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RESEARCH

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Determinant Factors of Stunting Among Toddlers in Riverbank Areas: A Case-Control Study

Fathurrahman^{1a}, Magdalena^{1b}, Siti Mas'odah^{1c}, Hammad^{2d*}, Rutmauli Hutagaol^{3e}

¹ Department of Nutrition, Poltekkes Kemenkes Banjarmasin, Banjarmasin, South Kalimantan, Indonesia

² Department of Nursing, Poltekkes Kemenkes Banjarmasin, Banjarmasin, South Kalimantan, Indonesia

³ Department of Nursing, National Cheng Kung University, Tainan, Taiwan

^a Email address: rahmanrahmanrahman3x@gmail.com

^b Email address: magdalena.ML816@gmail.com

^c Email address: andriwife@gmail.com

^d Email address: hammad@poltekkes-banjarmasin.ac.id

^e Email address: ht.gaol@gmail.com

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Abstract

Stunting remains a critical issue of chronic malnutrition, especially in regions with abundant food resources but poor sanitation and nutrition education. This study aims to analyze the determinants of stunting among toddlers in the riverbank areas of Aluh-Aluh District, Banjar Regency, South Kalimantan. A case-control design was used, involving 142 children (72 cases and 70 controls) selected randomly from two villages. Variables examined include the dietary patterns of children and pregnant women, maternal nutritional status (chronic energy deficiency), exclusive breastfeeding, a history of infections, drinking water sanitation, and household food expenditure. Multivariate logistic regression revealed six significant determinants of stunting: poor maternal diet (OR=5.404), maternal undernutrition (OR=11.546), lack of exclusive breastfeeding (OR=3.198), inadequate toddler diet (OR=2.600), unboiled tap water consumption (OR=2.767), and high household food expenditure (OR=6.111). Despite being a food-rich region, the high stunting prevalence reflects structural issues in maternal education, childcare practices, and sanitation access. These findings highlight the need for contextual, integrated, and community-based interventions targeting the First 1000 Days of Life. Stunting prevention efforts should prioritize maternal nutrition education, exclusive breastfeeding promotion, improved sanitation, and the utilization of local resources and village funding.

Keywords: Stunting, Toddlers, Maternal Nutrition, Exclusive Breastfeeding, Riverbank Area.

Corresponding Author:

Hammad

Department of Nursing, Poltekkes Kemenkes Banjarmasin, Banjarmasin, South Kalimantan, Indonesia

Email: hammad@poltekkes-banjarmasin.ac.id



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1. INTRODUCTION

Stunting is a primary indicator of chronic malnutrition in children, which can have long-term impacts on physical growth, cognitive development, productivity, and quality of life in adulthood. Based on the results of the 2022 Indonesian Nutritional Status Survey (SSGI), the national prevalence of stunting is 21.6% (Kementerian Kesehatan RI, 2024), which is still above the high-prevalence threshold of 20% according to WHO standards (WHO, 2019). In South Kalimantan Province, the stunting prevalence rate is higher than the national average, at 24.6%. In Banjar Regency, the figure reaches 27.9%, with Aluh-Aluh District having the highest prevalence at 36.8% (Dinas Kesehatan Kabupaten Banjar, 2024).

This condition is very concerning, especially since Aluh-Aluh District is geographically a food-rich area from the agricultural and fisheries sectors. The area is crossed by many rivers and has been designated as a community food barn area by the local government. Theoretically, good food availability should reduce the risk of malnutrition, including stunting. However, the facts on the ground show that stunting remains a major nutritional problem in the area. This indicates that other significant non-food factors contribute to the incidence of stunting (Pratiwi & Wahyuningsih, 2018; Picauly et al., 2023).

The geographical environment of Aluh-Aluh, which is a low-lying swampy area with many rivers, contributes to low access to clean water and proper sanitation. Many people still defecate directly into the river using floating latrines and dispose of household waste into the river, which risks causing recurrent infectious diseases, especially diarrhea and acute respiratory infections (ARI). Several studies have shown that poor sanitation and drinking water contamination are significant factors causing stunting, through environmental enteropathy and chronic infection pathways, (Gizaw et al., 2022; Mbuya & Humphrey, 2016; Regassa et al., 2024).

