ORIGINAL ARTICLE

Determinants of wasting in infants in South Sulawesi Province, Indonesia

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ABSTRACT

In children, wasting can lead to impaired growth, Inhibited muscular growth, weakened immune systems, and heightened vulnerability to illnesses, including flu, cough, diarrhea, and serious infections. This study aimed to determine the factors that contribute to the incidence of wasting in infants aged 0-59 months. This type of research used a cross-sectional design, observational analytical methods, and quantitative analysis. Proportional random sampling was used for sampling. Questionnaires, interview sheets, and multifunctional devices with 0.1 cm precision length and height measurements were employed for data collection. In this study, logistic regression and chi-square tests were performed. The findings of the study suggest a connection between 0-59 month-old infants' calorie, carbohydrates, protein, and fat intake, and household income and wasting. With a p-value of 0.033 ($p < 0.05$) and an OR value of 0.309, the logistic regression test findings showed that protein consumption was the most significant subvariable for wasting. This indicates that infants who consume insufficient amounts of protein have a 0.309-fold higher risk of experiencing wasting. In conclusion, infants' nutritional health between the ages of 0-59 months is significantly influenced by their protein intake. This study implies that programs aimed at increasing protein intake can reduce the incidence of wasting.

Keywords:
wasting, infants, determinants, macro, micro, nutrients

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INTRODUCTION

Acute malnutrition, is characterized by rapid and severe deterioration of the nutritional status.[1] Malnutrition refers to a child's inability to grow or lose weight due to the lack of necessary nutrients for good health. It is a major public health issue, especially for children between the ages of 6 and 59 months.[2] According to a report by the World Health Organization (WHO), millions of malnourished children in this age group include 47 million wasted, 14.3 million severely wasted, and 144 million stunted in 2020. As a result, malnutrition is responsible for more than one-third of all deaths in children under the age of five worldwide, with nearly 400,000 child deaths annually.[3]

Most undernourished infants (>90%) live in developing countries.[4] Malnutrition not only leads to physical health issues, but also hinders cognitive development in children, affecting their ability to learn and thrive.[5] Efforts to address malnutrition through nutrition programs and education are crucial for reducing childhood mortality rates in developing countries.[6]

In children, wasting can cause suboptimal growth and inhibit muscle formation in children.[7] Children suffering from wasting also have weakened immunity, and they face an increased risk of death, particularly in severe cases.[8] Malnutrition also inhibits the growth and development of babies. This can cause permanent damage to brain function, including reduced thinking ability. Wasting in children is a major public health concern worldwide [9]. The most common types of malnutrition in children under the age of five are stunting and wasting.[10]

It is important to understand the determinants of waste to implement effective policies. By understanding these factors, policymakers can target interventions towards the root causes of wasting and work towards reducing its prevalence in vulnerable populations. This knowledge can also help in designing sustainable programs that address the underlying issues contributing to waste.[11,12] Furthermore, understanding the determinants of wasting can also aid in the allocation of resources and funding towards initiatives that have the greatest impact on reducing malnutrition. By addressing these root causes, policymakers can make significant strides in improving the health and well-being of populations at risk for wasting.

Cultural beliefs, including dietary taboos, significantly impact the eating habits and health of fishing families, particularly females, and potentially affect the nutritional status of children in south sulawesi [13]. According to research examining dietary and cultural shifts and child nutrition status in fishing families in several regions, including South Sulawesi, the nutritional status of children in fishing families is influenced by complex interactions among dietary diversity, female's economic roles, family food environment, food insecurity, socioeconomic factors, and cultural practices [14]. The unclear determinants of wasting in South Sulawesi as a research area and the many factors that can influence it made us try to determine what factors influence wasting in infants aged 0-59 months in South Sulawesi, Indonesia.

This study aimed to analyze the determinants of wasting in infants aged 0-59 months in the South Sulawesi Province, Indonesia. The novelty of this study lies in the use of analytical methods to identify risk factors that contribute to wasting in infants. The results of this study are expected to provide useful information for efforts to prevent and overcome nutritional problems in infants. This study is expected

to contribute to increasing our understanding of the factors that influence wasting in infants so that it can help in designing more effective intervention programs. Thus, it is expected that the incidence of wasting in infants will be significantly reduced.

