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Risk factors associated with stunting among toddlers aged 24–59 months: A Case Control

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ABSTRACT

Introduction: Stunting remains a significant public health concern in Indonesia, particularly in remote and highland regions such as the Bintang Mountains of Papua. It is characterized by impaired physical and cognitive development due to chronic malnutrition, repeated infections, and inadequate health services. Understanding the determinants of stunting in these settings is critical to inform effective interventions and policies.

Methods: This study employed an analytical survey with a case-control design to examine risk factors associated with stunting among toddlers aged 24–59 months in the Oksibil Health Center working area, Bintang Mountains Regency, Papua. A total of 66 respondents were recruited between April and May 2024, consisting of 33 stunted toddlers (cases) and 33 non-stunted toddlers (controls). Data were collected through structured interviews and analyzed using odds ratios (ORs) with 95% confidence intervals to identify significant risk factors.

Results: The findings revealed that several factors were significantly associated with stunting: maternal knowledge (OR = 1.911), history of infectious diseases (OR = 8.090), environmental sanitation (OR = 1.375), socio-cultural practices (OR = 3.801), and health service utilization (OR = 9.339). Among these, inadequate health service utilization posed the highest risk. Socio-cultural norms, poor hygiene practices, and limited maternal awareness were also strongly linked to stunting prevalence.

Conclusion: Stunting in the Bintang Mountains is strongly influenced by a combination of health service gaps, infectious diseases, socio-cultural factors, and insufficient maternal knowledge. Strengthening maternal Education, improving sanitation, addressing harmful cultural practices, and expanding access to health services are critical strategies to reduce stunting prevalence in highland and resource-limited areas of Indonesia.

Keywords: Children, Health Services, Infections, Knowledge, Stunting.

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INTRODUCTION

Stunting, defined as impaired growth and development in children due to chronic malnutrition, remains one of the most persistent public health problems globally (Suprapto, 2022). It reflects a failure to achieve genetic growth potential, primarily during the first 1,000 days of life, from conception to two years of age. Children suffering from stunting are physically shorter than their peers of the same age and often demonstrate delayed cognitive development, which significantly affects their future educational achievements, productivity, and overall quality of life (Alam *et al.*, 2024). According to the World Health Organization (WHO), stunting is not only a marker of undernutrition but also an indicator of social inequality, poor maternal health, inadequate child care, and insufficient access to health services (Amegbor *et al.*, 2025). Despite considerable global progress in reducing stunting, it remains a significant challenge in many developing countries, including Indonesia (Arda, Lalla and Suprapto, 2023).

Stunting remains a major health concern in Indonesia, with prevalence declining from 30.8% in 2018 to 17.8% in 2023, yet still above the national target of 14%. In Papua's highland areas, particularly the Bintang Mountains (34.6% in 2022), rates are among the highest in the country (Ashar *et al.*, 2025). Geographic isolation, poor infrastructure, limited health services, inadequate nutrition, cultural practices such as food taboos and delayed breastfeeding, and poor sanitation drive the persistence of stunting (Ataullahjan *et al.*, 2025). These combined factors create a high-risk environment where children face chronic malnutrition and frequent infections that impede growth (Ayu Rahmadani *et al.*, 2025).

Most studies on stunting in Indonesia focus on urban or better-served regions, while little is known about remote highlands like the Bintang Mountains, where cultural and environmental factors play a major role. Existing research often examines single factors (e.g., maternal Education, income, breastfeeding) rather than integrating multiple dimensions such as knowledge, infections, sanitation, socio-cultural practices, and health services (Balza *et al.*, 2025). This gap limits understanding of how these factors interact in isolated, resource-limited settings, which may compromise the effectiveness of national stunting reduction strategies. Furthermore, existing literature often emphasizes national-level statistics and broad interventions but rarely captures the micro-level realities of health service delivery in remote districts (Bhutta *et al.*, 2025). For example, while health services are widely recognized as crucial in preventing stunting, few studies have quantified the magnitude of their role compared to other determinants in isolated highland populations (Garina *et al.*, 2024). Similarly, socio-cultural barriers, though acknowledged, are underexplored in empirical research, particularly in communities where traditions strongly influence maternal and child health practices. Addressing this gap is essential to design interventions that are not only evidence-based but also culturally sensitive and context-specific.

The present study contributes to the literature by offering a case-control analysis that examines multiple risk factors: maternal knowledge, infectious diseases, environmental sanitation, socio-cultural practices, and health service utilization in the context of toddlers aged 24–59 months in the Oksibil Health Center working area of the Bintang Mountains. By applying a retrospective case-control approach, this research not only identifies associations but also quantifies the relative risks of different determinants, highlighting which factors exert the greatest Influence on stunting incidence (Gayawan and Egbon, 2023). The study found that while all analyzed variables were associated with stunting, health service utilization emerged as the strongest predictor, with children from

families who did not actively engage in health services being more than nine times at risk of stunting compared to those who did. This finding underscores the critical role of accessible, reliable, and culturally acceptable health services in stunting prevention.