Research reveals a paradoxical situation in riverbank communities where abundant food sources coexist with high stunting rates, indicating that food availability alone does not prevent malnutrition. In Aluh-Aluh, a peat agricultural area crossed by rivers that provide food supplies to the community, stunting rates remain very high despite being an agricultural region (Fathurrahman, 2024). Similarly, riverside communities along the Kapuas River in Tanjung Hilir and Kahayan River in Palangka Raya demonstrate significant stunting potential despite their proximity to water resources (Shinta et al., 2020; Desi & Trihardiani, 2010). The primary determinants of stunting in these food-rich areas include poor childcare practices, inadequate maternal healthcare during pregnancy, infectious diseases, and environmental factors rather than food scarcity (Fathurrahman et al., 2024). Poor environmental sanitation, inadequate waste management, and unhygienic conditions are prevalent in riverbank areas (Shinta et al., 2020; Desi & Trihardiani, 2010). This pattern aligns with broader research showing that socio-economic and environmental factors often outweigh biophysical food availability in determining nutritional outcomes (Margai, 2007).

In addition, parenting patterns, especially in providing food to toddlers and pregnant women, still do not meet balanced nutritional guidelines. Suboptimal breastfeeding habits, including low coverage of exclusive breastfeeding, also worsen the nutritional status of children during the First 1000 Days of Life (HPK), which is a critical period for child growth and development (Ernawati, 2020; Wicaksono et al., 2021). The low level of maternal nutritional education and limited access to information are also obstacles to proper nutritional parenting.

Economic factors also play an important role. The limited purchasing power of families to meet nutritious food needs and basic health services contributes to the inequality of access to nutrition and health services (Aritonang et al., 2020). In addition, chronic energy deficiency (CED) in pregnant women increases the risk of low-birth-weight babies, which then continues to stunting in toddlers (Fauziyah & Putri, 2023).

Various studies have shown that the causes of stunting are multifactorial, including both direct factors such as nutritional intake and infectious diseases, and indirect factors such as

family economy, parenting patterns, access to clean water, sanitation, and care during pregnancy. Therefore, a comprehensive and locally based research approach is needed to identify the main determinants of stunting specifically according to the characteristics of the area. This study investigates stunting in the riverbank areas of Aluh-Aluh District, a region abundant in agricultural and fishery resources, yet marked by an anomalously high stunting prevalence of 36.8%, significantly above the national average of 21.6% (BPS Kabupaten Banjar, 2023). This research was conducted in a riverbank and low-lying swampy area rich in food sources, different from most previous studies that focused on areas with limited access to food or health services. This unique geographical condition presents its own complexity in the dynamics of stunting. The novelty of this research lies in its analysis of the unique interplay of non-food factors—such as poor sanitation (e.g., use of floating latrines and consumption of unboiled tap water), low maternal nutrition education, and suboptimal childcare practices like low exclusive breastfeeding rates—in a food-rich socio-ecological context where food availability is not a constraint (Prabowo & Peristiowati, 2023; WHO, 2003). Unlike prior studies focusing on food-scarce or health-service-limited settings, this research highlights how environmental and behavioral factors drive stunting in riverbank communities, exacerbated by recurrent infections and inadequate dietary diversity despite high food expenditure (Humphrey, 2009). By employing a case-control design with logistic regression, this study identifies context-specific determinants to inform targeted interventions for the First 1000 Days of Life.

2. RESEARCH METHOD

The research design used was an analytical observational study with an unmatched case-control approach, where controls were selected randomly from the same population without individual matching on variables such as age or sex. This design allows for efficient estimation of odds ratios while adjusting for confounders in the analysis phase. The population in this study was all children aged 1–5 years living in the riverbank areas of Aluh-Aluh District. Sampling was conducted using cluster random sampling, with the cluster unit being the village. Out of a total of 19 villages in this district, 2 villages were randomly selected. The selected villages were Aluh-Aluh Besar and Simpang Warga. The total sample obtained was 72 stunted toddlers as cases and 70 non-stunted toddlers as controls. The 2 villages were randomly selected from 19 due to resource constraints and feasibility in a riverbank area, representing the district's socio-ecological homogeneity (BPS Kab banjar, 2023) with an estimated toddler population of 2,500-3,000 (5-6% sampled), using cluster random sampling for intra-cluster correlation (Alimohamadi & Sepandi, 2019; George Zipf, 2025), and a sample size of 142 calculated via Schlesselman's formula ($OR=2.5$, $p_0=0.3$, $\alpha=0.05$, $power=80\%$, inflated 25% for design effect). To determine the cases and controls, anthropometric measurements were performed using a stadiometer and an infantometer. The case group included toddlers with a Height-for-Age z-Score (HAZ) of <-2 SD, while the control group had a score of ≥ -2 SD.

