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Analysis of Dietary Patterns and Food Security in Relation to Children's Nutritional Status in Central Sulawesi, 2021–2023

Analisis Hubungan Pola Konsumsi Pangan Dan Ketahanan Pangan Provinsi Terhadap Status Gizi Anak Di Sulawesi Tengah, 2021-2023

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Abstract: *A diverse and nutritious diet is essential to support nutritional status. Nutritional issues such as stunting and wasting in Central Sulawesi are influenced by dietary patterns, food security, and vulnerability. The Desirable Dietary Pattern (DDP) Score is used to evaluate the quality of dietary intake and its impact on nutritional status. This study aimed to analyze changes in DDP scores, food security and vulnerability indices, and their relationship with the nutritional status of children in Central Sulawesi from 2021 to 2023. This ecological study utilized secondary data from districts in Central Sulawesi, analyzed descriptively and through linear regression to assess variable relationships. The average DDP score remained stable, ranging from 77.2% to 80.6%. Both energy and protein adequacy levels improved in most areas, but wasting prevalence increased from 8.9% in 2021 to 13.0% in 2023. Regression analysis indicated that better dietary patterns and food utilization significantly reduced stunting ($p < 0.05$), while life expectancy had a significant effect in reducing wasting ($p = 0.014$). Research in Central Sulawesi (2021–2023) reveals a reduction in stunting from 28.9% to 27.0% but a rise in wasting from 8.9% to 13.0%. Key factors include access to clean water and effective food utilization, which lower stunting risk, while life expectancy reduces wasting. The Desirable Dietary Pattern (DDP) Score negatively correlates with stunting. Interventions should prioritize clean water access, food utilization, nutrition education, and public health programs to enhance life expectancy and reduce malnutrition.*

Keyword: *Central Sulawesi, dietary patterns, food security, stunting, wasting.*

1. INTRODUCTION

Nutritional issues such as stunting and wasting remain pressing public health challenges in Indonesia. Nationally, the prevalence of stunting decreased from 24.4% in 2021 to 21.6% in 2022 according to the Indonesian Nutritional Status Survey (SSGI), and showed a slight decline to 21.5% in 2023 based on the Nutritional Quality Survey (SKI). However, the prevalence of wasting demonstrates an increasing trend—from 7.1% in 2021 to 7.7% in 2022 (SSGI), and further rising to 8.5% in 2023 (SKI). In Central Sulawesi, these conditions are even more critical. Stunting in the province stood at 29.7% in 2021, decreased slightly to 28.2% in 2022 (SSGI), and reached 27.2% in 2023 (SKI), still well above the national average. Wasting, meanwhile, has shown a concerning upward trend from 9.4% (2021) to 11.3% (2022), and climbed to 12.9% in 2023 [1–3]. These figures indicate that Central Sulawesi continues to face serious nutrition-related challenges that require

integrated and region-specific interventions to improve child health and development outcomes.

A diverse, nutritious, balanced, and safe diet is crucial for maintaining good nutritional status. According to the Indonesian Ministry of Health Regulation No. 41 of 2014 on Balanced Nutrition Guidelines, dietary habits significantly influence nutritional status [4]. These habits are shaped by the quantity and quality of food consumed to enhance health. Proper dietary practices help meet nutritional needs, maintain health, and reduce the risk of chronic non-communicable diseases (NCDs) [5]. In this context, Eastern Indonesia, including Central Sulawesi, is particularly noteworthy due to its diverse socioeconomic conditions, which affect dietary patterns and nutritional status [6]. Factors such as income levels, education, access to food, and knowledge of nutrition play critical roles in determining food consumption quality and public health [6,7].

According to the 2022 Regulation of the National Food Agency of the Republic of Indonesia, food security is defined as a condition in which food needs—from the national level down to the individual level—are adequately met through sufficient food availability. This availability must not only fulfill quantity and quality requirements but also ensure that food is safe, diverse, nutritious, equitably distributed, and accessible to all segments of society. Furthermore, food provision must respect and align with existing religious values, beliefs, and cultural practices. [8]

Central Sulawesi Province was selected as the study site due to its complex challenges in food security and nutritional status, which are relatively more significant compared to other regions in Indonesia. Although the province is endowed with abundant natural resources, such as fertile land, a tropical climate favorable for agriculture, and rich marine products, it continues to face major socio-economic challenges and persistent issues in food availability and access [9]. Data show that over 3.1 million people in the province require guaranteed food provision [10]. In addition, Central Sulawesi experiences geographic vulnerabilities and uneven infrastructure development, which further hinder equitable food access. Within the framework of national policy, the province represents a priority area where the implementation of the Regional Action Plan for Food and Nutrition (RAD-PG) must be strengthened to support the achievement of national development targets (RPJMN) and the Sustainable Development Goals (SDGs), particularly in the pillars of food security and the improvement of nutritional status.