This study uniquely examines socio-cultural determinants in the Papuan highlands, showing how traditional beliefs and poor sanitation significantly contribute to stunting alongside nutritional and health service factors. By integrating biomedical, environmental, and cultural perspectives, it provides context-specific evidence to inform tailored interventions. These findings support multisectoral approaches and contribute to global efforts toward achieving the SDG target of ending malnutrition by 2030, ensuring no community is left behind.

RESEARCH METHODOLOGY

Study Design

This study employed an analytical survey with a case-control design, which is commonly used to investigate the relationship between exposure to potential risk factors and specific health outcomes. The retrospective approach allowed the researchers to compare children who had already experienced stunting (cases) with those who had not (controls), and then examine past exposures to various determinants such as maternal knowledge, infectious diseases, environmental sanitation, socio-cultural practices, and health service utilization.

Study Setting and Period

The research was conducted in the working area of Oksibil Community Health Center (Puskesmas Oksibil), Bintang Mountains Regency, Papua Province, Indonesia. The data collection took place between March and May 2024. The study site includes four villages, Kabiding, Mabilabol, Okmakot, and Aldom, which represent the catchment area of the Oksibil Health Center. This setting is characterized by geographical isolation, limited infrastructure, and strong socio-cultural traditions that Influence maternal and child health practices.

Study Population and Sample

The study population consisted of toddlers aged 24–59 months residing in the Oksibil Health Center working area. A total of 66 respondents were included, consisting of 33 cases (children identified as stunted) and 33 controls (children with normal growth). Cases were selected from health center records and community-based surveys, while controls were chosen from the same population to ensure comparability. Inclusion criteria required that children be within the specified age range, reside in the study area, and have complete health and growth data. Children with congenital anomalies or chronic illnesses unrelated to nutrition were excluded to reduce bias.

Data Collection

Primary data were collected through structured questionnaires and interviews with mothers or primary caregivers, supported by direct observation and health records from the Puskesmas. The questionnaire covered demographic information, maternal knowledge about nutrition and stunting, history of infectious diseases in the past three months, household sanitation conditions, socio-cultural practices related to child feeding and maternal care, and utilization of health services. Data collectors were trained to ensure consistency and minimize interviewer bias.

Variables

Dependent variable: Stunting incidence, defined as a height-for-age z-score (HAZ)<– 2 SD based on WHO growth standards. Independent variables: Maternal knowledge (adequate vs. inadequate). History of infectious diseases (yes vs. no in the last three months). Environmental sanitation (safe vs. unsafe). Socio-cultural practices (supportive vs. risky). Health service utilization (active vs. inactive participation)

Data Analysis

Data were analyzed using both bivariate and multivariate approaches.

Bivariate analysis was conducted using Odds Ratios (OR) to determine the association between each independent variable and stunting incidence. Multivariate analysis employed logistic regression to control for confounding factors and to identify the most dominant risk factors. Statistical significance was set at $p < 0.05$.

Ethical Considerations

This study adhered to ethical research standards for public health studies. Approval and research permits were obtained from the local health authorities and the Oksibil Community Health Center. Participation was voluntary, and informed consent was obtained from all mothers or caregivers before data collection. Confidentiality of respondents' personal information was strictly maintained.

RESULT

Table 1. Characteristics of respondents

Variable	Case (Stunted) n=33	Control (Normal) n=33	Total n=66	%
Parental Education				
High (Senior HS/College)	11 (33.3%)	19 (57.6%)	30	45.5
Low (≤Junior HS/None)	22 (66.7%)	14 (42.4%)	36	54.5
Household Income				
> UMP	11 (33.3%)	12 (36.4%)	23	34.8
< UMP	22 (66.7%)	21 (63.6%)	43	65.2
Child's Sex				
Male	18 (54.5%)	15 (45.5%)	33	50.0
Female	15 (45.5%)	18 (54.5%)	33	50.0
Child's Age (Months)				
25–31	9 (27.3%)	6 (18.2%)	15	22.7
32–38	12 (36.4%)	6 (18.2%)	18	27.3
39–45	7 (21.2%)	3 (9.1%)	10	15.2
46–52	4 (12.1%)	7 (21.2%)	11	16.7
53–59	1 (3.0%)	10 (30.3%)	11	16.7

Most stunted children came from families with low parental education and low income. The majority of stunted children were boys, and most were in the 32–38-month age group. The analysis revealed that stunting among toddlers aged 24–59 months in the Oksibil Health Center, Bintang Mountains, is influenced by multiple interrelated factors. Univariate findings showed that most stunted children came from families with low Education and income, with boys and children aged 32–38 months more frequently affected.