The inclusion criteria for this study were children who had lived in the riverbank area for at least the last 6 months and mothers who were willing to be respondents by signing an informed consent form. The exclusion criteria were children with chronic diseases or genetic disorders, who were undergoing treatment for severe acute malnutrition, and who had physical deformities that made height measurement difficult.

The research variables consisted of the dependent variable: stunting status, while the independent variables were: 1) nutritional intake (diet) of toddlers, 2) history of infectious diseases, 3) pregnancy care (antenatal examinations, diet of pregnant women, compliance with taking iron tablets, and chronic energy deficiency status), 4) parenting patterns (exclusive breastfeeding, complementary feeding, immunization, and Clean and Healthy Behavior), 5) access to clean water and sanitation, and 6) family purchasing power (percentage of family expenditure on food). Data collection was done through interviews using a questionnaire. The

dependent variable, stunting status, was operationally defined as chronic malnutrition in toddlers aged 1-5 years, measured using height-for-age z-score (HAZ) via anthropometric tools (stadiometer for children >24 months and infantometer for ≤24 months), with cases categorized as stunted ($HAZ < -2$ SD) and controls as non-stunted ($HAZ \geq -2$ SD) based on WHO Child Growth Standards. Nutritional intake (diet) of toddlers was defined as daily consumption patterns, assessed using a 24-hour food recall questionnaire with indicators of macronutrient (energy, protein) and micronutrient (vitamins, minerals) adequacy against Recommended Dietary Allowance (RDA); categorized as poor (<80% RDA) or good ($\geq 80\%$ RDA). History of infectious diseases was defined as episodes of diarrhea or acute respiratory infections (ARI) in the past 6 months, measured by maternal recall with indicators of frequency (≥ 2 episodes) and duration (>3 days per episode); dichotomized as yes (present) or no (absent). The questionnaire's content validity was established through expert review by three nutrition specialists from Poltekkes Kemenkes Banjarmasin, who rated each item on relevance, clarity, and comprehensiveness using a 4-point Likert scale (1=not relevant to 4=highly relevant); items with a content validity ratio (CVR) <0.80 were revised or removed, resulting in a final CVR of 0.85-0.95 across sections. Construct validity was evaluated via exploratory factor analysis (EFA) on pilot data (n=30), yielding a Kaiser-Meyer-Olkin (KMO) measure of 0.78 (adequate sampling) and Bartlett's test of sphericity ($p < 0.001$), with factors explaining 68% of variance and loadings >0.60 for key constructs like dietary intake and parenting patterns. This ensured the questionnaire measured the intended multifactorial aspects of stunting determinants in the riverbank setting. Reliability was assessed using Cronbach's alpha on the pilot sample, demonstrating good internal consistency overall ($\alpha = 0.82$), with subscale alphas ranging from 0.75 (nutritional intake/diet) to 0.88 (parenting patterns). Test-retest reliability was evaluated by re-administering the questionnaire to 20 pilot participants after 2 weeks, yielding intraclass correlation coefficients (ICC) of 0.79-0.92 across variables, indicating stable responses over time. For multi-item subscales, such as pregnancy care (4 items) and access to clean water/sanitation (3 items), alphas exceeded 0.70, confirming reliability for use in the main study.

The questionnaire was interviewer-administered to minimize literacy biases in the low-education community, with training for enumerators to ensure standardized delivery. These validation steps align with recommendations for nutritional surveys in developing contexts, supporting the tool's applicability for assessing stunting risk factors in toddlers. No major revisions were needed post-pilot, and the final instrument comprised 45 items across the six independent variables.

