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Macronutrient and Micronutrient Intake as Determinants of Underweight Among Toddlers in Toddlers at the Molino Community Health Center, North Morowali Regency

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ABSTRACT

Introduction: The prevalence of underweight in toddlers in the Molino Community Health Center mining area increased sharply from 9.98% (2023) to 15.32% (2024), exceeding the national target of 12% and reflecting a serious nutritional crisis in North Morowali Regency which also increased from 6.41% to 13.24%. This condition differs from the stability of the national prevalence of around 16.29%, indicating a specific problem in the mining area related to the imbalance of macro and micro nutrient intake. This study aims to macronutrient and micronutrient intake as determinants of underweight among toddlers in toddlers at the Molino Community Health Center, North Morowali Regency.

Method: This study used a quantitative approach with a case-control matching design of toddlers in the Molino Community Health Center area from April to June. A sample of 186 toddlers (93 underweight, 93 with normal nutrition) was selected from a population of 1,253 children using the Slovin formula and cluster random sampling.

Result: The results of the analysis showed that there was an influence of limited access to health services with OR=1.729, while the most dominant factors were the influence of macronutrient intake (OR=4.912; CI 95%: 2.635–9.159) and the influence of micronutrient intake (OR=4.013; CI 95%: 2.179–7.390) on the nutritional status of toddlers.

Conclusion: The analysis model shows that the variation in nutritional status is quite good, it is recommended to carry out family-based nutritional interventions, increase education for parents, and strengthen community economic empowerment programs through integrated promotive and preventive services at the Community Health Center.

Introduction

Underweight in toddlers is a health problem characterized by weight for age (BB/U) being below the child growth standards according to WHO, namely having a Weight-for-Age Z-score (WAZ) value of less than -2 standard deviations.[1] This condition is generally caused by an imbalance in nutritional intake, both macro and micro, and is exacerbated by environmental factors such as low family income, limited access to health services, and inadequate sanitation.[2] As a result, children are at risk of experiencing growth disorders, decreased immunity, and susceptibility to disease.[3] Amidst national efforts to achieve SDGs point 2, realizing Healthy Indonesia 2030, and welcoming Golden Indonesia 2045, the problem of underweight remains a challenge that needs to be addressed, especially in remote areas and mining areas that are vulnerable to inequality in access to nutrition and health services.[4]

This condition is closely related to an imbalance in nutritional intake, both from an individual and environmental perspective. From an individual perspective, factors such as malnutrition, metabolic disorders, and genetic predisposition can be triggers. Meanwhile, from an environmental perspective, socioeconomic conditions, food availability, and access to and quality of health services also contribute. Nutritional deficiencies can include macronutrients such as carbohydrates, protein, and fat, which are needed in large quantities for energy and body growth, as well as micronutrients such as iron, zinc, vitamins A, D, calcium, and the B-complex vitamins, which play a vital role in physiological function and immunity. The impact on health is serious, including decreased immunity, an increased risk of osteoporosis, and stunted growth, especially in children.[5]

Prevention can be done as early as possible, where during pregnancy (the first 270 days), fulfilling the mother's nutritional needs, including iron, folic acid, and protein, is very important to support fetal growth.[6] After birth, care continues for the next 730 days until the child is 2 years old, which is part of the golden period of the First 1,000 Days of Life. This period includes exclusive breastfeeding for 6 months, followed by nutritious, balanced complementary foods, complete immunizations, proper sanitation, and good health care.[7] The golden period, from pregnancy to the age of 2 years, is a critical phase because 80% of a child's brain development and growth occurs during this age range, so intervention during this period determines the child's quality of life in the future.[8]

Nutritional issues in toddlers are a public health challenge in Indonesia that requires serious attention. Underweight toddlers are at high risk of impaired growth, development, and health, including increased susceptibility to infectious diseases.[9] This condition can lead to serious problems, such as stunting and wasting, which impact the child's quality of life in the future.[10]

Underweight in toddlers is caused by inadequate nutritional intake, repeated infections, digestive disorders, chronic diseases, and socio-economic factors such as limited access to nutritious food and suboptimal parenting patterns.[11] This condition can inhibit growth, weaken the immune system, and increase the risk of stunting.[12] In mining areas, natural resource exploitation activities have the potential to impact food availability, water quality, and public health. Environmental pollution increases the risk of infection, while economic disparities limit access to nutrition for low-income families, ultimately worsening the nutritional status of children under five.[13]