METHOD

Design

Using a cross-sectional study design and observational analytical approach, this study was quantitative. The link between independent and dependent variables was observed simultaneously at one point in time as part of the research process. This study was conducted between January and August of 2024 in the Indonesian province of South Sulawesi.

South Sulawesi Province consists of 24 cities. So considering the representation of each region, the researchers divided the team into 24 and spread them to each city to conduct this survey, the samples taken from each city ranged from 194-195 infants. Sampling in each city also considered the number of districts in the city so that the sample could represent the smallest area in the city.

Sampling techniques

The sampling method used in this study was proportional random sampling, which involved selecting samples from the population at random without considering the strata within the population. The sample size was calculated using the Slovin formula, and a sample size of 778. Because the province of South Sulawesi has 24 regencies, the sample was divided per region and obtained for each city will be taken as many as 194-195 infants while still considering the representation of the smallest region in each city.

The inclusion criteria were being healthy at the time of measurement and not having a medical history of any long-term condition that would have affected their nutritional status. Exclusion criteria were Infants with genetic problems, metabolic issues, or other illnesses that could potentially impair growth and development were excluded from the study

Data collection technique

Researchers directly obtained primary data from the original sources through observations, interviews, questionnaires, and a infant's book, obtaining information from the first source.

The specific procedure during the investigation conducted by the researcher was to display a data collection consent form. Subsequently, the researcher interviewed parents who provided their consent. The research team directly asked all questions on the questionnaire. Our research team comprised 144 people who were spread across each city. We spread six people in each city, which were divided based on the number of subdistricts in the city. Indonesian is the main language used by the community in the research area; therefore, our questionnaire used Indonesian.

Instrument

A series of inquiries on research factors, such as respondent identity, household food security, income, and 24-hour food recall, were included in the questionnaire. Weight and height of the infants were measured using a Multifunction Measuring Instrument with a 2 m measurement capacity and 0.1 cm precision. Household food security is carried out by asking and directly observing five important points: the cleanliness of food ingredients, containers, and kitchen areas; separation of raw and cooked food ingredients; cooking properly until perfectly cooked; storing at a safe temperature; and using safe water and raw materials. A 24-hour food recall was carried out by a research assistant whose data were later translated by a nutritionist during data analysis.

Energy intake was considered insufficient if the total energy consumed was less than the total energy required. The following are the categories of energy adequacy based on the percentage of Nutritional Adequacy Rate (AKG): poor (Insufficient Category) <70% or > 120% AKG (Excessive Category), Good: 80—119% AKG.

Children's vitamin C needs are approximately 40/50 mg/day, which can be met through food intake. Based on this, we categorized whether the child consumed vitamin C > 2 times a week as good. However, if a child consumed vitamin C < 2 times per week, it was categorized as poor. The vitamin C in question is not limited to tablets or drinks.

Data analysis

Based on the findings, both dependent and independent variables were interpreted as tables and narratives describing the features of each variable under study using Excel. In this study, the association between two variables was examined using the chi-square test, and all associated variables were found using a multiple logistic regression test. Based on the findings of bivariate analysis, independent variables with an effect were selected for the multivariate test. The sub-variables that satisfied the requirements and were practicable were acquired. A p-value of less than 0.05. In addition, a multiple logistic regression test was run with a 95% confidence interval on the subvariables that satisfied the requirements to identify the subvariables that had the greatest influence based on the Odds Ratio value. The software used in this study was SPSS 26.

Research Ethics

This study was approved by the Faculty of Medicine and Health Sciences of Alauddin University, Makassar (no. 14354/UA.12.1/EK.01.02/2024). The study adhered to all the ethical guidelines outlined by the University Research Ethics Committee. The participants' confidentiality and informed consent were maintained throughout the study. Consent for data collection was obtained from the infants' parents.

RESULTS AND DISCUSSION

This study revealed that the most common age group for fathers was 37-41 years, followed by 27-31 years for mothers. The most common occupation for fathers was self-employment, while the least common occupations were furniture craftsmen, security guards, and bricklayers. The most common occupation of the mothers was housewives. The highest education level for fathers was high school/vocational high school, whereas the lowest for mothers was elementary school.

