality, culminating in weakness, physical disability, functional impairment, and insulin resistance[5].

Several lifestyle and health-related factors significantly contribute to the onset and progression of sarcopenia. Cigarette smoking reduces protein synthesis and negatively influences muscle maintenance by altering gene expression[6]. Alcohol consumption is associated with alcoholic myopathy, which accelerates muscle atrophy and weakness[7]. Falls predispose individuals to reduced mobility and subsequent muscle loss, while unintentional weight loss driven by systemic inflammation accelerates catabolism of skeletal muscle[8]. Malnutrition and low BMI are strongly associated with reduced muscle mass and heightened sarcopenia risk[9]. In contrast, regular physical activity is protective, whereas physical inactivity substantially increases the likelihood of sarcopenia development[10].

Although the etiology of sarcopenia is multifactorial and complex, its progression is thought to result from the failure of compensatory mechanisms within skeletal muscle to counteract degenerative changes[11]. Sustained resistance training has been demonstrated to enhance muscular strength, power, and functional mobility; however, the hypertrophic response to exercise

tends to be less pronounced in older adults than in younger populations[11]. This diminished response may be partly attributable to age-related nutritional deficiencies, particularly inadequate protein intake. Current evidence suggests that older adults require approximately 1.1–1.2 g/kg/day of protein substantially higher than the 0.8 g/kg/day recommended for younger populations[12]. yet nearly half of the elderly population fails to meet these requirements. Reduced capacity and efficiency of protein synthesis, combined with increased proteolysis mediated through the ubiquitin–proteasome pathway, further accelerate the progression of sarcopenia[13].

The consequences of sarcopenia span a broad spectrum of adverse health outcomes, ranging from minor functional limitations to severe, life-threatening conditions in advanced stages. These consequences fall within two principal domains. First, sarcopenia significantly elevates the risk of developing comorbidities, contributing to a higher incidence of chronic disease and increased mortality. Second, it predisposes individuals to progressive physical disability and functional decline, which undermines overall quality of life, erodes personal autonomy, and impairs the capacity to perform fundamental activities of daily living (ADLs), including bathing, dressing, rising from a chair, climbing stairs, and carrying groceries[12]. Sarcopenia has been identified as an independent risk factor for disability, with evidence indicating that older adults with severe sarcopenia are 2 to 5 times more likely to experience disability compared to those with normal muscle mass[14,15]. As individuals age, the interplay between physiological decline and sarcopenia accelerates functional deterioration, establishing a self-reinforcing cycle in which loss of functional capacity further exacerbates muscle weakness, heightening vulnerability and the risk of premature death.

Sarcopenia is diagnosed in accordance with the criteria of the Asian Working Group for Sarcopenia 2019 (AWGS 2019), which defines the condition based on three components: 1) low muscle mass, defined as appendicular skeletal muscle mass measured by dual-energy X-ray absorptiometry (DXA) below 7.0 kg/m² in men and below 5.4 kg/m² in women; 2) low muscle strength, defined as handgrip strength below 28 kg in men and below 18 kg in women; and 3) low physical performance, defined as a 6-meter walk speed below 1.0 meter/sec or a Short Physical Performance Battery (SPPB) score of 9 or below. A diagnosis of sarcopenia requires the presence of criterion 1) in conjunction with at least one of criteria 2) or 3)[12].

Contemporary clinical guidelines emphasize the importance of both resistance training and targeted nutritional support in the management of sarcopenia and frailty. Resistance exercise, particularly when combined with adequate protein and energy intake, has been shown to improve physical function even among the most frail older adults. In a 24-week, randomized, placebo-controlled, double-blind trial, daily protein supplementation of 15 g at both breakfast and lunch improved physical performance, as assessed by the SPPB, in frail older adults, even in the absence of significant changes in muscle mass[16]. Furthermore, a meta-analysis of randomized controlled trials reported that whey protein supplementation alone improved appendicular muscle mass index and gait speed in older adults with sarcopenia, and when combined with resistance training, further increased handgrip

strength[17]. These findings underscore the synergistic benefit of integrating structured resistance exercise with appropriate nutritional supplementation in the clinical management of sarcopenia.