Table 2. Bivariate Analysis of Risk Factors for Stunting

Risk Factor	Case (Stunted) n=33	Control (Normal) n=33	OR	95% CI
Maternal Knowledge				
Poor	10 (30.3%)	3 (9.1%)	1.911	0.215–16.976
Adequate	23 (69.7%)	30 (90.9%)	Ref	
Infectious Diseases				
Yes	29 (87.9%)	17 (51.5%)	8.090	1.593–41.088
No	4 (12.1%)	16 (48.5%)	Ref	
Environmental Sanitation				
Poor	17 (51.5%)	25 (75.8%)	1.375	0.220–8.591
Good	16 (48.5%)	8 (24.2%)	Ref	
Socio-Cultural Practices				
Risky	26 (78.8%)	11 (33.3%)	3.801	0.874–16.537
Non-Risky	7 (21.2%)	22 (66.7%)	Ref	
Health Service Utilization				
Inactive	26 (78.8%)	6 (18.2%)	9.339	1.990–43.820
Active	7 (21.2%)	27 (81.8%)	Ref	

All risk factors were associated with stunting. Health service utilization and infectious diseases showed the strongest effects. Bivariate analysis indicated that maternal knowledge, infectious diseases, environmental sanitation, socio-cultural practices, and health service utilization were all associated with stunting. Among these, infectious diseases and health service utilization showed the strongest associations.

Table 3. Multivariate Logistic Regression Analysis

Variable	B	Std. Error	OR	p-value	95% CI (Lower–Upper)
Maternal Knowledge	0.648	1.114	1.911	0.561	0.215–16.976
Infectious Diseases	2.091	0.829	8.090	0.012*	1.593–41.088
Environmental Sanitation	0.319	0.935	1.375	0.733	0.220–8.591
Socio-Cultural Practices	1.335	0.750	3.801	0.075	0.874–16.537
Health Service Utilization	2.234	0.789	9.339	0.005*	1.990–43.820

In the multivariate model, health service utilization (OR=9.339) and infectious diseases (OR=8.090) were the strongest independent predictors of stunting. Maternal knowledge, sanitation, and socio-cultural practices contributed but were not statistically significant after adjustment. Multivariate logistic regression confirmed that limited utilization of health services (OR=9.339, p=0.005) and recent infectious diseases (OR=8.090, p=0.012) were the most significant independent predictors of stunting. Meanwhile, maternal knowledge, environmental sanitation, and socio-cultural practices contributed to risk but were not statistically significant after adjustment. The persistence of stunting in this region is largely driven by poor access and low engagement with health services, coupled with frequent infections. These findings highlight the urgent need to strengthen maternal and child health services, improve infection prevention and treatment, and design culturally sensitive interventions to address socio-cultural and behavioral risk factors.

DISCUSSION

This study investigated the risk factors associated with stunting among toddlers aged 24–59 months in the Oksibil Health Center working area of the Bintang Mountains, Papua, Indonesia. The findings demonstrated that multiple determinants, including maternal knowledge, infectious diseases, environmental sanitation, socio-cultural practices, and health service utilization, were related to stunting incidence (Godoy *et al.*,

2024). Among these, health service utilization and infectious diseases emerged as the strongest predictors, emphasizing the importance of accessible, effective, and culturally appropriate health care in preventing growth failure (Htay *et al.*, 2023).

Maternal knowledge plays a central role in child nutrition and growth. In this study, low maternal knowledge was associated with nearly twice the risk of stunting (OR=1.911). However, the effect was not statistically significant in multivariate analysis, suggesting that knowledge alone may not directly Influence child growth without supportive practices and access to resources. Who observed that knowledge was significantly associated with stunting prevention behaviors but was moderated by socioeconomic and environmental conditions (Islam *et al.*, 2025). In Oksibil, many mothers possess basic awareness of nutrition but fail to apply it consistently, often due to competing priorities such as agricultural work or adherence to local traditions (Jalloh *et al.*, 2025). This indicates that while education interventions are essential, they must be coupled with structural support and behavior change programs to be effective (Jokhu and Syauqy, 2024).

The study highlighted infectious diseases as one of the strongest determinants of stunting, with affected children being over eight times more likely to be stunted (OR=8.090). This aligns with previous research showing that repeated infections, especially diarrhea, respiratory illnesses, and parasitic infestations, impair nutrient absorption and increase metabolic demands, thereby restricting linear growth. That toddlers with recurrent infections were at significantly higher risk of stunting. In the Oksibil context, poor sanitation, limited access to clean water, and overcrowded housing environments exacerbate the transmission of infectious agents. Moreover, delayed health-seeking behaviors, influenced by geographic barriers and cultural norms, further aggravate disease outcomes (Landin Basterra *et al.*, 2025). These findings reinforce the urgent need to strengthen both preventive and curative strategies for infectious diseases, including immunization coverage, sanitation improvement, and prompt medical treatment (Koomson, Afoakwah and Twumasi, 2024).