According to the report, The State of Food Security and Nutrition in the World 2024, released by the FAO and other UN partners, the number of people globally experiencing undernourishment in 2023 is estimated to range between 713 and 757 million, with a median estimate of around 735 million. While this figure represents a slight decrease compared to 2021, it still reflects a worrying stagnation since the sharp spike caused by the Covid-19 pandemic. Asia remains the region with the highest number of undernourished people, at around 384.5 million. Factors such as conflict, climate change, and the global economic crisis continue to be major obstacles to efforts to significantly reduce hunger. This situation underscores the need for a more comprehensive and coordinated approach to achieving the target of Zero Hunger by 2030.[14]

In Asia, approximately 55% of global malnutrition cases occur. Economic inequality, limited access to nutritious food, and the impact of the COVID-19 pandemic have exacerbated this situation.[15] Indonesia has the highest malnutrition

rate in Southeast Asia, with more than 17 million people affected during the 2019–2021 period.[16]

Over the past three years, the prevalence of underweight in Indonesia has fluctuated, according to Indonesian Nutritional Status Survey and Indonesian Health Survey data. In 2021, the underweight rate was recorded at 17.1%, then decreased to 16.2% in 2022. Indonesian Health Survey data for 2023 showed the underweight rate remained at around 16.3%, and in 2024, according to the Indonesian Nutritional Status Survey, the prevalence was recorded at 16.29%. Although relatively stable and slightly decreasing, these figures still reflect significant nutritional challenges among Indonesian toddlers. Untreated underweight can be a gateway to other chronic nutritional problems, such as stunting, especially if it occurs during a child's golden period of growth.[17]

The problem of underweight in toddlers remains a complex public health challenge, particularly in areas with limited access and resources. Factors such as family income status, maternal education, and family size influence a household's ability to provide balanced nutrition and optimally utilize health services. Furthermore, limited access to health facilities, both due to distance and minimal family involvement in reporting and monitoring children's nutritional status, exacerbates the situation. Low macro- and micronutrient intake due to a lack of knowledge and affordability of nutritious food further increases the risk of underweight in toddlers.[18]

According to data from the North Morowali Regency Health Office, the percentage of underweight toddlers in 2021 was recorded at 9.52%. This figure then decreased significantly in 2023, reaching 6.41%. However, in 2024, there was a significant spike, with the underweight percentage increasing to 13.24%. This trend continued in January 2025, with a slight increase again to 13.65%, indicating a changing pattern that requires further attention.[19]

The prevalence of underweight among toddlers at the Molino Community Health Center has fluctuated over the past few years. In 2021, the underweight rate was recorded at 12.41%, then decreased to 11.26% in 2022 and further decreased to 9.98% in 2023, reflecting progress in efforts to improve child nutrition. However, in 2024, there was a significant spike, reaching 15.32%. Although this figure decreased slightly in January 2025 to 14.13% in the first quarter, it remains above the national target of 12%. This situation indicates the need for a comprehensive evaluation to identify the causes of the increase in cases and develop more appropriate and sustainable intervention strategies.[19]

The increasing prevalence of underweight among toddlers at the Molino Community Health Center reflects a worsening nutritional problem due to socioeconomic factors, limited access to nutritious food, and the environmental impacts of mining. This is a critical issue that requires special attention, given its impact on children's health in the region. This study aims to analyze the effect of macro and micronutrient intake on underweight among toddlers at the Molino Community Health Center in North Morowali Regency.

Method

This study used a quantitative approach with a case-control study design. The case group consisted of 93 underweight toddlers, while the control group consisted of 93 toddlers with normal nutritional status, with age matching to control for confounding variables. The total sample size was 186, obtained through cluster random sampling based on the division of villages within the Molino Community Health Center's working area. The research instruments were questionnaires and nutritional status recording forms. Bivariate analysis was performed using the Odds Ratio (OR) and the Chi-Square test, and multivariate analysis using logistic regression to identify the most influential factors.

In this study, the researcher applied ethical research principles, including informed consent, anonymity, and confidentiality. During the informed consent stage, the researcher explained the purpose, benefits, and procedures of the study to respondents, and gave them the freedom to agree or refuse to participate without coercion. To maintain anonymity, respondents' identities were not included in the research instrument and replaced with specific codes or initials so that they could not be directly identified. Furthermore, the principle of confidentiality was applied by ensuring that all information obtained from

respondents would be kept confidential and used only for research purposes.

Result

Table 1 showed a significant influence between macronutrient intake and toddler nutritional status. As many as 70.79% of toddlers with insufficient macronutrient intake were underweight, while only 29.21% of toddlers with sufficient intake experienced the same condition. The Odds Ratio (OR) of 4.912 indicates that toddlers with insufficient intake were almost 5 times more likely to be underweight compared to toddlers with sufficient intake. The Confidence Interval (CI) between 2.635 and 9.159 showed that this result was statistically significant, indicating that adequate macronutrient intake plays an important role in determining toddler nutritional status.