The COVID-19 pandemic further compounded the burden of sarcopenia among older adults by severely restricting opportunities for physical activity. Prolonged physical inactivity accelerated the decline in muscle mass, contributing to frailty, impaired capacity to perform daily activities, reduced quality of life, increased fall risk, and elevated healthcare costs and mortality. Sarcopenia should therefore be regarded not merely as an inevitable consequence of aging, but as a critical public health issue requiring early identification and targeted intervention. Integrated approaches encompassing nutritional optimization, structured resistance training, and evidence-based preventive strategies hold the potential to mitigate the adverse outcomes of sarcopenia and to extend both lifespan and health span in aging populations.

OBJECTIVES

To investigate the effectiveness of the nutrition counseling and exercise program in community-dwelling older adults with sarcopenia

MATERIALS AND METHODS

This study employed a quasi-experimental one-group pretest-posttest design. The target population comprised community-dwelling older adults aged 60 years and above, of both sexes, who presented with low muscle mass and resided within the catchment area of Ramathibodi Hospital, Bangkok.

A purposive sampling method was used to recruit 27 participants. The inclusion criteria were as follows: aged 60 years or older; calf circumference less than 34 cm in males or less than 33 cm in females; a Modified Mini Sarcopenia Risk Assessment-5 (MSRA-5) score of 30 or below; ability to ambulate and maintain balance independently; absence of shoulder injury on the dominant side within one week prior to the study; absence of severe comorbidities such as end-stage renal disease or heart failure; residence in Bangkok for a minimum of one year; and ability to communicate in Thai. The exclusion criteria were as follows: severe knee or back pain; severe mobility impairment; cognitive impairment; and unstable cardiac conditions.

Data Collection and Research Instruments

The research instruments were organized into three sections:

Section 1: Demographic Data A seven-item questionnaire was used to collect personal information, including age, gender, marital status, educational level, occupation, average monthly income, and underlying medical conditions.

Section 2: Health and Body Composition Assessment Tools

Thai Mental State Examination (TMSE): A cognitive screening tool used to detect dementia by assessing six cognitive domains, with a maximum score of 30 points. A score of 0 – 23 indicates cognitive impairment and constitutes grounds for exclusion from the study.

Calf Circumference (CC): An anthropometric index used to assess skeletal muscle mass and nutritional risk in older adults, measured at the widest point of the calf. In accordance with the Asian Working Group for Sarcopenia 2019 (AWGS 2019) criteria, a calf circumference of

less than 34 cm in males or less than 33 cm in females is indicative of sarcopenia risk.

Modified Mini Sarcopenia Risk Assessment-5 (MSRA-5): A five-item screening questionnaire for sarcopenia risk. A score of 30 or below is considered indicative of risk for low muscle mass.

Muscle Strength: Assessed using a handgrip dynamometer. Values below 28 kg in males and below 18 kg in females are classified as low muscle strength.

Muscle Mass: Measured using bioelectrical impedance analysis (BIA) and expressed as the Appendicular Skeletal Muscle Mass Index (ASMI). Values below 7.0 kg/m² in males and below 5.4 kg/m² in females are classified as low muscle mass.

Physical Performance: Evaluated using the 6-meter walk test. A gait speed of less than 1.0 meters/sec is classified as low physical performance.

Nutritional Assessment: Conducted using the Mini Nutritional Assessment (MNA) and a 24-hour dietary recall. Dietary data were analyzed using INMUCAL-Nutrients software (version 4.0).

Section 3: Nutrition Counseling and Exercise Program (Intervention)

The intervention was implemented from December 2024 to March 2025, spanning a total duration of eight weeks. The program was conducted by the principal researcher (a Master's student in Nutrition) and was structured as follows:

Week 1: Orientation and Baseline Training

Participants attended three core activities:

Awareness Building and Readiness Assessment (30 minutes): Designed to enhance participants' foundational understanding of the program and assess their readiness for participation. Practical Workshop (1–1.5 hours): Comprised didactic lectures on sarcopenia and nutritional principles, followed by supervised demonstration and hands-on practice of 10 resistance exercises The training was conducted by the researcher, utilizing an exercise protocol validated by qualified specialists. Individual Counseling Session (30–60 minutes): Conducted to establish personalized health goals and to formulate an individualized nutrition and exercise plan tailored to each participant's health status.