One of the key indicators used to assess the quality of dietary intake is The Desirable Dietary Pattern (DDP) Score. DDP score evaluates how well a population's diet aligns with balanced nutrition recommendations, reflecting the quality and diversity of food intake and its correlation with nutritional and health status [11]. As such, DDP is a vital tool in evaluating the success of nutrition interventions and food policy implementation. The government's 2023 target of achieving a DDP score of 94.1 underscores its commitment to improving food availability and security in

Indonesia. Nutritional issues in the country often stem from insufficient dietary intake. For pregnant women, inadequate energy, protein, and micronutrient intake can lead to chronic energy deficiency (CED) and anemia [12]. Similarly, children face various nutritional issues caused by both undernutrition and overnutrition, including stunting, wasting, underweight, and overweight (obesity). This study aims to analyze dietary patterns and food security and their relationship with the nutritional status of children in Central Sulawesi from 2021 to 2023. It further examines trends in food consumption, food security conditions, and child nutritional indicators during this period. The study seeks to understand how dietary patterns and food security interact and influence children's nutritional status, in order to provide comprehensive insights into the key factors affecting health and nutrition outcomes in the region.

2. METHODS

This study employs an ecological design based on policy data regarding food consumption patterns, food security and vulnerability, and children's nutritional status in Central Sulawesi. The population includes all districts and municipalities in the province. Data used in the study comprise various indicators of nutritional development, health, and community welfare collected from all administrative regions in Central Sulawesi during 2021, 2022, and 2023. Data were sourced from official databases containing indicators of nutrition, health, and welfare at the district and municipal levels. These indicators include The Desirable Dietary Pattern (DDP) Score, Food Security and Vulnerability Assessment (FSPA), and Food Security Index (IKP) from National Food Agency, and child nutritional status form Indonesian Nutritional Status Survey (SSGI) 2021-2022 and Indonesian Health Survey (SKI) 2023. The IKP is categorized into six levels: 1) highly vulnerable, 2) vulnerable, 3) moderately vulnerable, 4) moderately secure, 5) secure, and 6) highly secure. Data collection relied on database systems covering all administrative regions, including regional health reports, nutrition and health surveys, and other relevant secondary sources. Data analysis was performed using univariate, bivariate, and multivariate methods. Univariate analysis involved descriptive statistics and variance analysis (ANOVA) to present data for each year individually and summarize trends over the 2021–2023 period. The analysis included a descriptive analysis to describe the distribution of consumption patterns and food security in the region, as well as a multiple linear regression multivariate test to explore the relationship between independent variables and children's nutritional status. Trend analysis identified yearly patterns in the variables, while correlation and regression analyses explored the relationships between variables either for individual years or across the three-year period to detect changes in the strength or direction of these relationships over time.

3. RESULTS

In this subchapter of results and discussion, the main findings related to food consumption patterns and provincial food security and their influence on the nutritional status of children in Central Sulawesi during the 2021-2023 period will be presented.

Table 1. Protein-energy adequacy and The Desirable Dietary Pattern (DDP) Score of Central Sulawesi Province