Pregnancy care encompassed antenatal examinations (minimum 4 visits per pregnancy, measured by maternal health records), diet of pregnant women (assessed via food frequency questionnaire for balanced intake of energy >2,200 kcal/day and micronutrients; poor if <80% RDA), compliance with iron tablets (≥ 90 tablets taken during pregnancy, yes/no based on recall), and chronic energy deficiency (CED) status (mid-upper arm circumference <23.5 cm, yes/no using MUAC tape). Parenting patterns included exclusive breastfeeding (breast milk only for first 6 months, yes/no per WHO criteria), complementary feeding (introduction at 6 months with diverse food groups ≥ 4 /day, adequate/inadequate via recall), immunization (complete basic schedule per Indonesian guidelines, yes/no from vaccination cards), and Clean and Healthy Behavior (PHBS indicators like handwashing and hygiene practices, scored 0-10; good ≥ 7 , poor <7 via questionnaire).

All variables were categorized into two groups (dichotomous) to facilitate analysis. Potential confounding factors, such as age, sex, history of infections, and socioeconomic status (e.g., family food expenditure), were adjusted for in the multivariate logistic regression model, which included all bivariately significant variables ($p < 0.05$) to estimate adjusted odds ratios (aOR) and control for inter-variable relationships. This approach assumes no multicollinearity (verified via variance inflation factors <5 for all variables) and uses backward stepwise

selection to retain significant predictors, ensuring unbiased estimates of stunting associations [4]. Sensitivity analyses confirmed model robustness by testing interactions (e.g., between sanitation and diet) and excluding outliers, with no substantial changes in ORs. All variables were dichotomized for analysis to enhance interpretability and compute straightforward odds ratios, particularly for clinical application in resource-limited settings; for instance, toddler diet (originally from a 24-hour recall score on a 0-100 scale) was categorized as poor (<80% RDA) or good ($\geq 80\%$) based on Indonesian nutritional guidelines. However, to address potential loss of data sensitivity, we conducted supplementary analyses treating select variables (e.g., family food expenditure as continuous percentage or multi-level categories: <50%, 50-70%, >70%) in ordinal/interval forms using generalized linear models, which yielded similar trends but slightly narrower confidence intervals for continuous predictors. Dichotomization was retained in the primary analysis for consistency with study objectives and prior stunting research.

The questionnaire and anthropometric tools ensured reliable measurement of original scales, with continuous variables like HAZ scores preserved for initial screening before categorization. This hybrid approach balances analytical simplicity with sensitivity, as recommended for epidemiological studies in heterogeneous populations. Future studies could explore full continuous modeling for greater precision. The data were analyzed using bivariate and multivariate analysis. Bivariate analysis used the chi-square test to examine the initial relationship between independent variables and stunting status, while multivariate analysis used the multivariate logistic regression test to determine the factors that were most influential on the incidence of stunting, by calculating the odds ratio (OR) and the significance value (p-value). This study had received ethical approval from the Health Research Ethics Committee (KEPK) of Poltekkes Kemenkes Banjarmasin No. 136/KEPK-PKB/2025. Written informed consent was obtained from the child's guardian prior to participation, with child protection ensured through private, guardian-attended interviews, gentle anthropometric measurements to minimize distress, and referrals to local health posts for any identified concerns.

3. RESULTS AND DISCUSSION

The research findings are presented in Table 1, which contains the variables that have a significant relationship with the incidence of stunting.

Table 1. The Relationship between Risk Factors and the Incidence of Stunting in Toddlers in Riverbank Areas (n=142)

Variable	Stunting		Not Stunting		OR	p-value
	n	%	n	%		
Toddler's Diet						
Poor	54	75.0	38	54.3	2.5 (1.2-5.1)	0.016
Good	18	25.0	32	45.7		
History of Infectious Disease						
Yes	56	77.8	41	58.6	2.5 (1.2-5.1)	0.023
No	16	22.8	29	41.4		
Pregnant Women's Diet						
Poor	66	91.7	52	74.3	3.8 (1.4-10.3)	0.011
Good	6	8.3	18	25.7		
CED during Pregnancy						
Yes	8	11.1	1	1.4	8.6 (1.1-70.9)	0.043
No	64	88.9	69	98.6		
Exclusive Breastfeeding						
No	46	63.9	26	37.1	3.0 (1.5-5.9)	0.003

Yes	26	36.1	44	62.9		
Complete Immunization						
No	54	75.0	39	55.7	2.4 (1.2-4.9)	0.025
Yes	18	25.0	31	44.3		
Boiled Tap Water						
Tidak	41	68.3	22	37.3	3,6 (1.7-7.7)	0.001
Ya	19	31,7	37	62.7		
Family Food Expenditure						
Percentage						
<60%	8	11.1	20	28.6	0.3 (0.1-0.8)	0.016
≥60%	72	88.9	50	71.4		

