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Original Research

Protein Intake, Dietary Diversity, and Length-for-Age Nutritional Status Among Children Aged 6-23 Months: A Comprehensive Overview Study

Asupan Protein, Keanekaragaman Makanan, dan Status Gizi (Panjang Badan menurut Umur) pada Anak Usia 6-23 Bulan: Study Tinjauan Komprehensif

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Abstract: *Breastfeeding fulfills the nutritional needs of infants aged 0-6 months. However, after six months, the nutritional requirements increase, necessitating the introduction of complementary foods (CF) rich in diverse protein sources, including animal and plant proteins, to support child growth. This study aims to describe the intake of animal and plant proteins, dietary diversity, and nutritional status (length-for-age) among children aged 6-23 months in the Maros Baru Public Health Center area. A descriptive quantitative study with a cross-sectional design was conducted, involving 171 children aged 6-23 months selected using multistage simple random sampling. Nutrient intake was assessed through a 24-hour food recall questionnaire, and dietary diversity was evaluated using the Minimum Dietary Diversity for Children (MDDC) questionnaire. Results showed that 42.7% of children were stunted. The daily total protein intake of stunted children (15.80 g) was lower than that of non-stunted children (19.65 g). Daily animal protein intake was also lower in stunted children (11.10 g) compared to non-stunted children (17.15 g), while plant protein intake was higher in stunted children (2.30 g) than in non-stunted children (1.90 g). Dietary diversity levels were lower among stunted children than non-stunted children. In conclusion, daily total protein and animal protein intakes from CF among stunted children were lower, and their dietary diversity was less compared to non-stunted children. Nutrition programs are recommended to promote protein-rich, diverse, and appropriately portioned CF for stunted children to support their growth and development.*

Key word: complementary foods, dietary diversity, nutritional status, protein intake, stunting

1. INTRODUCTION

The first 1,000 days of life, or the period from conception to a child's second birthday, represents a critical window for optimal growth and development. During this time, rapid physical, psychomotor, mental, and social development occurs, necessitating balanced and adequate nutritional intake. Failure to meet nutritional needs during this period can lead to various nutritional problems, including growth retardation (1).

Anthropometric measurements are commonly used to assess the nutritional status of children. Height-for-age is a key indicator reflecting growth status. Normally, height increases with age, but when height-for-age falls below the standard, it indicates chronic malnutrition, which can lead to stunting (2). Stunting refers to impaired growth and development due to chronic malnutrition, resulting in a height significantly below that of peers. According to the World Health Organization (WHO), stunting is diagnosed when the height-for-age Z-score (HAZ) is less than -2 standard deviations (SD) (3).

Stunting can lead to irreversible brain development issues, learning difficulties, reduced motor skills, a higher risk of chronic diseases in adulthood, and diminished productivity, potentially perpetuating cycles of poverty (4).

Nutritional problems, particularly stunting, remain a global challenge, especially in developing countries (5). WHO estimated that in 2020, 22.2% (149.2 million) of children under five years of age were stunted (6). In Indonesia, the 2022 National Nutrition Status Survey (SSGI) reported a stunting prevalence of 21.6%. In South Sulawesi Province, the prevalence reached 27.2%, with Maros Regency reporting a prevalence of 30.1%. Despite a significant decrease from 37.5% in 2021, the prevalence remains very high, placing Maros among the top 10 regencies in South Sulawesi with the highest stunting rates (7).

To address stunting, specific nutritional interventions outlined in the National Action Plan for Stunting Reduction include supporting the provision of complementary feeding (CF) for children aged 6-24 months. CF consists of nutrient-rich and balanced foods provided alongside breastfeeding. Effective CF must include diverse food types to meet nutritional needs, particularly micronutrients. CF should be introduced at the appropriate time (at six months of age), provided in adequate quantity, frequency, consistency, and variety, and contain sufficient protein suitable for the child's age (8).

Protein intake is crucial during the first 1,000 days of life to support cognitive function and optimal nutritional status (9). Protein-rich foods are divided into animal-based proteins (e.g., fish, eggs, milk, poultry, red meat, seafood) and plant-based proteins (e.g., tofu, tempeh, legumes). The quality of protein is determined by its amino acid composition, with animal-based proteins generally offering more complete and bioavailable amino acids. These amino acids are essential for synthesizing hormones like thyroid hormones, which regulate growth and metabolism (10). According to Indonesia's Ministry of Health (2019), the recommended protein intake for children is 9 g/day for ages 0-5 months, 15 g/day for ages 6-11 months, 20 g/day for ages 1-3 years, and 25 g/day for ages 4-6 years (11).