Weeks 2–8: Intervention Implementation and Weekly Follow-Up

Participants were required to adhere to their individualized intervention plans throughout this phase. Weekly monitoring and behavioral reinforcement were conducted by the researcher via telephone calls and the LINE application, encompassing the following components:

Nutritional Component: Participants maintained dietary records, documenting food items consumed, portion sizes, and meal photographs to assess adherence to their individualized nutrition care plans. The researcher reviewed and adjusted each plan on a weekly basis.

Exercise Component: Participants performed home-based resistance training using elastic resistance bands provided by the researcher, with a prescribed duration of 30 minutes per session at a frequency of five days per week. Exercise adherence was monitored weekly, and training intensity was progressively adjusted in accordance with each participant's progress.

ETHICAL CONSIDERATIONS

This study received ethical approval for human research from the Institutional Review Board of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University, under certificate number MURA2024/495, issued on 16 July 2024.

STATISTICAL ANALYSIS

All data were analyzed using SPSS software (version 18), with a statistical significance level set at $p < .05$. The analytical procedures were as follows: The normality of data distribution was assessed using the Shapiro-Wilk test. Descriptive statistics, including mean, standard deviation, and frequency with percentage (n, %), were used to summarize demographic characteristics and study variables. Hypothesis testing was conducted using Paired t-test to compare mean values of outcome variables between the pre-test and post-test assessments.

RESULTS

Participant Characteristics

A total of 27 participants were enrolled in the study, comprising 3 males (11.1%) and 24 females (88.9%). The largest age group was 65–69 years (n = 11, 40.7%), followed by 70–74 years (n = 8, 29.6%). Regarding marital status, 44.4% were married, and 29.6% were single. Regarding educational attainment, the majority had completed primary education (40.7%), followed by upper secondary education or a vocational certificate (33.3%). The majority of participants were not currently employed (77.8%), and 70.4% reported an average monthly income of less than 5,000 Thai Baht.

Health Status

Regarding health status, the majority of participants had multiple comorbidities; only 18.5% reported no underlying medical conditions. The most common comorbidity pattern was the co-occurrence of diabetes mellitus, hypertension, and dyslipidemia (22.0%), followed by hypertension combined with dyslipidemia, and dyslipidemia alone (18.5% each).

Cognitive Function and Sarcopenia Risk Screening

All participants (100%) obtained Thai Mental State Examination (TMSE) scores greater than 24, indicating normal cognitive function. Furthermore, all participants recorded MSRA-5 scores below 30, confirming that the entire sample met the screening threshold for risk of low muscle mass.

As shown in **Table 1**, a comparison of nutritional status assessed by the Mini Nutritional Assessment (MNA) among the 27 participants revealed that, following the intervention, the proportion of older adults with normal nutritional status increased from 48.1% to 81.5%, while the proportion at risk of malnutrition decreased from 51.9% to 18.5%. No participants were classified as malnourished at either assessment point.

Table 1. Comparisons of Mini Nutritional Assessment (MNA) outcomes before and after the intervention (n = 27)

MNA Score	Before intervention		After intervention	
	n	%	n	%
12–14 points (normal nutritional status)	13	48.1	22	81.5
8–11 points (at risk of malnutrition)	14	51.9	5	18.5
0–7 points (malnourished)	0	0.00	0	0.00
Total	27	100.00	27	100.00

Table 2. Comparisons of clinical assessment outcomes before and after the intervention (n = 27)

Clinical variable	Before intervention (Mean±SD)	After intervention (Mean±SD)	*t*	*p*-value
Weight (kg)	58.98 ±15.19	60.01±15.39	3.672	<.001
Waist circumference (cm)	84.59±12.74	86.89±12.19	4.158	<.001
BMI (kg/m^2)	24.71±5.19	25.16±5.25	3.937	<.001
Calf circumference (cm)	31.06±1.59	33.28±3.22	5.055	<.001
Muscle mass (kg/m^2)	6.82±1.01	6.88±1.02	0.584	0.565
Body fat percentage (%)	36.13±5.14	35.97±5.13	0.32	0.589
Skeletal muscle percentage (%)	35.97±5.13	34.53±8.81	0.55	0.754
Handgrip strength (kg)	18.46±4.95	20.45±5.08	4.275	<.001
Gait speed (seconds)	6.53±1.06	6.37±1.08	0.949	3.51