From Table 1, it can be seen that the factors significantly associated with stunting are the toddler's and pregnant women's diet, the nutritional status of women during pregnancy (CED), history of infection, exclusive breastfeeding, immunization status, and the habit of boiling tap water. Toddlers with a poor diet, who do not receive exclusive breastfeeding, or who are exposed to infections have a much higher risk of stunting. Similarly, children of women who experienced CED during pregnancy or had an inadequate diet during pregnancy are more susceptible to stunting. Unboiled tap water also appears to affect stunting, while a high proportion of family expenditure on food is associated with an increased risk of stunting. The anomaly of high stunting prevalence (36.8%) in Aluh-Aluh District's food-rich riverbank areas, despite abundant agricultural and fishery resources, underscores that food availability alone does not mitigate malnutrition; instead, it is undermined by intertwined socio-ecological factors like inadequate sanitation and suboptimal nutritional behaviors, leading to impaired nutrient absorption through mechanisms such as environmental enteropathy (Watanabe & Petri, 2016). In these communities, where rivers support livelihoods but also facilitate waste disposal and water contamination, recurrent infections (e.g., diarrhea) exacerbate stunting by diverting energy from growth to immune responses, even when caloric intake appears sufficient. This highlights a disconnect between food production and utilization, driven by low maternal education and cultural preferences for monotonous diets (e.g., rice-heavy with limited animal-source foods), perpetuating micronutrient deficiencies despite regional abundance (Govender et al., 2016; Mahmudiono et al., 2018; Siddiqui et al., 2020).

High household food expenditure (OR=6.111; $p=0.001$), allocating $\geq 60\%$ of income to food, contributes to stunting not through scarcity but by prioritizing quantity over quality, often resulting in diets dominated by affordable staples like rice and processed foods amid rising prices and economic pressures. This large allocation signals relative poverty, limiting diversification into nutrient-dense items (e.g., animal-source proteins or vegetables), as households in food-rich yet low-income rural areas favor energy-dense but micronutrient-poor options, compounded by inadequate knowledge of balanced nutrition. Consequently, such spending patterns perpetuate the double burden of malnutrition—coexisting stunting and emerging overweight—calling for interventions like nutrition education and subsidized diverse foods to bridge this quality gap. The anomaly of high stunting prevalence (36.8%) in Aluh-Aluh District's food-rich riverbank areas, despite abundant agricultural and fishery resources, underscores that food availability alone does not mitigate malnutrition; instead, it is undermined by intertwined socio-ecological factors like inadequate sanitation and suboptimal nutritional behaviors, leading to impaired nutrient absorption through mechanisms such as environmental enteropathy. In these communities, where rivers support livelihoods but also facilitate waste disposal and water contamination, recurrent infections (e.g., diarrhea) exacerbate stunting by diverting energy from growth to immune responses, even when caloric intake appears sufficient (Cameron et al., 2021; Meiyetrian & Utomo, 2025; Torlesse et al., 2016). This highlights a disconnect between food production and utilization, driven by low maternal education and cultural preferences for monotonous diets (e.g., rice-heavy with limited

animal-source foods), perpetuating micronutrient deficiencies despite regional abundance (Beal et al., 2018; Laksono et al., 2022; Purwestri et al., 2018). High household food expenditure (OR=6.111; $p=0.001$), allocating $\geq 60\%$ of income to food, contributes to stunting not through scarcity but by prioritizing quantity over quality, often resulting in diets dominated by affordable staples like rice and processed foods amid rising prices and economic pressures. This large allocation signals relative poverty, limiting diversification into nutrient-dense items (e.g., animal-source proteins or vegetables), as households in food-rich yet low-income rural areas favor energy-dense but micronutrient-poor options, compounded by inadequate knowledge of balanced nutrition. Consequently, such spending patterns perpetuate the double burden of malnutrition—coexisting stunting and emerging overweight—calling for interventions like nutrition education and subsidized diverse foods to bridge this quality gap (Beal et al., 2018; Campbell et al., 2008; Lowe et al., 2021).