In addition to protein, dietary diversity is vital for meeting all nutritional requirements. No single food can provide all the nutrients needed to support growth and health. Diverse diets, consisting of staple foods, animal protein, vegetables, and fruits, are crucial for achieving balanced nutrition and optimal growth (12). Research indicates that greater dietary diversity is associated with better nutritional status (13). Ensuring balanced nutrition through diverse food intake is an important strategy for achieving optimal growth and nutrition outcomes (14).

This background provides the foundation for exploring the intake of animal and plant-based proteins, dietary diversity, and nutritional status (height-for-age) among children aged 6-23 months in the Maros Baru Public Health Center, Maros Regency, in 2024.

2. METHODS

This study utilized an observational analytic design with a cross-sectional approach to examine the intake of animal and plant-based protein, dietary diversity, and their association with stunting among children aged 6–23 months. The research was conducted in the service area of the Maros Baru Public Health Center, Maros Regency, from April to May 2024.

The study population consisted of 1,027 children aged 6–23 months. A total sample of 171 children was selected using a multistage simple random sampling technique. Instruments included a 24-hour food recall questionnaire to assess nutrient intake, the Minimum Dietary Diversity for Children (MDDC) questionnaire to evaluate dietary diversity, a food model booklet, and a length board.

Primary data were collected through anthropometric measurements to determine nutritional status (length-for-age), assessment of protein intake, and evaluation of dietary diversity using standardized questionnaires. Secondary data regarding the number of children aged under two years in each village and integrated health post (posyandu) were obtained from the nutrition division of the Maros Baru Public Health Center.

Data were processed and analyzed using statistical software to generate descriptive statistics such as frequencies and percentages. This study adheres to ethical research principles and received approval from the Ethics Committee of the Faculty of Public Health, Hasanuddin University (Approval Number: 1209/UN4.14.1/TP.01.02/2024).

3. RESULTS

In this study, most mothers of toddlers (baduta) are aged 20-35 years (86.5%) and have completed high school (45.6%). The majority are housewives (95.9%) and live in households with income below the minimum wage of Kabupaten Maros (81.3%).

Regarding the toddlers, most are aged 12-23 months (69.6%), with a nearly equal gender distribution (50.9% male, 49.1% female). Most were born with normal birth weight (88.9%). Based on z-scores, 16.4% have a z-score < -3 SD, 26.3% between -3 SD and < -2 SD, and 57.3% between -2 SD and +3 SD. In terms of nutritional status, 42.7% of the toddlers are stunted, while 57.3% are not.

Table 1. Distribution of Sample Age Groups Based on Nutritional Status

Age Group	Stunting		Non-Stunting		Total	
	n	%	n	%	n	%
6–8 months	7	36.8	12	63.2	19	100%
9–11 months	11	33.3	22	66.7	33	100%
12–23 months	55	42.7	64	57.3	119	100%
Total	**73**	**42.7**	**98**	**57.3**	**171**	**100%**

Table 1 show that in the age group of 6–8 months, there were 7 children identified as stunted and 12 children classified as non-stunted. In the 9–11 months age group, 11 children were stunted, while 22 were non-stunted. Meanwhile, in the age group of 12–23 months, 55 children were identified as stunted, and 64 children were classified as non-stunted. This distribution highlights the prevalence of stunting across different age groups, with the highest percentage of stunted children observed in the 12–23 months age group.

Table 2. Protein Intake from Complementary Feeding (MPASI) by Age Group and Breastfeeding Status

Age Group and Breastfeeding Status	Protein Intake (g)/Day			
	Mean	SD	Min	Max
Children who are breastfed:				
6-8 months	9.1	2.33	6.00	12.34
9-11 months	12.34	3.25	6.00	18.58
12-23 months	18.58	3.33	9.10	19.40
Children who are not breastfed:				
6-8 months	13.58	2.92	11.30	16.71
9-11 months	16.71	5.00	8.30	18.97
12-23 months	18.97	3.06	15.59	26.60

Table 2 shows that protein intake from complementary feeding (MPASI) increases with age. For breastfed toddlers, average daily protein intake is 9.1 g at 6-8 months, 12.34 g at 9-11 months, and 18.58 g at 12-23 months, all meeting recommended intake levels. Non-breastfed toddlers have higher protein intake: 13.58 g at 6-8 months, 16.71 g at 9-11 months, and 18.97 g at 12-23 months, also meeting the required intake levels.