No	Regency / City	Energy Adequacy Rate (%)			Protein Adequacy Rate (%)			Desirable Dietary Pattern (DDP) Score		
		2021	2022	2023	2021	2022	2023	2021	2022	2023
1	Banggai kepulauan	93,3	96,6	95,3	92,8	94,0	102,5	73,3	74,8	77,5
2	Banggai	91,2	98,0	99,7	1001,1	103,2	106,4	77,9	83,8	82,8
3	Morowali	102,5	97,2	107,4	113,1	107,3	120,4	80,8	80,3	86,8
4	Poso	105,0	101,6	105,8	105,3	104,7	110,0	82,0	83,5	87,5
5	Donggala	96,1	102,3	122,9	95,0	107,9	130,7	71,3	76,0	84,9
6	Toli-toli	84,9	84,9	82,6	87,3	94,6	88,3	65,9	72,6	68,9
7	Buol	87,3	80,3	85,4	82,9	79,2	85,2	75,7	73,4	73,5
8	Parigi Moutong	93,2	94,5	88,5	96,2	102,7	92,0	77,8	84,0	79,8
9	Tojo Una-una	88,1	88,2	89,3	85,0	90,6	90,4	72,0	76,4	76,4
10	Sigi	100,0	102,2	98,5	105,7	105,7	101,9	78,6	79,0	80,1
11	Banggai Laut	99,1	110,5	101,8	99,7	115,8	103,5	70,0	78,6	74,7
12	North Morowali	113,4	103,1	103,2	121,1	116,1	106,4	93,2	92,1	84,4
13	Palu City	97,2	88,6	96,3	106,0	103,1	107,0	79,2	80,3	82,0
Central Sulawesi Province (Average ± SD)		**95,6 ± 7,915**	**95,3 ± 8,483**	**97,9 ± 10,744**	**99,1 ± 11,101**	**102,0 ± 10,185**	**103,6 ± 12,813**	**77,2 ± 6,80**	**80,6 ± 5,358**	**81,2 ± 5,556**

Based on Table 1, the average Energy Adequacy Rate (EAR) in Central Sulawesi Province showed fluctuations over the three-year period. The Energy Adequacy Rate was 95.6% in 2021, slightly decreased to 95.3% in 2022, and increased again to 97.9% in 2023. The highest Energy Adequacy Rate in 2023 was recorded in North Morowali Regency at 113.2%, while the lowest was observed in Tojo Una-Una at 89.5%. Similarly, the Protein Adequacy Rate (PAR) demonstrated a consistent increase, from 99.1% in 2021, to 102.0% in 2022, and further to 103.6% in 2023. The highest Protein Adequacy Rate in 2023 was also found in North Morowali at 121.1%, whereas the lowest Protein Adequacy Rate was in Banggai Laut, with a value of 95.3%. The Desirable Dietary Pattern (DDP) Score, reflecting diet quality based on food group diversity and balance, showed a relatively stable upward trend, from 77.2 in 2021, rising to 80.6 in 2022, and slightly increasing to 81.2 in 2023. The highest DDP in 2023 was again recorded in North Morowali at 84.4, while Tojo Una-Una had the lowest DDP at 76.4. Both energy and protein adequacy levels have improved across Central Sulawesi over the three-year period, with North Morowali consistently outperforming other regions. However, variations in food pattern quality still persist, indicating the need for localized nutrition interventions to ensure balanced food consumption across all regencies.

Table 2. Food Security Vulnerable Atlas of Central Sulawesi Province

No	FSVA Indicator	2021		2022		2023	
		Average	SD	Average	SD	Average	SD
1	Normative consumption ratio per capita to net production of rice, corn, sweet potato, and cassava, as well as local government rice stocks (NCPR)	4,8	1,850	4,5	1,883	4,4	1,782
2	Percentage of the population living below the poverty line (POV)	4,8	0,689	4,8	0,689	4,9	0,641
3	Percentage of households with a proportion of expenditure on food >65 percent of total expenditure (FOOD)	5,8	0,439	6,0	0,000	5,8	0,439
4	Percentage of households without access to electricity (ELEC)	5,9	0,277	6,0	0,000	6,0	0,000
5	Percentage of households without access to clean water (WATER)	5,6	0,768	5,7	0,630	5,5	0,776
6	Life expectancy at birth (LIFE)	4,8	0,801	4,9	0,862	4,9	0,862
7	The ratio of population per health worker to population density (HEALTH)	5,5	0,660	5,5	0,660	6,0	0,000
8	The average length of schooling for girls over 15 years old (SCHOOL)	5,1	0,760	4,8	0,927	5,1	0,760

Based on the table "Food Security Vulnerable Atlas of Central Sulawesi Province" 2021-2023, several indicators of food security and welfare show a positive trend. The normative food consumption ratio (NCPR) decreased from 4.8 (2021) to 4.4 (2023). The percentage of people below the poverty line (POV) and households that spend more than 65% of their spending on food (FOOD) also fell, from 4.8% and 5.8% in 2021 to 4.0% and 5.1% in 2023, respectively. Access to electricity (ELEC) and clean water (WATER) remained stable, while life expectancy (LIFE) increased from 5.7 to 6.0. The average length of schooling for girls (SCHOOL) also increased from 5.1 to 5.6 years. Overall, there has been an improvement in people's welfare, especially in the areas of poverty, health, and education.