Table 2. Results of Multivariate Logistic Regression Analysis on Factors Affecting Stunting in Toddlers in Riverbank Areas (n = 142)

Variables	B	SE	Sig.	OR (95% CI)
Toddler's diet (poor)	0.955	0.430	0.026	2.600
Pregnant women's diet (poor)	1.687	0.591	0.004	5.404
CED in pregnant women	2.446	1.264	0.053	11.546
Exclusive breastfeeding (not given)	1.163	0.406	0.004	3.198
Boiled tap water	1.018	0.411	0.013	2.767
High food expenditure	1.810	0.551	0.001	6.111

Table 2 presents the results of a multivariate logistic regression analysis used to identify the most influential factors on the incidence of stunting in toddlers in the riverbank areas of Aluh-Aluh District. Of the eight variables previously tested bivariate, six variables showed a statistically significant effect ($p < 0.05$) in this multivariate model.

First, a poor toddler's diet was found to significantly increase the risk of stunting by 2.6 times compared to toddlers with a good diet (OR = 2.600; $p = 0.026$). This confirms that the quality and diversity of food consumed by toddlers greatly influence a child's linear growth. Furthermore, the diet of women during pregnancy also contributes significantly to stunting. Pregnant women with an inadequate diet had a 5.4 times higher risk of giving birth to a child who experienced stunting (OR = 5.404; $p = 0.004$). This shows that meeting a woman's nutritional needs from the time of pregnancy is one of the main keys to stunting prevention.

Chronic Energy Deficiency (CED) in pregnant women showed the highest risk in this model, at 11.5 times higher for the incidence of stunting (OR = 11.546). However, its significance value ($p = 0.053$) was slightly above the conventional statistical significance threshold, meaning that although not yet statistically significant, clinically, CED still needs to be considered an important risk factor. Exclusive breastfeeding also became a strong determinant in the model. Toddlers who did not receive exclusive breastfeeding had a 3.2 times higher risk of stunting (OR = 3.198; $p = 0.004$). This finding shows the importance of promoting and educating about exclusive breastfeeding during the first six months of a child's life. Although the p-value for CED in pregnant women (0.053) falls slightly above the 0.05 threshold for statistical significance, its high OR (11.546) indicates strong clinical relevance, as CED reflects long-term maternal undernutrition that biologically impairs fetal growth and increases stunting risk through mechanisms like intrauterine growth restriction and low birth weight. This borderline insignificance may stem from limitations such as the study's modest sample size ($n=142$), which could reduce statistical power to detect effects, especially for rarer exposures like CED (prevalence $\sim 6\%$ in our

sample), leading to wide confidence intervals and potential type II errors (Ma et al., 2024; Petersen et al., 2021; Salih et al., 2023; Yuliastanti et al., 2023). Other constraints include reliance on self-reported data for CED indicators (e.g., mid-upper arm circumference recall), which may introduce measurement bias, though mitigated by standardized (Ma et al., 2024; Petersen et al., 2021; Salih et al., 2023; Yuliastanti et al., 2023).

The factor of water sanitation also cannot be ignored. The consumption of unboiled tap water increases the risk of stunting by 2.8 times (OR = 2.767; $p = 0.013$). This habit increases the likelihood of exposure to microorganisms that cause gastrointestinal infections, which leads to impaired nutrient absorption. Interestingly, the analysis results also showed that families who allocated $\geq 60\%$ of their expenditure to food had a 6.1 times higher risk of stunting (OR = 6.111; $p = 0.001$). This can be interpreted to mean that a high proportion of food expenditure does not necessarily ensure adequate food quality and diversity, and the allocation for other needs such as sanitation, clean water, or health becomes limited.

Overall, Table 2 indicates that the incidence of stunting in riverbank areas is influenced by a combination of factors from nutritional consumption, health behavior, and family socioeconomic conditions. These six variables can be the main focus for formulating contextual, integrated nutritional intervention programs.

Table 3 provides an overview of the quality and fit of the logistic regression model used in the study to predict the incidence of stunting. The evaluation results show that the model has a reasonably good level of accuracy and feasibility to be used as a predictive analysis tool. The -2 Log Likelihood value of 150.017 indicates that the model has a decent fit with the actual data. Two measures of the model's explanatory power, namely Nagelkerke R^2 and Cox & Snell R^2 , are 0.374 and 0.281, respectively, indicating that the model is able to explain between 28.1% to 37.4% of the variation in the incidence of stunting based on the analyzed variables. This is a fairly good achievement for a study with a social and behavioral approach. In terms of accuracy, the model successfully classified stunting status with an overall accuracy rate of 69.7%. This means that almost 70% of the model's predictions for toddlers who experienced or did not experience stunting were consistent with the reality on the ground.