As presented in **Table 2**, comparison of clinical variables before and after the intervention revealed several statistically significant changes. Body weight increased from 58.98±15.19 kg to 60.01±15.39 kg ($p < 0.001$), BMI from 24.71±5.19 kg/m² to 25.16±5.25 kg/m² ($p = 0.001$), waist circumference from 84.59±12.74 cm to 86.89±12.19 cm ($p < 0.001$), calf circumference from 31.06±1.59 cm to 33.28±3.22 cm ($p < 0.001$), and handgrip strength from 18.46±4.95 kg to 20.45±5.08 kg ($p < 0.001$). In contrast, no statistically significant changes were observed in parameters related to body composition or movement speed. Specifically, muscle mass index showed only a marginal increase from 6.82±1.01 kg/m² to 6.88±1.02 kg/m² ($p = 0.565$).

Similarly, body fat percentage slightly decreased from 36.13±5.14 % to 35.97±5.13% (p = 0.589), skeletal muscle percentage shifted from 35.97±5.13% to 34.53±8.81% (p = 0.754), and gait speed demonstrated a minor, non-significant reduction from 6.53±1.06 seconds to 6.37±1.08 seconds (p > 0.05). Overall, these findings indicate that the eight-week nutrition counseling and exercise program effectively improved key anthropometric measurements and physical strength (handgrip strength). At the same time, absolute muscle mass, overall body composition percentages, and gait speed remained statistically significant.

Table 3. Comparison of Muscle Mass Status Classifications Before and After the Intervention (n=27)

Muscle mass	Before intervention n (%)	After intervention n (%)
Low	2 (7.41)	2 (7.41)
Normal	25 (92.59)	25 (92.59)

As shown in **Table 3**, the categorical distribution of muscle mass status among participants remained unchanged before and after the 8-week intervention. Both pre- and post-intervention, the vast majority of community-dwelling older adults maintained normal muscle mass (n = 25, 92.6 %), whereas only a minor proportion was classified as having low muscle mass (n = 2, 7.4%).

Table 4. Comparisons of energy and protein intake before and after intervention using paired t-test (n=27)

Variable	Before intervention (Mean±SD)	After intervention (Mean±SD)	*t*	*p*-value
Energy (kcal)	796.83±253.77	925.50±222.10	4.394	< .001
Protein (g)	29.15±8.86	39.39±8.51	5.878	< .001

As shown in **Table 4**, the comparison of dietary intake before and after the intervention demonstrated statistically significant improvements in both energy and protein intake. Mean energy intake increased from 796.83±253.77 kcal at baseline to 925.50±222.10 kcal post-intervention (p < 0.001), and mean protein intake increased from 29.15±8.86 g to 39.39±8.51 g (p < 0.001). These findings indicate that the eight-week nutrition counseling program significantly enhanced both caloric and protein consumption among participants.

DISCUSSION

This study examined the effectiveness of an eight-week individualized nutrition counseling and resistance exercise program among

community- dwelling older adults at risk of sarcopenia. The findings provide evidence that an integrated intervention can yield meaningful improvements in nutritional status, anthropometric parameters, and muscle strength, even within a relatively brief timeframe.

Nutritional Status and Dietary Intake

The significant improvement in MNA scores, with the proportion of participants classified as having normal nutritional status rising from 48.1% to 81.5%, reflects a clinically meaningful shift in overall nutritional adequacy. This improvement is consistent with prior evidence demonstrating that individualized dietary counseling, combined with continuous monitoring and weekly plan adjustment, promotes sustained behavioral change and adherence to nutritional recommendations in older adults. [17] Importantly, the observed increases in energy and protein intake — from 796.83±253.77 kcal to 925.50±222.10 kcal and from 29.15±8.86 g to 39.39±8.51 g, respectively — suggest that structured counseling can effectively address the habitual dietary inadequacies commonly reported in this population. Adequate protein intake is particularly critical, as it directly supports muscle protein synthesis, preservation of lean body mass, and maintenance of physical function[18,19]. The dietary improvements observed here align with current recommendations that older adults consume 1.0–1.2 g/kg/day of protein to counteract age-related anabolic resistance[20,21].