Table 3. North Sulawesi Province Food Security Index

No	Regency / City	Food Availability (%)			Food Affordability (%)			Food Utilization (%)		
		2021	2022	2023	2021	2022	2023	2021	2022	2023
1	Banggai kepulauan	34,07	28	5,41	74,73	78,58	76,14	73,13	72,25	72,85
2	Banggai	95,26	95,02	93,92	75,14	89,54	90,69	75,14	75,89	75,83
3	Morowali	89,74	89,63	85,73	76,45	82,34	83,94	76,45	74,79	78,65
4	Poso	95,36	94,92	92,82	78,74	79,64	79,87	78,74	76,07	79,4
5	Donggala	88,47	85,95	84,3	62,78	75,98	73,83	62,78	66,8	62,07
6	Toli-toli	91,65	89,98	88,2	69,89	81,52	82,93	69,89	67,96	69,59
7	Buol	94,06	92,07	91,27	73,7	81,65	80,69	73,7	76,67	78,81
8	Parigi Moutong	95,47	96,66	95,71	61,31	77,62	77,86	61,31	61,37	63,8
9	Tojo Una-una	90,58	79,22	83,26	74,38	73,9	75,41	74,38	72,15	73,32
10	Sigi	94,25	93,46	91,45	59,67	81,86	81,75	59,67	63,36	64,77

No	Regency / City	Food Availability (%)			Food Affordability (%)			Food Utilization (%)		
		2021	2022	2023	2021	2022	2023	2021	2022	2023
11	Banggai Laut	0	0	0	70,26	76,1	75,04	70,26	68,81	70,66
12	North Morowali	92	90,8	89,19	72,74	79,44	83,11	72,74	71,08	77,07
13	Palu City	0	0	0	87,17	86,9	90,27	75,81	74,25	71,69
Central Sulawesi Province (Average ± SD)		87,35 ± **17,836**	85,06 ± **19,543**	81,93 ± **25,689**	72,07 ± **7,530**	80,39 ± **4,352**	80,88 ± **5,401**	71,08 ± **6,108**	70,88 ± **4,934**	72,19 ± **5,870**

Based on the table "North Sulawesi Province Food Security Index" 2021-2023, there are variations in three indicators: food availability, food affordability, and food utilization. Parigi Moutong Regency recorded the highest value in food availability above 95%, Banggai Islands Regency showed the lowest value, especially in food availability which decreased from 34.07% (2021) to 28.25% (2023) and food utilization decreased from 35.22% (2021) to 27.85% (2023). The provincial average is in the range of 87-89% for availability, 74-77% for affordability, and 71-74% for food utilization.

Table 4. Nutritional status of stunting and wasting in Central Sulawesi Province

No	City Regency	Stunting			Wasting		
		2021	2022	2023	2021	2022	2023
1	Banggai kepulauan	30,6	32,6	27,7	10,3	8,3	11,5
2	Banggai	26,0	24,3	29,1	6,9	10,4	9,7
3	Morowali	28,9	23,3	26,0	11,0	7,6	9,5
4	Poso	26,7	24,6	26,5	6,6	6,8	10,0
5	Donggala	29,5	32,4	34,1	8,5	12,6	13,6
6	Toli-toli	29,3	30,7	29,0	8,9	13,5	22,9
7	Buol	28,6	32,7	30,0	10,1	8,8	15,1
8	Parigi Moutong	31,7	27,4	28,5	9,8	12,3	12,7
9	Tojo Una-una	29,4	31,3	21,3	8,6	13,3	18,6
10	Sigi	40,7	36,8	26,4	11,1	15,6	12,2
11	Banggai Laut	26,0	20,0	25,6	6,9	9,8	11,9
12	North Morowali	24,6	24,7	24,7	9,0	8,7	10,7
13	Palu City	23,9	24,7	22,1	7,4	12,8	10,9
Central Sulawesi Province (Average ± SD)		**28,9 ± 4,242**	**28,1 ± 4,929**	**27,0 ± 3,366**	**8,9 ±1,561**	**10,8 ± 2,710**	**13,0 ± 3,857**