Table 1. Respondent characteristics

Variables	Frequency (n)	Percentage (%)
Father Age Group (Years)		
22-26	132	16.97
27-31	138	17.74
32-36	131	16.84
37-41	148	19.02
42-46	120	15.42
47-51	109	14.01
Total	**778**	100

Variables	Frequency (n)	Percentage (%)
Mother's Age Group (Years)		
22-26	96	12.34
27-31	125	16.07
32-36	126	16.20
37-41	120	15.42
42-46	123	15.81
47-51	96	12.34
22-26	92	11.83
Total	**778**	100
Father's occupation		
Employee	92	11.83
Furniture Craftsmen	80	10.28
Cruise	81	10.41
Farmer	139	17.87
Security	80	10.28
Driver	81	10.41
Bricklayer	80	10.28
Self-employed	145	18.64
Total	**778**	100
Mother's Occupation		
Midwife	161	20.69
Teacher	163	20.95
Honorary	160	20.57
Housewife	294	37.79
Total	**778**	100
Father's Education		
Elementary School	174	22.37
Junior High School	198	25.45
Senior High School	237	30.46
Bachelor	169	21.72
Total	**778**	100
Mother's Education		
Elementary School	173	22.24
Junior High School	198	25.45
Senior High School	230	29.56
Bachelor	177	22.75
Total	**778**	**100**

Table 2 shows that out of the 778 infants, 51.16% were wasted and 48.84% were normal. The average nutritional status was -1.5801, with the highest value being -2.66. Current energy, carbohydrate, protein, fat, zinc, iron, and vitamin C intakes are insufficient.

Table 2. Characteristics of infants

Variables	Frequency (n)	Percentage (%)	Z-Score Description
Infant Nutritional Status			
Waste	398	51.16	$\bar{x}$ = -1.5801
Normal	380	48.84	Max = -2.66
Total	**778**	100	Min = 1.21
Energy Intake			
Poor	442	56.81	$\bar{x}$ = 793,314
Good	336	43.19	Max = 1325.15
Total	**778**	100	Min = 347.60
Carbohydrate Intake			
Poor	429	55.14	$\bar{x}$ = 126,337
Good	349	44.86	Max = 245.4
Total	**778**	100	Min = 61.4
Protein Intake			
Poor	428	55.01	$\bar{x}$ = 14,527
Good	350	44.99	Max = 22.0
Total	**778**	100	Min = 9.2
Fat Intake			
Poor	454	58.35	$\bar{x}$ = 21,545
Good	324	41.65	Max = 45.0
Total	**778**	100	Min = 6.8
Zinc Intake			
Poor	393	50.51	$\bar{x}$ = 2.546
Good	385	49.49	Max = 3.7
Total	**778**	100	Min = 1.0
Iron Intake			
Poor	455	58.48	$\bar{x}$ = 2.298
Good	323	41.52	Max = 8.3
Total	**778**	100	Min = 0.9
Vitamin C Intake			
Poor	456	58.61	$\bar{x}$ = 4.046
Good	322	41.39	Max = 38.0
Total	**778**	100	Min = 0.0
Infant gender			
Male	386	49.61	
Female	392	50.39	
Total	**778**	100	
Infant Age			
7-23 months	317	40.75	
24-59 months	401	51.54	
Total	**778**	100	

Variables	Frequency (n)	Percentage (%)	Z-Score Description
Giving Vitamin Supplements			
Not given	350	44.99	
Given	428	55.01	
Total	**778**	100	
Growth monitoring			
Not Routine	316	40.62	
Routine	432	55.53	
Total	**778**	100	
Immunization Status			
Incomplete	333	42.80	
Complete	445	57.20	
Total	**778**	100	
Family Income			
Low Income	446	57.33	
High Income	332	42.67	
Total	**778**	100	

In children under five years of age, Table 3 demonstrates a substantial correlation between energy consumption, carbohydrate intake, protein intake, fat intake, and household income. Of the 50 youngsters, 60.50% consumed less energy, 59.80% consumed less carbohydrate, 58.04% consumed less protein, and 60.05% consumed less fat. Furthermore, energy waste was observed in 57.04% of children from low-income homes, suggesting a strong correlation between energy, protein, fat, carbohydrate intake, and family income.