Table 2 showed a significant influence between micronutrient intake and the nutritional status of toddlers. Of the 186 toddlers, 68.82% who had insufficient micronutrient intake were underweight, while only 31.18% of those with sufficient intake experienced the same condition. The Odds Ratio (OR) of 4.013 indicates that toddlers with insufficient micronutrient intake were 4 times more likely to be underweight compared to toddlers with sufficient intake. The Confidence Interval (CI) between 2.179 and 7.390 indicates that this result is statistically significant, confirming the important role of adequate micronutrient intake in supporting toddlers' nutritional status.

Table 3 shows the results of a logistic regression analysis that demonstrates the influence of various variables on the nutritional status of toddlers. In the first step, the Macronutrient Intake variable has a coefficient (B) of 1.592, with an odds ratio (Exp(B)) of 4.912, which means that toddlers with insufficient macronutrient intake are almost 5 times more likely to be underweight than those with sufficient intake.

Table 1.
Macronutrient intake influences the incidence of underweight in toddlers at the Molino Community Health Center, North Morowali Regency.

Macro nutrient intake	Toddler				Σ	%	OR	Confidence Internal	
	Case		Control						
	F	%	f	%				Lower	Upper
Not enough	63	70.79	32	34.41	95	52.20	4.912	2.635	9.159
Enough	26	29.21	61	65.59	87	47.80			
Total	89	100.0	93	100.0	182	100.0			

Table 2.
Micronutrient intake influences the incidence of underweight in toddlers at the Molino Community Health Center, North Morowali Regency.

Micro nutrient intake	Toddler				Σ	%	OR	Confidence Internal	
	Case		Control						
	f	%	f	%				Lower	Upper
Not enough	64	68.82	33	35.48	97	52.15	4.013	2.179	7.390
Enough	29	31.18	60	64.52	89	47.85			
Total	93	100.0	93	100.0	186	100.0			

Table 3.
Logistic Regression Analysis Results: Variables in the Equation

		B	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Step 1[a]	Macronutrient intake	1,592	25,078	1	.000	4,912	2,635	9,159
	Constant	-.739	11,826	1	.001	.478		
Step 2[b]	Income	1,319	15,184	1	.000	3,738	1,926	7,256
	Macronutrient intake	1,688	24,768	1	.000	5,409	2,782	10,516
	Constant	-1,414	22,760	1	.000	.243		

Discussion

Macronutrient intake influences the incidence of underweight in toddlers at Molino Community Health Center

This study shows that macronutrient intake significantly influences the incidence of underweight in toddlers, with toddlers with insufficient macronutrient intake 4.91 times more likely to be underweight than those with adequate macronutrient intake. These findings underscore the crucial role of macronutrients in supporting optimal growth and development in early childhood.

The finding that macronutrient intake significantly influences the incidence of underweight in toddlers is highly relevant and can be scientifically justified through a basic understanding of child growth physiology. Macronutrients such as carbohydrates, protein, and fat are essential components the body needs to provide energy, build tissue, and support optimal metabolic function during growth. A deficiency in macronutrient intake will inhibit the process of cell and tissue formation, leading to impaired physical growth that can lead to underweight.[20]

Previous studies have also shown that prolonged energy and protein deficits in toddlers are strongly correlated with weight loss and impaired nutritional status. Inadequate macronutrient intake weakens a child's immune system, making them more susceptible to infection and reducing appetite, thus worsening the ongoing state of malnutrition.[21]

Macronutrients such as carbohydrates, protein, and fat are the primary sources of energy needed for the body's metabolic processes, tissue growth, and organ function. A deficiency in macronutrient intake will result in the body not receiving enough energy and building materials, directly impacting weight loss and stunted growth, which in turn leads to underweight.[22]

In addition, the concept of "Window of Opportunity" in child nutrition states that the initial period of the first 1000 days of life is a critical period where adequate macro intake determines long-term growth and development outcomes.[23] Inadequate macronutrient intake during this period can lead to growth retardation that is difficult to correct later in life, as well as increasing susceptibility to infectious diseases that worsen the child's nutritional status.[24]

Previous research also supports this finding, where it was found that macronutrient supplementation in toddlers in high-potential areas significantly reduced the prevalence of underweight and stunting.[25] In the Molino Community Health Center work area, 24-hour consumption survey data revealed that many toddlers receive food intake with excessive carbohydrate content but insufficient protein and fat, so that children's nutrition becomes unbalanced and they are vulnerable to energy and essential nutrient deficits.