However, when comparing these post-intervention intakes to the actual target requirements for older adults typically established at 25–30 kcal/kg/day for energy and 1.0–1.2 g/kg/day for protein a critical clinical gap remains[22]. Despite the statistically significant increases, the final absolute intakes (925.50±222.10 kcal and 39.39±8.51 g) still fall below the optimal thresholds required to fully satisfy daily metabolic demands and maximize lean mass preservation for the majority of the sample. This discrepancy suggests that while structured counseling is highly effective in driving positive behavioral changes, relying solely on volumetric adjustments of habitual foods may be limited by physiological barriers common in older populations, such as early satiety, age-related anorexia, and dentition issues[23]. Therefore, to safely bridge this residual nutritional gap and achieve complete dietary adequacy, future interventions or long-term management may necessitate the integration of nutrientdense food strategies or oral nutritional supplements (ONS) alongside behavioral counseling[22].

Muscle Strength

The significant increase in handgrip strength following the intervention is consistent with established evidence that resistance training stimulates skeletal muscle hypertrophy by upregulating contractile proteins, primarily actin and myosin, and activating satellite cells in type II muscle fibers, which are predominantly responsible for force generation[22,23]. Progressive resistance training has also been associated with dose- dependent gains in muscle strength, supporting the structured, progressive nature of the exercise protocol employed in this study[24]. The concurrent improvement in nutritional status likely amplified these gains, as protein availability is a key determinant of the anabolic response to exercise in older adults[25]. This synergistic effect between nutritional optimization and resistance training is a central, clinically relevant finding of the present study.

Anthropometric Parameters

The significant increases in body weight, BMI, waist circumference, and calf circumference observed post-intervention warrant careful interpretation in the context of sarcopenia management. Although elevated waist circumference is conventionally associated with central adiposity and cardiometabolic risk, modest increases in anthropometric measures among older adults with low muscle mass and at-risk nutritional status may instead reflect favorable anabolic adaptations, including lean tissue restoration and improved energy reserves, rather than excess fat accumulation[28]. The increase in calf circumference is clinically significant, as it serves as a surrogate marker of skeletal muscle mass and has been validated as an indicator of sarcopenia risk under the AWGS 2019 criteria. The magnitude of improvement observed in this parameter suggests that the combined intervention may have initiated early structural adaptations in peripheral muscle tissue[12].

Muscle Mass and Physical Performance

The absence of statistically significant changes in muscle mass (6.82±1.01 to 6.88±1.02 kg/m²; $p = 0.565$) and gait speed ($p > 0.05$) following the intervention is consistent with the understanding that measurable hypertrophy requires sustained mechanical and biochemical stimulation over a prolonged period. Muscle mass accrual is mediated by mTOR signaling pathway activation, exercise-induced satellite cell proliferation, and protein synthesis processes that typically require intervention durations exceeding eight weeks to produce detectable changes on body composition assessment[29]. This physiological limitation is further evidenced by the statistically unchanged body composition percentages observed in this study. Following the program, body fat percentage demonstrated only a slight, non-significant reduction (from 36.13±5.14 % to 35.97±5.13% ($p = 0.589$), while skeletal muscle percentage shifted from 35.97±5.13% to 34.53±8.81 % ($p = 0.754$). The lack of statistically significant shifts in these percentages reinforces the premise that a short-term, 8-week timeframe may be insufficient to induce profound tissue-level body recomposition in older adults[30,31]. Aging is intrinsically characterized by anabolic resistance and age-associated hormonal decline, both of which slow down lipolysis and blunt muscle protein synthesis response to nutritional and exercise stimuli[32]. Additionally, the marked increase in the standard deviation of skeletal muscle percentage post-intervention (8.81) suggests a high degree of inter-individual variability in participant response, likely driven by varying levels of home-based exercise adherence and inherent recall biases in self-reported dietary intake[32,33].