Table 3. Adequacy of Protein Intake from Complementary Feeding (MPASI) Based on Nutritional Status (PB/U) in Children Aged 6-23 Months

Nutritional Status (Length/Age)	Protein Intake Category				
	Deficit Severe	Deficit Moderate	Deficit Mild	Normal	Excess
Stunting	8 (100%)	26 (100%)	39 (100%)	0	0
Not Stunting	0	0	0	76 (100%)	22 (100%)
Total	8	26	39	76	22

Table 3 shows that all toddlers whose daily protein intake falls under the categories of severe, moderate, or mild deficit are those with stunting, amounting to 73 stunted toddlers (100%). On the other hand, toddlers whose protein intake is categorized as normal or excessive are those without stunting, totaling 98 toddlers (100%).

Table 4. Protein Intake from Complementary Feeding (MPASI) Based on Nutritional Status and Protein Type

Nutritional Status and Protein Type	Total Protein Intake (g)/day	Animal Protein (g)/day	Plant Protein (g)/day
Stunting	Median: 15.80	Median: 11.10	Median: 2.30
	Min: 6.00	Min: 0.00	Min: 0.00
	Max: 17.90	Max: 16.70	Max: 16.30
Not Stunting	Median: 19.65	Median: 17.15	Median: 1.90
	Min: 7.00	Min: 0.00	Min: 0.00
	Max: 26.60	Max: 25.40	Max: 12.00

The data for total protein intake, animal protein, and plant protein are not normally distributed, so the median was used as a measure of central tendency. Table 4 shows that the median total protein intake from MPASI for stunted toddlers (15.80 g) is lower compared to non-stunted toddlers (19.65 g). The median intake of animal protein for stunted toddlers (11.10 g) is also lower than that for non-stunted toddlers (17.15 g). However, the median intake of plant protein for stunted toddlers (2.30 g) is higher than that for non-stunted toddlers (1.90 g). The higher median intake of total protein and animal protein in non-stunted toddlers is likely due to the fact that a larger portion of non-stunted toddlers consume animal protein-rich foods in greater quantities compared to those with stunting.

Table 5. Dietary Diversity Variables Based on Nutritional Status of Children Aged 6-23 Months

Dietary Diversity	Stunting (%)	Non-Stunting (%)
Carbohydrate Sources and Tubers		
No Consumption	33 (56.9%)	25 (43.1%)
Consumption	40 (35.4%)	73 (64.6%)
Legumes, Seeds, and Processed Products		
No Consumption	3 (100%)	0 (0%)
Consumption	70 (41.7%)	98 (58.3%)
Milk and Dairy Products		
No Consumption	48 (38.7%)	40 (42.6%)
Consumption	25 (53.2%)	33 (42.9%)
Meat and Fish		
No Consumption	28 (47.5%)	31 (52.5%)
Consumption	45 (40.2%)	67 (59.8%)
Eggs		
No Consumption	48 (57.1%)	36 (42.9%)
Consumption	25 (28.7%)	62 (71.3%)
Fruits and Other Vegetables		
No Consumption	41 (45.1%)	50 (54.9%)
Consumption	32 (40.0%)	48 (60.0%)
Vitamin A-Rich Fruits and Vegetables		
No Consumption	32 (50.8%)	31 (49.2%)
Consumption	41 (38.0%)	67 (62.0%)
Total		
No Consumption	31 (52.5%)	67 (59.8%)
Consumption	36 (42.9%)	62 (71.3%)

This table represents the distribution of dietary diversity variables, comparing stunted and non-stunted children. It shows how the consumption of various food groups like carbohydrate sources, legumes, dairy, meat, eggs, fruits, and vitamin A-rich vegetables varies between these groups. Based on Table 5, it is observed that toddlers who consume a less diverse diet are more prevalent in the stunting group (56.9%) compared to the non-stunting group (43.1%). Conversely, toddlers with a more diverse diet are more common in the non-stunting group (64.6%) than in the stunting group (35.4%).

Regarding the type of food, most stunted toddlers tend to consume carbohydrate sources, animal protein foods, and fruits and vegetables containing vitamin A, as well as other vegetables and fruits, in smaller quantities compared to non-stunted toddlers. However, plant-based protein sources, such as legumes and seeds, are consumed more frequently by stunted toddlers compared to non-stunted toddlers.

4. DISCUSSION

Protein Intake

Protein intake from complementary feeding (CF) is observed to increase with the age of toddlers. This is influenced by the texture of CF, where coarser textures are associated with higher chances of nutrient intake. This finding aligns with research by Hasanah (2020) in Tajinan Village, Malang Regency, which revealed that mothers providing CF with inappropriate consistency had toddlers with good nutritional status (20.4%) and undernutrition status (18.5%). In contrast, mothers offering CF with proper consistency tended to have toddlers with good nutritional status (15).