The table "Nutritional Status of Stunting and Wasting in Central Sulawesi Province" shows that the highest stunting in 2023 is in Banggai Islands (32.6%), while the lowest is in Palu City (24.7%). The average stunting in this province is stable, decreasing slightly from 28.9% (2021) to 28.7% (2023). Meanwhile, the highest wasting was also in Banggai Islands (11.5% in 2023), with the provincial average rising from 8.9% (2021) to 13.0% (2023), indicating an increase in the prevalence of wasting. Table 5 shows the results of multiple linear regression with stunting incidence as a dependent variable in Central Sulawesi. The results of the analysis found that energy and protein adequacy figures had no significant effect on stunting (p-value 0.491 and 0.638), while the expected food pattern score (DDP) had a

negative influence close to significant (p-value 0.073), which showed that a better food pattern could reduce the risk of stunting.

From the aspect of food safety, the percentage of households without access to clean water has a significant positive relationship with stunting (B = 0.087, p-value = 0.025), indicating that the risk of stunting increases along with the increase in households without access to clean water. On the other hand, food utilization had a significant negative influence on stunting (B = -0.256, p-value = 0.044), while food availability showed a positive influence close to significant (B = 0.032, p-value = 0.054). The regression model with the Food Security Index showed significant results (p-value test F = 0.002) and could explain 33.8% of the variation in stunting incidence. Table 6 presents the results of multiple linear regression with the event of wasting as a dependent variable in Central Sulawesi. The analysis showed that variables in the Hope Food Pattern category had no significant effect on wasting, with all p-values above 0.05. In contrast, the variable life expectancy (LIFE) had a significant negative influence (B = -1,025, p-value = 0.014), which means that an increase in life expectancy may reduce the risk of wasting. In the Food Security Index category, Food Utilization showed a significant negative influence (B = -0.275, p-value = 0.014), while Food Affordability also had a significant effect (B = 0.179, p-value = 0.042). This regression model explains 18.5% variability of wasting events with R^2 value, and the F test is close to significance (p-value = 0.064), indicating that factors such as life expectancy, affordability, and food utilization are significant in reducing the risk of wasting, while other variables are not significant.

Table 5. Results of linear regression analysis of dependent variables on stunting incidence

Variable	Unstandardized Coefficients		t	p-Value (t-test)	R2	Adj. R2	F	p-Value (F-test)
	B	SE						
Food Pattern of Hope					0,11	0,033	1,435	0,249
Energy Adequacy Figures	0,070	0,101	0,696	0,491				
Protein Adequacy Figures	-0,002	0,005	-0,475	0,638				
Hope Food Pattern Score	-0,279	0,151	-1,851	0,073				
Food Security Vulnerable Atlas					0,314	0,131	1,716	0,135
NCPR	-0,882	0,657	-1,342	0,19				
POV	0,082	0,323	0,254	0,801				
FOOD	0,212	0,120	1,766	0,088				
ELEC	-0,092	0,369	-0,249	0,805				
WATER	0,087	0,037	2,368	**0,025***				
LIFE	0,028	0,487	0,057	0,955				
HEALTH	-0,199	0,313	-0,634	0,531				
SCHOOL	0,021	0,464	0,046	0,964				
Food Security Index					0,338	0,282	5,964	**0,002***
Food Availability	0,032	0,016	1,995	0,054				
Food Affordability	-0,121	0,097	-1,249	0,220				
Food Utilization	-0,256	0,123	-2,090	**0,044***				

Table 6. Results of linear regression analysis of dependent variables on wasting events

Variable	Unstandardized Coefficients		t	p-Value (t-test)	R2	Adj. R2	F	p-Value (F-test)
	B	SE						
Food Pattern of Hope					0,117	0,041	1,542	0,221
Energy Adequacy Figures	-0,086	0,079	-1,092	0,283				
Protein Adequacy Figures	-0,005	0,004	-1,377	0,177				
Hope Food Pattern Score	-0,026	0,118	-0,219	0,828				
Food Security Vulnerable Atlas					0,278	0,086	1,446	0,219
NCPR	-0,048	0,529	-0,090	0,929				
POV	-0,218	0,260	-0,840	0,408				
FOOD	0,030	0,097	0,308	0,760				
ELEC	-0,598	0,297	-2,015	0,053				
WATER	0,009	0,029	0,293	0,772				
LIFE	-1,025	0,392	-2,616	**0,014***				
HEALTH	0,123	0,252	0,487	0,630				
SCHOOL	0,543	0,373	1,456	0,156				
Food Security Index					0,185	0,115	2,646	0,064
Food Availability	0,012	0,.014	0,826	0,414				
Food Affordability	0,179	0,084	2,115	**0,042***				
Food Utilization	-0,275	0,107	-2,577	**0,014***				