The lack of improvement in gait speed may reflect the multifactorial nature of physical performance in older adults, which is influenced not only by muscle strength but also by age-related reductions in bone mineral density, joint flexibility, motor unit recruitment, and neuromuscular coordination These findings suggest that while short-term interventions may be sufficient to improve strength and nutritional outcomes, longer programs are likely necessary to achieve meaningful gains in muscle mass and functional mobility. Importantly, from a geriatric care perspective, stabilizing muscle mass and body fat percentages, preventing further

sarcopenic deterioration and progressive muscle attrition, represents a clinically successful protective outcome.

Comorbidities and Clinical Implications

The high prevalence of diabetes, hypertension, and dyslipidemia observed in this sample highlights the complex clinical context in which sarcopenia commonly presents. Type 2 diabetes in particular accelerates muscle loss through mechanisms including insulin resistance, chronic inflammation, oxidative stress, and accumulation of advanced glycation end-products (AGEs)[16,33]. while sarcopenia reciprocally worsens metabolic control by reducing myokine secretion and promoting ectopic intramuscular fat deposition[5,24]. The coexistence of these conditions increases the risk of falls, functional decline, and vascular complications[26,33], underscoring the importance of early, integrated intervention strategies that target both metabolic and musculoskeletal health.

Limitations

Several limitations of this study should be acknowledged. The small sample size (n = 27) and single-group design without a control arm limit the statistical power and internal validity of the findings. Notably, the calculated minimum sample size constrained our ability to perform gender-stratified or covariance analysis (ANCOVA). The inclusion of both male and female participants may have introduced physiological variance in muscle mass and physical performance parameters, which could mask gender-specific intervention effects. The eight-week intervention period may have been insufficient to detect significant changes in muscle mass or physical performance. Dietary intake was assessed via 24-hour dietary recall, which is susceptible to recall bias. This approach may have led to an underreporting of daily energy intake a common inherent bias in self-reported dietary records which might not fully reflect actual nutritional consumption, despite the participants' average BMI falling within the overweight range particularlyin older adults with limited health literacy. The single-site setting further restricts generalizability across diverse socioeconomic and cultural contexts. Additionally, potential confounders, including concurrent physical activities, psychosocial factors such as motivation and family support, and variability in comorbidity burden, were not fully controlled for and may have influenced outcomes.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future studies should employ randomized controlled trial designs with larger, more heterogeneous samples drawn from multiple community settings to enhance both internal and external validity. Extending the intervention and follow- up period would allow assessment of the long- term sustainability of improvements in dietary intake, muscle strength, and body composition. More objective dietary assessment methods, such as multiple- day food records or nutritional biomarkers, should be considered to improve measurement accuracy. Future research should also investigate the psychosocial and environmental determinants of adherence, including family support, motivation, and access to healthy food and exercise facilities, as these factors are critical for designing effective, scalable programs for older adults. Finally, exploring the additive effects of combining resistance training with aerobic, balance, or

functional exercise modalities may yield further insights into optimizing interventions to prevent and manage sarcopenia.

CONCLUSION

This study demonstrated that an eight-week individualized nutrition counseling and resistance exercise program produced significant improvements in nutritional status, dietary intake, anthropometric parameters, and muscle strength among community-dwelling older adults at risk of sarcopenia. Notably, the proportion of participants with normal nutritional status increased substantially, accompanied by significant gains in energy intake, protein consumption, handgrip strength, and calf circumference — a surrogate marker of skeletal muscle mass. These findings underscore the clinical value of integrating structured resistance training with individualized dietary counseling as a feasible and effective approach to addressing sarcopenia risk in community settings.

However, no statistically significant changes were observed in muscle mass or gait speed, likely attributable to the relatively short intervention duration and the multifactorial nature of physical performance in older adults. These results highlight the need for extended intervention periods to achieve measurable improvements in body composition and functional mobility.

Taken together, the evidence from this study supports the implementation of combined nutrition and exercise programs as a practical strategy for improving the health and functional capacity of older adults with sarcopenia. Given the rapidly aging population in Thailand and the substantial public health burden associated with sarcopenia, early identification and targeted intervention remain essential priorities. Future research employing randomized controlled designs, larger and more diverse samples, and longer follow-up periods is warranted to confirm and extend these findings, and to inform the development of evidence-based clinical guidelines for sarcopenia prevention and management in community-dwelling older adults.

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