Table 3. Relationship between Energy Intake and Wasting Incidents in Infants

Variables	Wasting Incident				PValue
	Waste		Normal		
	n	%	n	%	
Energy					
Poor	239	60.05	203	53.42	0.000
Good	159	39.95	177	46.58	
Total	398	100	380	100	
Carbohydrate					
Poor	238	59.80	191	50.26	0.000
Good	160	40.20	189	49.74	
Total	398	100	380	100	
Protein					
Poor	231	58.04	167	43.95	0.000
Good	167	41.96	213	56.05	
Total	398	100	380	100	

Variables	Wasting Incident				PValue
	Waste		Normal		
	n	%	n	%	
Fat					
Poor	239	60.05	215	56.58	0.001
Good	159	39.95	165	43.42	
Total	398	100	380	100	
Zinc					
Poor	199	50.00	194	51.05	0.453
Good	199	50.00	186	48.95	
Total	398	100	380	100	
Iron					
Poor	235	59.05	190	50.00	0.550
Good	163	40.95	160	42.11	
Total	398	100	380	100	
Vitamin C					
Poor	238	59.80	218	57.37	0.250
Good	160	40.20	162	42.63	
Total	398	100	380	100	
Growth monitoring					
Not Routine	172	43.22	174	45.79	0.240
Routine	226	56.78	206	54.21	
Total	398	100	380	100	
Immunization Status					
Incomplete	167	41.96	166	43.68	0.776
Complete	231	58.04	214	56.32	
Total	398	100	380	100	
Family Income					
Low Income	227	57.04	219	57.63	0.032
High Income	171	42.96	161	42.37	
Total	398	100	380	100	

Table 4 displays the variables and sub-variables with significant values of > 0.025 in the first selection test results: food security (0.607), immunization status (0.682), zinc (0.174), iron (0.690), vitamin C consumption (0.803), growth monitoring (0.172), and family income (0.031). Therefore, calorie intake (0.006), carbohydrates (0.000), protein (0.048), and fat (0.061) were sub-variables that satisfied the criteria for the multivariate analysis using multiple logistic regression tests. The sub-variable that had the greatest impact on the incidence of wasting among all the independent variables was protein intake, with an OR value of 0.309 and a p-value of 0.033 (<0.05). This indicates that infants who did not consume sufficient protein had a 0.309 chance of experiencing wasting.

Table 4. Determinants of Wasting Incidents in Infants

No.	Subvariables	Coef	SE	p (sig.)	OR	CI 95%
1.	Energy intake	-3.035	1.110	0.006	0.048	0.005 – 0.476
2.	Intake Carbohydrate	-3.415	0.787	0.000	0.033	0.007 – 0.154
3.	Protein Intake	-1.174	0.551	0.033	0.309	0.105 – 0.911
4.	Fat Intake	-2,340	1.190	0.049	0.096	0.009 – 0.992
	Constants	11,405	2.126	0.000	89775.029	

The nutritional demand of a person can be determined by sex. Compared to female, male demand more energy. This is in line with the research conducted by [15] which states that males have a higher energy expenditure than females. This is due to the fact that male engage in heavier and more physically demanding activities than female.[16] During infancy and childhood, girls tend to have lower rates of poor nutritional status than boys in most developing countries including Indonesia.[17] In most developing nations, including Indonesia, females are less likely than boys to have poor nutritional status during infancy and childhood. Of the 778 infants, 48.84% were normal, and 51.16% were wasted. The average nutritional status was -1.5801 on average, with a maximum value of -2.66. The calorie, protein, fat, carbohydrate, zinc, iron, and vitamin C intakes of the infants were inadequate. One of the elements crucial to raising health standards is a good nutritional status. One factor influencing an infant's quality of growth and development, which in turn influences the calibration of human resources, is their nutritional state. The severity of nutritional issues in young children susceptible to malnutrition typically reflects the nutritional status of the community.