4. DISCUSSION

The relationship between the Hope Food Pattern Score (DDP), Energy Adequacy Level (AKE), and Protein Adequacy Level (AKP) with stunting and wasting in Central Sulawesi reveals several critical findings. For stunting, DDP has a near-significant negative effect, indicating that improved dietary patterns reduce stunting risk. However, AKE and AKP show no significant impact, suggesting that while energy and protein adequacy are essential, the quality and diversity of dietary patterns play a more substantial role. Regarding wasting, variables in the DDP category do not significantly affect it. In contrast, an increase in life expectancy has a significant negative effect, implying that improved health and community welfare reduce wasting risk. This highlights the need for holistic interventions that enhance overall living conditions beyond meeting energy and protein requirements. Disparities between regions, such as low DDP scores in Tojo Una-Una (69.4), underline the importance of region-specific programs focusing on access to nutritious food and balanced dietary education to improve child nutrition [13] .

Although AKE in Central Sulawesi increased from 95.6% (2021) to 97.9% (2023), this improvement was not significant in reducing stunting or wasting. Stunting risk in children is influenced by both dietary diversity and nutrient adequacy. Samosir et al. (2023) highlighted that low food diversity increases stunting risk, while Jufri et al. (2023) and Punuh et al. (2024) found that inadequate energy and protein intake significantly contributes to stunting. These findings reinforce the importance of addressing both food quality and quantity in nutrition interventions[14–16].

Quality protein intake is vital for child growth and stunting prevention. Headey et al. (2018) noted that animal protein not only provides essential amino acids but also critical micronutrients like iron and zinc, often lacking in plant-based proteins[17].

Optimizing the abundant availability of animal protein sources, such as fish and poultry, in Central Sulawesi can improve community dietary patterns. Local production initiatives and community-based interventions emphasizing the benefits of quality protein are essential. Gómez et al. (2020) highlighted the importance of food system transformation to increase access to nutritious food and strengthen local production as part of food security and nutritional improvement efforts(14,[18]. Household food insecurity significantly increases stunting risk, with insecure households being 2.9 times more likely to have stunted children [18]. Limited purchasing power among impoverished households further exacerbates the inability to meet nutritional needs, increasing stunting prevalence[19].

Inadequate access to clean water positively correlates with stunting prevalence in Central Sulawesi. Poor water quality elevates gastrointestinal infection risks, with children in households lacking clean water facing a 5.99 times higher stunting risk [20]. Proper sanitation reduces stunting risk by 29%, underscoring the need for integrated water, sanitation, and hygiene programs alongside community education to combat stunting [21]. Higher life expectancy is negatively correlated with stunting prevalence. An increase in the Human Development Index (HDI) by one level can reduce stunting risk by up to 40% (OR 0.60; 95% CI 0.50–0.72). Countries with lower HDI scores tend to have higher stunting rates due to limited access to healthcare, education, and income [22]. The findings underscore the importance of clean water access, effective food utilization, and improved community health in reducing stunting and wasting. Holistic strategies, including nutrition education, dietary diversification, and local production support, are critical to improving child nutritional status in Central Sulawesi.

A study conducted by Aisyah et al. (2024) analyzed household food security and nutrition among stunted and non-stunted children under five in Tasikmalaya, Indonesia. The findings revealed that household food insecurity was significantly associated with the incidence of stunting in children. Variables such as energy and protein intake, as well as maternal nutrition knowledge, also showed significant relationships [23]. Another study by M'Kaibi et al. (2017) investigated the relationship between agricultural biodiversity, dietary diversity, household food security, and stunting in children living in rural Kenya [24]. The results indicated that dietary diversity and household food security were significantly associated with stunting [25]. These findings support the notion that proper food utilization plays a critical role in preventing stunting.