Environmental sanitation was found to be a contributing factor (OR=1.375), although not statistically significant in the adjusted model. Poor sanitation exposes children to pathogens that cause repeated infections, particularly diarrhea and intestinal parasites, which are known to hinder nutrient absorption and growth. Previous studies, such as those by Li, (2024), demonstrated that households lacking proper waste disposal, safe toilets, and clean water access had significantly higher rates of stunting. In Oksibil, the geographic and climatic conditions, including heavy rainfall, complicate sanitation practices, while cultural practices of open defecation and limited hygiene awareness further compound the problem (Mgomezulu *et al.*, 2025). Although sanitation did not emerge as a dominant predictor in this study, it remains a critical underlying determinant that interacts with other risk factors, particularly infectious diseases (Mulatu *et al.*, 2025).

Socio-cultural factors were significantly associated with stunting in bivariate analysis (OR=3.801). Traditions such as food taboos during pregnancy, avoidance of colostrum feeding due to misconceptions, and limited dietary diversity contribute to undernutrition in children. Similar observations were made by Ndovie *et al.*, (2025), who found that maternal beliefs and practices strongly influenced nutritional outcomes in toddlers. In Oksibil, reliance on carbohydrate-based foods such as sweet potatoes, with limited access to protein sources due to cost and transportation constraints, further worsens dietary inadequacies (Otoo *et al.*, 2025). The influence of socio-cultural norms underscores the need for culturally sensitive health education interventions (Oyenubi and

Rossouw, 2024). Public health messages must be tailored to address harmful practices while respecting local traditions, using trusted community figures and leaders to facilitate acceptance (Putri, Bachtiar and Suprapto, 2025).

Among all variables, health service utilization was identified as the strongest independent predictor of stunting (OR=9.339). Children from families that did not actively engage with health services were nearly ten times more likely to be stunted compared to those who did. This highlights the critical role of community health centers (Puskesmas) and posyandu (integrated health posts) in growth monitoring, early detection of malnutrition, and timely management of infections. However, in Oksibil, geographic isolation, limited transportation, and shortages of trained health personnel pose major barriers to consistent service delivery. Safitri *et al.*, (2025) also reported that poor access to health services was one of the leading determinants of stunting in Banda Aceh. The findings suggest that improving health service availability, accessibility, and community participation must be prioritized as a core intervention in stunting reduction strategies, particularly in remote highland areas (Supadmi *et al.*, 2024).

While individual factors such as knowledge, sanitation, or socio-cultural practices may not independently reach statistical significance in multivariate analysis, their combined effect contributes significantly to stunting risk (Tyarini *et al.*, 2024). For instance, poor maternal knowledge, when combined with harmful socio-cultural beliefs and weak engagement with health services, amplifies the likelihood of delayed growth. Similarly, poor sanitation facilitates infections, which, without timely medical care, result in chronic malnutrition (Wand *et al.*, 2024). These interactions emphasize that stunting is a multifactorial condition requiring integrated interventions (Suprapto *et al.*, 2025).

The findings of this study provide important insights for public health policy. First, strengthening primary health care services in remote areas is critical, including expanding the presence of trained health workers, improving infrastructure, and ensuring reliable supply chains for essential medicines and supplements. Second, community-based education programs should be designed to improve maternal knowledge, address harmful cultural practices, and promote healthy behaviors. Third, investments in sanitation and clean water infrastructure are essential to break the cycle of infections and malnutrition. Importantly, interventions must be context-specific and culturally tailored to ensure acceptance and sustainability.

Limitations

This study has certain limitations. The sample size was relatively small, which may affect the generalizability of the findings. Additionally, the case-control design, while useful for identifying associations, does not establish causality. Future research with larger cohorts and longitudinal designs would provide stronger evidence of causal pathways. Nevertheless, the study makes a valuable contribution by highlighting the multifactorial nature of stunting in a remote highland setting that has been underrepresented in previous research.

CONCLUSION

In conclusion, this study demonstrates that stunting among toddlers in the Bintang Mountains is strongly influenced by limited health service utilization and recurrent infectious diseases, alongside the contributory roles of maternal knowledge, sanitation, and socio-cultural practices. The findings emphasize the importance of strengthening health systems, addressing infectious diseases, and promoting culturally sensitive education and sanitation improvements. By focusing on these determinants, policymakers

and health practitioners can design more effective, context-specific interventions to reduce stunting in Papua and similar resource-limited highland regions.

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Conflict of Interest

There are no potential conflicts of interest relevant to this article.

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