Field research shows that the main obstacle is a family diet limited to inexpensive and readily available foods, such as rice and instant foods, without sufficient side dishes rich in protein or healthy fats. Mothers' limited knowledge of nutritional composition and the importance of dietary variety exacerbate this problem. Observations also noted low consumption of animal protein sources and vegetables containing

healthy fats, resulting in children's macronutrient intake not being optimally met.

This study assumes that increasing macronutrient intake is key to preventing and reducing underweight in toddlers, especially in areas with challenging socioeconomic conditions like the Molino Community Health Center. Therefore, effective nutrition interventions should focus on educating families about the importance of balanced macronutrient intake and encouraging adequate dietary diversification, along with support for the provision of affordable, nutritious food.

Micronutrient intake influences the incidence of underweight in toddlers at the Molino Community Health Center

The results of this study indicate that micronutrient intake significantly influences the incidence of underweight in toddlers, with toddlers with insufficient micronutrient intake having a 4.01 times greater risk of underweight compared to those with adequate micronutrient intake. This finding underscores the crucial role of micronutrients in maintaining health and supporting optimal child growth.

The results of this study, which show that low micronutrient intake significantly influences the incidence of underweight in toddlers, have a strong scientific basis and are supported by various studies on child nutrition. Micronutrients such as iron, zinc, vitamin A, and iodine play a vital role in metabolism, the immune system, and cell formation and repair.[26] Deficiencies in these substances can disrupt bodily functions, reduce appetite, increase the incidence of infections, and inhibit the absorption of other nutrients, which can impact a child's growth and weight gain.[21]

Previous research also shows that children who are deficient in micronutrients are more susceptible to growth retardation and health problems that can worsen their nutritional status.[27] In the long term, this condition affects not only weight but also brain development and the child's immune system. Therefore, the results of this study emphasize the importance of providing food that is not only adequate in quantity but also rich in micronutrients. Meeting micronutrient needs should be a key component of strategies to prevent underweight in early childhood.

Micronutrients, such as iron, vitamin A, zinc, iodine, and folic acid, are nutrients that are needed in small amounts but have vital functions in the metabolic process, blood formation, the immune system, and the maintenance of body tissues.[28] Micronutrient deficiencies can lead to anemia, immune disorders, and even growth and developmental delays. According to the WHO, micronutrient deficiencies are a global public health problem and a major factor in increasing child mortality and morbidity in developing countries.[7]

Micronutrients not only act as cofactors for enzymes and hormones, but also influence appetite, nutrient absorption, and immunological function.[29] Children deficient in micronutrients often experience recurrent infections, which then worsens their nutritional status through a mutually reinforcing cycle of malnutrition and disease. This suggests that inadequate micronutrient intake not only causes direct deficiencies but also contributes to other nutritional problems, including underweight.[30]

Previous relevant research supports this finding, showing that micronutrient deficiencies, such as iron and vitamin A, are significantly correlated with malnutrition in toddlers across Indonesia. This study confirms that micronutrient supplementation and dietary diversification are effective strategies in reducing the prevalence of underweight and stunting.

Based on observations and surveys in the Molino Community Health Center work area, children's food consumption patterns show poor nutritional habits, not due to limited food availability, but rather due to parental behavior. While vegetables and fruit are readily available, children's feeding tends to be irregular and dependent on inappropriate habits. Many children are only given snacks in the morning and only receive their main meal around 9 or 10 a.m., waiting for the vegetable vendor to arrive. This inconsistent meal schedule is often due to mothers' lack of awareness and willingness to properly manage their children's diets, rather than limited economic resources or food access.

This mining region, with its unique socioeconomic characteristics, also exhibits the phenomenon that family income does not automatically increase consumption of micronutrient foods. Consumption behaviors that

tend to prioritize fast food and pay little attention to micronutrient needs are factors that hinder improvements in children's nutritional status. This aligns with the research assumption that improving family nutrition literacy is essential to direct household income allocation more toward meeting children's micronutrient needs.

Inadequate micronutrient intake is a contributing factor to underweight among toddlers at the Molino Community Health Center. Therefore, the intervention program designed must not only provide micronutrient supplementation but also educate families about the importance of dietary diversification and ensure easy and affordable access to micronutrient-rich foods. Comprehensive education is expected to improve consumption patterns and sustainably enhance the nutritional status of toddlers.

Conclusion

The analysis model indicates that variations in nutritional status are well-managed. Family-based nutrition interventions, increased education for parents, and strengthening community economic empowerment programs through integrated promotive and preventive services at community health centers are recommended. Mining companies should also be involved in social responsibility initiatives to support community health and nutrition. Monitoring systems should be implemented to assess the effectiveness of interventions and make adjustments based on the results.

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