Energy intake is a result of carbohydrate, protein, and fat metabolism, which are essential for growth, metabolism, and utilization of food materials and activities.[18] The body needs to balance energy intake with its needs, and an imbalance can lead to nutritional problems, especially with highly concentrated energy sources such as fats, oils, nuts, and seeds.[19] Energy is obtained from carbohydrates such as rice, tubers, and sugars. This is essential for normal body functioning. If not used, it is stored as body fat, causing weight gain. Conversely, if less energy is consumed, energy reserves decrease, causing weight loss.[20]

The study found that 60.05% of infants had insufficient energy intake, leading to a significant relationship between energy consumption and wasting, with children with insufficient energy experiencing 2-3 times more wasting.[21] This is in line with research conducted by [21] stating that there is a significant correlation between stunting and household food insecurity and suboptimal child dietary diversity scores. The implication of this finding is the importance of ensuring that children receive sufficient energy intake to prevent nutritional problems, such as wasting and stunting, in South Sulawesi. South Sulawesi is the national rice barn in Indonesia, and most of its areas are coastal. The existence of a culture that prioritizes adults when hosting meals may cause wastage in some areas. However, this cannot be generalized to all regions. Therefore, efforts to improve household food security and children's dietary welfare can help to overcome this problem. Infants with low energy intake affect the function and structure of brain development and can experience stunted growth and cognitive development.[22] Energy intake is also

closely related to waste consumption. Energy is a nutritional requirement that must be met during the growth and development of children.[23] In this study, many infants still lack energy intake from their bodies. Therefore, researchers suggest that parents should pay more attention to infants' food intake. Energy can be obtained from foods that contain carbohydrates, proteins, and fat.[24] These include tubers, rice, corn, fish, meat, and shrimp.

Carbohydrates are the most dominant energy-supplying nutrients in the body because 60-80% of the energy needs are met by carbohydrates. Most of the consumed carbohydrates are converted into glucose, which can then directly supply energy to the body. If carbohydrates are consumed to meet the needs, the body does not use fat and protein reserves to produce energy. Carbohydrates function as the main source of energy in the body, and carbohydrate intake is correlated with adequacy of energy intake.[25] Carbohydrate intake is also closely associated with wasting. This is because based on data obtained in the field, the consumption of carbohydrates in infants is still very low. Therefore, it can be said to have a close impact on the nutritional status of infants. Carbohydrates are one of the main macronutrients involved in the process of child growth and development.[26] Carbohydrates can be obtained from rice, corn, cassava, flour, sugar, and dietary fiber. If the infant does not have a good appetite for staple foods such as rice, fish, and vegetables, it can be done by making processed tubers that are processed into more attractive foods so that they are in demand by the infant.

Protein is a nutrient that is needed for the recovery of conditions and restructuring of body tissues that do not function as a cause of organ dysfunction.[27] Adequate energy and protein for infants who need more based on their weight because part of the food intake must be provided for growth and more active energy exchange, as well as for maintaining a more optimal level of health.[8] Based on the results of this analysis, 58.04% of the infants had insufficient protein intake and experienced wasting. There was a significant relationship between protein intake and wasting in the infants. According to a research conducted by [28]stated that a high intake of dairy protein, mainly from infant formula, has a greater impact on weight gain and growth-related hormones. This is because infants with sufficient protein intake have good cell building and maintenance but do not necessarily have sufficient energy. However, proteins are not the primary source of energy. Therefore, this condition causes infants to be wasted. The function of a protein as a building substance in muscles, bones, blood, skin, and lymph is not the main energy producer. Proteins can be broken down into energy sources if the energy supply from carbohydrates and fats is insufficient.[29]

Proteins influence wasting cases because the amino acids contained in proteins can be converted into fat if energy and protein intake exceeds needs, and carbohydrate intake is also sufficient. These amino acids undergo deamination, namely, breaking of the nitrogen group, which then converts the carbon group into fat and is stored. If protein intake increases, body weight also increased.[30] Protein intake in this study was closely related to wasting events because protein is a macronutrient that plays an important role in the growth and development processes of infants when compared to the need for micronutrients. Protein can be obtained from livestock, which is part of the animal protein that has benefits for body health, especially in meeting the daily nutritional intake, which, of course, will also affect nutritional status.