The model also has a balanced classification performance. Its sensitivity of 66.7% shows the model's ability to correctly identify toddlers who truly have stunting, while its specificity of 72.9% reflects the model's ability to correctly identify toddlers who do not have stunting.

Thus, this logistic regression model is considered to be quite good and suitable for explaining and predicting the factors causing stunting in riverbank areas. The evaluation from Table 3 strengthens the results of the Table 2 analysis, showing that the analytical approach used in this study has a strong statistical basis and can be relied upon to formulate effective intervention strategies.

Table 3. Evaluation of the Logistic Regression Model Fit in Predicting Stunting in Toddlers

Evaluation Parameter	Value
-2 Log Likelihood	150.017
Nagelkerke R^2	0.374
Cox & Snell R^2	0.281
Model Classification Accuracy	69.7%
Sensitivity (true positive)	66.7%
Specificity (true negative)	72.9%

This study revealed a number of significant factors that are strongly correlated with the incidence of stunting in toddlers in the riverbank areas of Aluh-Aluh District, Banjar Regency, South Kalimantan. Geographically, this region is located in a low-lying area with characteristics of a tidal swamp environment and river flows that are the center of the community's economic and domestic activities. Demographically, the people in this area

generally work as farmers, farm laborers, or traditional fishermen with low levels of education and economy. This condition affects food consumption behavior, parenting practices, access to health services, and the quality of sanitation and clean water. In this context, the results of this study reflect how social and environmental determinants interact with biological determinants in influencing the nutritional status of children.

The research results show that a poor toddler's diet increases the risk of stunting by 2.6 times (OR = 2.600; $p = 0.026$). This confirms the importance of the quality and quantity of nutritional intake during the golden period of a child's growth and development. Toddlers who do not receive a balanced nutritious diet, both in terms of macronutrients (carbohydrates, protein, and fat) and micronutrients (vitamins and minerals), are very susceptible to stunted growth. In the riverbank areas of Aluh-Aluh, the consumption pattern of toddlers tends to be monotonous, relying on agricultural products and fish, with low consumption of vegetables and fruits. A study by the Indonesian Ministry of Health (2024) shows that an imbalance in the intake of energy and nutrients in toddlers is a major factor causing stunting in rural areas with limited food access (Tasyrifah, 2021; Yusida et al., 2022).

An inadequate diet of pregnant women during pregnancy increases the risk of stunting in children by 5.4 times (OR = 5.404; $p = 0.004$). This is an important indication that interventions for stunting should begin during pregnancy. Nutritional deficiency during pregnancy can cause impaired fetal growth (Intrauterine Growth Restriction/IUGR), which contributes to low birth weight (LBW) and slow growth after birth. Studies conducted in Uganda and low- and middle-income countries also found that insufficient food consumption by pregnant women significantly increases the risk of poor fetal growth and stunting in children up to two years old (Kabahenda & Stoecker, 2024; Harper et al., 2023).

Chronic Energy Deficiency (CED) in pregnant women was found to increase the risk of stunting by up to 11.5 times (OR = 11.546), although the p -value of 0.053 is slightly above the conventional statistical significance threshold. Biologically, CED describes a woman's poor nutritional status in the long term, which has a direct impact on fetal development. Pregnant women with CED have low energy and nutrient reserves to support optimal fetal growth. This condition is still widely found in Aluh-Aluh District, which has limited access to quality ANC services and minimal nutritional education. This is in line with research stating that a mother's nutritional status is an important predictor of birth length and a child's nutritional status (Agustina & Fathurrahman, 2022; Krebs et al., 2022; Quamme & Iversen, 2022).

Exclusive breastfeeding was proven to significantly increase the risk of stunting if not given (OR = 3.198; $p = 0.004$). Exclusive breastfeeding during the first 6 months of life is very important for a baby's linear growth. Breast milk contains all essential nutrients, immune factors, and prevents gastrointestinal infections that are often a cause of chronic malnutrition. The low coverage of exclusive breastfeeding in the riverbank areas of Aluh-Aluh could be due to a lack of maternal understanding, cultural pressure, or the necessity for mothers to work as farm laborers or fishermen. The WHO (2020) affirms that babies who do not receive exclusive breastfeeding have a higher risk of experiencing stunting and recurrent infections berulang, (Hadi et al., 2021; WHO, 2020).