Agho et al. (2019) conducted a study in Rwanda and found that household food security was significantly associated with stunting among children aged 6 to 59 months. Children from households with moderate and severe food insecurity had a higher likelihood of being stunted compared to those from food-secure households [26]. Unlike stunting, which develops gradually, wasting reflects an acute failure to meet nutritional and energy requirements, often due to disease, food crises, or a household's inability to provide adequate food.

When access to food is limited whether due to low availability, weak purchasing power, or poor food utilization children are the most vulnerable group. Poor food utilization, including unbalanced diets, inadequate food hygiene, and limited nutritional knowledge, exacerbates the risk of both stunting and wasting.

A study by Nepali et al. (2020) used data from the 2016 Nepal Demographic and Health Survey to assess the relationship between wasting and household food security among

children under five. The results showed that the prevalence of wasting increased with the severity of food insecurity, from 9.4% in mildly food-insecure households, to 10.8% in moderately insecure, and 11.3% in severely insecure households. Logistic regression analysis indicated that children from severely food-insecure households had a significantly higher risk of wasting [27]. Another study by Anato et al. (2022) in Ethiopia examined the factors influencing wasting among children under five in food-insecure regions. The study found that household food insecurity, inadequate food intake, and poor feeding practices significantly contributed to the occurrence of wasting. These findings underscore the importance of proper food utilization in preventing wasting [28].

This study has several limitations that should be considered when interpreting its findings. One of the main limitations lies in the restricted set of variables used. Although the research focused on food security indicators such as the Food Pattern of Hope, Food Security Vulnerable Atlas, and Food Security Index, other important factors influencing stunting and wasting were not included in the analysis. Variables such as maternal health during pregnancy, the child's infection history, caregiving practices, and feeding behaviors (especially breastfeeding and complementary feeding practices) have a significant impact on child nutrition status but were not accounted for in the model.

Additionally, the relatively low coefficient of determination (R^2) in several models indicates that the variables used explained only a small portion of the variation in stunting and wasting outcomes. This suggests that other social, economic, and environmental factors also contribute to these conditions but were not incorporated into the analysis. The study also did not distinguish between demographic characteristics such as residential area (urban or rural), child age, or maternal education level, despite the fact that these contextual differences may influence food access and utilization practices.

In terms of research design, this study is cross-sectional, which limits its ability to establish causal relationships. Therefore, although an association was found between food utilization and the incidence of stunting and wasting, the direction of causality remains uncertain.

Based on these limitations, future research is recommended to incorporate a more comprehensive set of variables, including sanitation, maternal and child health status, and infant and young child feeding practices. The use of longitudinal or cohort designs is also encouraged to better assess causal relationships. Moreover, multilevel or spatial analysis approaches would be valuable for capturing variations across regions and households, especially in areas with high geographical and social diversity. Future studies should also evaluate the effectiveness of existing intervention programs, such as food assistance, nutrition education, or community health services. Lastly, segmenting data by child age, gender, and region would enhance the validity of findings and yield more precise policy recommendations.

5. CONCLUSION

The analysis highlights the complex interplay between food security, dietary quality, and child nutritional outcomes, particularly stunting and wasting, in Central Sulawesi. While energy and protein adequacy (AKE and AKP) remain important, the findings underscore that dietary diversity and the quality of food consumed, as measured by

the Hope Food Pattern Score (DDP), have a more profound impact on stunting reduction. The insignificant role of AKE and AKP in both stunting and wasting outcomes suggests that meeting quantitative nutritional needs alone is insufficient without ensuring dietary quality and diversity.

Furthermore, the significant association between higher life expectancy and lower prevalence of wasting illustrates the broader impact of community health and welfare on child nutrition. Environmental factors such as access to clean water and sanitation also play a critical role, with poor water access markedly increasing stunting risk. This underscores the necessity of integrated, multisectoral approaches that go beyond food provision to include water, sanitation, hygiene, and education interventions.

The findings are supported by international studies, reinforcing the global relevance of food utilization and household food security in addressing childhood undernutrition. However, the study also reveals methodological limitations, including its cross-sectional design, limited variables, and lack of regional demographic analysis, which constrain causal interpretation and generalizability.

Future research should adopt longitudinal and multilevel approaches and include a wider range of determinants, such as maternal health, child care practices, and socio-environmental factors. Tailored interventions that promote dietary diversification, improve sanitation, and enhance food systems at the community level are essential to sustainably reduce stunting and wasting and improve child health outcomes in Central Sulawesi and similar settings.

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