Based on the results of the selection of independent variables that influenced the incidence of wasting, four subvariables met the requirements for multivariate analysis with multiple logistic regression tests, namely the variables of energy, carbohydrate, protein, and fat intake. Thus, of the four subvariables, one variable had the most influence, namely protein intake, with a p-value of 0.033 (<0.05) and an OR value of 0.309, meaning that infants with insufficient protein intake had a 0.309 chance of experiencing wasting. This is in line with research conducted by [31] stated that knowledge of protein foods by mothers was a significant predictor of children being underweight. This shows that the need for protein intake has a major influence on the incidence of wasting compared with other micronutrient intake subvariables. Proteins can be obtained from various fish species. This was convenient for some communities in the coastal areas of southern Sulawesi. However, the tendency to prioritize adults for food consumption could be a driver of the lack of protein intake in these children. In addition, in the South Sulawesi region, although the majority of the coastal areas are rich in marine products, the distribution of marine products in this area is very uneven, even in remote areas, because of the many damaged road accesses that have not been repaired by the government. Therefore, it is recommended that parents of infants pay more attention to their protein intake needs, and policy makers should prioritize programs that focus on improving access to protein-rich foods for infants to prevent wasting and promote healthy growth.

Energy and macronutrient intakes both influence wasting incidents. However, the results of this study showed that the most influential factor in wasting incidents in infants is protein intake. Protein in the body is a source of energy if the carbohydrates consumed are insufficient, and the recommended protein consumption is approximately 15% of the total calories consumed from protein. Other functions of proteins include the growth and maintenance of tissue, formation of essential body compounds, regulation of water balance, maintenance of neutrality (acid-base) in the body, formation of antibodies, and transport of nutritional value.[32] Energy plays an important role in the body of infants because if the body's energy needs are lacking, it will cause stunted growth and tissue damage in the body. If accompanied by a lack of protein, children experience kwashiorkor.

Fat is the most energy-providing macronutrient, as a protector of various vital organs in the human body, and it maintains the body from body temperature. Insufficient fat intake results in low-calorie intake or energy requirements in the body. Fat is also one of the macronutrients of two types, namely fatty acids and triglycerides. Fat is dense in energy (9 kcal/g); therefore, it can maintain energy balance and body weight. Fat can also provide a medium for the absorption of fat-soluble vitamins, such as vitamins A, D, E, and K. Fat plays a role in enhancing the taste of food, so that most people like foods that contain fat. The body can form omega-6 and omega 3 fatty acids, which are essential components.[33] Based on the results of this study, 60.05% of infants with insufficient fat intake experienced wasting. A significant relationship was observed between fat intake and wasting in infants. Reduced energy consumption, followed by low fat intake, results in altered bodily tissues and poor absorption of fat-soluble vitamins. Nutrients that do not satisfy the body's requirements because of problems with nutrient utilization are the secondary elements that influence nutritional intake, while the major issue is incorrect dietary composition. If insufficient, fat intake obtained from food results in a lack of calorie intake or energy in the process of body activity and metabolism.[34] The lack of fat intake also reduces energy, which can cause changes in body mass and tissue and disorders in the

absorption of fat-soluble vitamins. Fat intake is also closely associated with wasting. This is because, based on data obtained in the field, the consumption of fat in infants is still very low and infants experience wasting. Fat-containing foods include salmon, mackerel, sardines, avocados, grains and nuts.

Nutritional problems in children are influenced by socioeconomic factors, including family income. Income is the amount of income earned by a family in one month to meet the daily needs of family members.[35] As previously mentioned, the majority of households in this study had low incomes, so they were unable to provide healthy and varied food according to the balanced nutrition guidelines.

CONCLUSION

There is a relationship between energy intake, carbohydrate intake, protein intake, fat intake, and family income and the incidence of wasting in infants aged 0-59 months. The determinant variables of wasting incidence in infants aged 0-59 months were energy, carbohydrate, protein, and fat intake, with protein intake being the most influential factor on wasting incidence, with a p-value of 0.033 ($p < 0.05$) and an OR value of 0.309. Policymakers should focus on improving protein intake among families with lower incomes to reduce the incidence of wasting in infants aged 0-59 months. Additionally, targeted interventions should be implemented to address the nutritional needs of vulnerable populations and improve overall health outcomes. Parents should also be educated on the importance of providing a balanced diet for their infants with an emphasis on adequate protein intake. This holistic approach can help address the root causes of wasting and promote better health outcomes in this age group.

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