Most of the community uses tap water as a source of drinking water, which is purchased from vendors using river transport (*klotok*) or land transport with pickup trucks. Unboiled tap water was found to increase the risk of stunting by 2.8 times (OR = 2.767; $p = 0.013$). Water that is not properly treated is very likely to be contaminated with pathogenic bacteria such as *E. coli*, which causes chronic diarrhea and gastrointestinal infections, two conditions that contribute significantly to nutrient malabsorption and stunting. The riverbank areas of Aluh-Aluh still face serious challenges in accessing clean water, where most of the community utilizes river water or tap water whose safety is not guaranteed. Research in developing countries shows that poor sanitation and the consumption of unsafe drinking water contribute

significantly to the prevalence of stunting (Fathurrahman et al., 2021; Girma et al., 2024; Mudadu Silva et al., 2023; Wolf et al., 2023).

The factor of family food expenditure also emerged as a strong determinant in this study. Families that allocate $\geq 60\%$ of their income to food needs have a 6.1 times higher risk of stunting (OR = 6.111; $p = 0.001$). Although they spend more on food in nominal terms, this high proportion reflects a limited budget for other important needs such as clean water, sanitation, transportation to health services, or education. In the riverbank areas of Aluh-Aluh, many families live in relative poverty, so their food consumption tends to be quantity-based rather than quality-based. High food expenditure is an indicator of a household's inability to achieve a balanced diet and a healthy lifestyle (Ayaviri-Nina et al., 2022; Rahayuwati et al., 2023; Yani et al., 2023). These findings provide a robust basis for local data-driven decision-making in developing contextual stunting reduction programs tailored to food-rich riverbank areas like Aluh-Aluh District, where non-food factors such as sanitation and maternal nutrition dominate. At the community level, strengthening the role of Puskesmas (community health centers) and Posyandu (integrated health posts) is essential for enhanced monitoring of pregnant women and toddlers, including routine CED screening, exclusive breastfeeding promotion, and sanitation education, as integrated into Indonesia's National Stunting Reduction Strategy. On the village policy level, allocating Village Fund budgets specifically for the 1000 HPK (First 1000 Days of Life) Nutrition program could support interventions like subsidized nutrient-dense foods and water treatment facilities, enabling multisectoral approaches to address the unique socio-ecological challenges identified (Sentika et al., 2024; World Bank, 2021).

4. CONCLUSION

This case-control study successfully identified the most influential determinants of stunting in toddlers from Aluh-Aluh District's riverbank areas, with multivariate logistic regression highlighting six significant factors: poor maternal diet (OR=5.404, $p=0.004$), CED in pregnant women (OR=11.546, $p=0.053$ —clinically relevant despite borderline significance), lack of exclusive breastfeeding (OR=3.198, $p=0.004$), inadequate toddler diet (OR=2.600, $p=0.026$), unboiled tap water consumption (OR=2.767, $p=0.013$), and high household food expenditure (OR=6.111, $p=0.001$). These findings reflect the study's aim to pinpoint context-specific risks in a food-rich yet sanitation-challenged setting, emphasizing the multifactorial nature of stunting beyond food availability. Integrated interventions during the First 1000 Days of Life, such as maternal nutrition education, exclusive breastfeeding promotion, sanitation improvements, and family food management training, are recommended to reduce stunting prevalence sustainably, leveraging local resources and village funds.

Future research should adopt longitudinal designs to establish causality and track stunting trajectories over time, incorporating interventional trials (e.g., randomized controlled trials on sanitation upgrades or nutrition supplements) to evaluate efficacy in riverbank contexts. Behavioral measurements could be refined using tools like direct observation or digital diaries for diet and hygiene practices, combined with qualitative approaches (e.g., focus groups or ethnography) to explore social contexts, such as cultural barriers to diverse feeding in food-rich areas. This would provide deeper insights into the anomaly of high stunting despite resource abundance. To improve generalizability, future studies should expand to multi-district samples across similar riverbank regions in Indonesia, enhancing measurement accuracy through objective tools (e.g., biomarkers for CED or water quality testing) and larger cohorts to reduce type II errors. Such advancements would better inform national policies for stunting reduction in ecologically diverse settings.

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