CF texture is a critical factor in its administration. It must be introduced gradually and adjusted to the child's age. According to the Ministry of Health (2020), CF should be thick enough to remain on a spoon without spilling, even when fully loaded. If the porridge is too thin, such that it can be put into a bottle or drunk from a cup, it is inadequate in energy and other nutrients. Therefore, the consistency of CF determines whether the child's nutritional needs are met. Thick CF provides more nutrients than thin porridge (16).

Daily protein intake from CF in toddlers, whether they are still breastfed or not, is generally sufficient, as it exceeds 90% of the total protein requirement. This is consistent with research by Surya et al. (2023), which states that energy and protein intake is considered good if it meets 90–120% of the total requirement based on RDA (17). However, daily protein intake from CF in stunted toddlers falls into the deficient category, while in non-stunted toddlers, it ranges from normal to surplus. Research by Agus Kundarwati et al. (2022) in North Raman Health Center, East Lampung Regency, revealed a relationship between protein intake and stunting incidence. Children with protein deficiencies are 4.5 times more likely to experience stunting (18).

Protein is a macronutrient that functions as a receptor influencing DNA activities controlling growth processes. Adequate quality and quantity of protein intake can increase Insulin Growth Factor 1 (IGF-1) levels, a mediator of growth hormone essential for bone matrix formation. Protein deficiency can impair bone mineral mass by reducing IGF-1 production, affecting bone growth by inhibiting the proliferation and differentiation of chondrocytes in the growth plate and osteoblast activity. Prolonged protein deficiency can disrupt linear growth, leading to stunting (19).

Low protein levels also impair calcium and phosphorus absorption in the intestines, processes influenced by IGF-1. Bone growth depends heavily on optimal calcium and phosphorus absorption, which is mediated by IGF-1 (19,20). Low protein intake in toddlers may result from limited provision of protein-rich foods in CF or frequent snacking before meals, making the child feel full and reluctant to eat CF.

Regarding nutritional status, total protein intake from CF in stunted toddlers is lower than in non-stunted toddlers. Protein intake from animal sources is also lower in stunted toddlers, while plant-based protein intake is higher than in non-stunted toddlers. This suggests that stunting is likely caused by insufficient animal protein intake. Research by Afiah et al. (2020) in the Juanda Public Health Center, Samarinda City, supports this finding, showing that children who do not consume animal protein are nine times more likely to experience stunting compared to those who do (21).

Animal protein is superior to plant-based protein due to its complete amino acid profile, including aromatic amino acids such as phenylalanine, tyrosine, and tryptophan. These amino acids have been shown in previous studies to increase IGF-1 serum levels more significantly than non-aromatic amino acids in plant-based protein. Furthermore, animal protein contains micronutrients like iron, zinc, selenium, calcium, and vitamin B12, which are essential for growth and have a more substantial impact on stunting prevention compared to plant-based protein (22).

The high intake of animal protein in some regions is attributed to the widespread availability of fish, making it easily accessible. Conversely, plant-based protein consumption tends to be low due to the long distances from homes to markets, discouraging families from purchasing plant-based protein sources such as legumes, tofu, and tempeh. Food availability is closely linked to physical access to food facilities, such as markets. The distance to markets influences food accessibility and daily dietary intake (23).

However, it is important to note some limitations in this study. The dietary intake data were collected using a 24-hour recall method, which is prone to recall bias and potential underreporting by caregivers. Some participants may forget or inaccurately estimate the amount and type of food consumed. Furthermore, this study did not control for potential confounding factors such as recent infection or inflammation, which can influence appetite, nutrient absorption, and growth outcomes. These limitations should be considered when interpreting the association between protein intake and stunting.

Dietary Diversity

The dietary diversity among stunted toddlers is observed to be lower compared to non-stunted toddlers. Additionally, stunted toddlers tend to consume fewer food types, including carbohydrate sources, animal protein sources, vegetables and fruits rich in vitamin A, and other vegetables and fruits. This indicates that the occurrence of stunting in toddlers may be linked to a lack of variety in their diets. This finding aligns with the study by Ardianti & Sumarmi (2023), which showed a significant relationship between dietary diversity and the risk of stunting in toddlers. An odds ratio (OR) of 17.744 indicated that low dietary diversity increases the likelihood of stunting 17.744 times compared to adequate dietary diversity (14).

One factor contributing to stunting is inadequate dietary intake. According to balanced nutrition guidelines, consuming various types of food is essential to meet nutritional needs. Limited dietary diversity can adversely affect the quality of nutrients consumed by toddlers, leading to insufficient daily nutrient fulfillment. This nutrient deficiency hinders growth and can trigger undernutrition, further increasing the likelihood of stunting (24).

Interestingly, the study also found stunted toddlers with diverse dietary scores. This may be due to insufficient food quantity or small portions provided to the children. Similar findings were reported in a previous study, which noted that 14.7% of children with diverse dietary scores had abnormal nutritional status. Even if dietary diversity is high, if it is not accompanied by adequate portions, nutritional problems can arise (25).

Conversely, this study also found toddlers with low dietary diversity scores but normal nutritional status. This could be attributed to the type and portion of food consumed. Previous studies have highlighted the relationship between food type and stunting incidence. In this research, children with normal nutritional status were found to consume more animal-based products than stunted children. Additionally, toddlers with normal nutritional status consumed sufficient portions of staple starches, protein sources, and other food groups, meeting their daily nutritional requirements. This aligns with the findings of other researchers who suggest that toddlers consuming less diverse but appropriately portioned meals can achieve normal nutritional status (25). Proper portion sizes are critical and should be adjusted to the child's age and capacity for food intake. Overfeeding can lead to satiety, causing toddlers to refuse breast milk, potentially resulting in micronutrient deficiencies and imbalances in body weight. Overfeeding may also disrupt digestion, while underfeeding can lead to malnutrition (26).

This study also did not assess food security or household income, which could be significant contributors to dietary diversity and nutritional outcomes. Additionally, seasonal variations in food availability were not accounted for, which may affect dietary patterns. These factors should be considered when generalizing the findings.

Nutritional Status

Anthropometric assessment is the most commonly used method for evaluating the nutritional status of toddlers. Generally, anthropometry involves various measurements of body dimensions and compositions across different age and nutritional status levels. Some frequently used anthropometric indices include weight-for-age (W/A), height-for-age (H/A), and weight-for-height (W/H), expressed in standard deviation units or Z-scores (27). Based on anthropometric measurements of toddlers' nutritional status using height-for-age indices, it was found that 16.4% of toddlers were categorized as severely stunted, 26.3% as stunted, and 57.3% as normal. This data indicates that 42.7% of toddlers are classified as stunted, while 57.3% are non-stunted.

Toddlers are among the age groups most vulnerable to nutritional problems, one of which is stunting, characterized by impaired linear growth. Nutritional status in children can be assessed using anthropometric measurements. The height-for-age (H/A) index provides insight into the child's linear growth relative to their age. This index can identify children who are stunted or severely stunted. A child is classified as stunted if their Z-score for height-for-age falls between -3 SD and <-2 SD, and as severely stunted if their Z-score is below -3 SD. Children with a Z-score between -2 SD and +3 SD are categorized as normal height, while those above +3 SD are considered tall (28).

Anthropometric measurements also reveal that stunting in toddlers may result from inadequate nutrient intake, particularly protein. Nutritional needs can be met by consuming a diverse range of foods, which complement the nutrient profiles of other food types, ensuring a balanced nutrient intake. Dietary diversity is determined by the variety of food items or food groups consumed. It reflects an increased consumption of various food groups that can fulfill nutrient requirements for optimal health (29). During the rapid growth phase of toddlers, their nutrient needs increase due to heightened growth and activity levels. No single food can provide all the necessary nutrients to support growth and maintain health. Therefore, consuming a diverse range of foods is essential to meet all the nutritional components required by the body (13).

CONCLUSION

The prevalence of stunting among toddlers in the working area of Maros Baru Health Center, Maros Regency, is 42.7%. Stunted toddlers tend to have lower total protein and animal protein intake from complementary feeding (CF) and lower dietary diversity compared to non-stunted toddlers. Limited intake of key food groups, including animal-based sources, vegetables, and fruits, contributes to inadequate nutrient fulfillment. Improving the nutritional status of toddlers requires targeted interventions that ensure access to protein-rich and diverse complementary foods. Nutrition education for caregivers should emphasize appropriate CF texture, portion size, and the inclusion of animal-based foods, particularly during the critical growth period of 6–23 months. Policy efforts may include local initiatives such as fish-based CF subsidies, integration of food diversity education into community health services, and regular growth monitoring with tailored counseling. These strategies aim to support optimal growth and reduce stunting prevalence effectively.

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