

## Risk Factors for Stunting Among Children Under Five in Dolok Sanggul District: A Case-Control Study

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### ABSTRACT

**Introduction:** Stunting remains a major public health challenge affecting children under five years of age in many developing countries, including Indonesia. Chronic undernutrition during early childhood can impair physical growth, cognitive development, and long-term health outcomes. Despite national efforts to reduce its prevalence, stunting persists in many regions due to multiple biological, behavioural, and socioeconomic determinants. Therefore, this study aimed to analyse risk factors associated with stunting among children under 5 years of age in Dolok Sanggul District, North Sumatra, Indonesia.

**Research Methodology:** This study employed an observational analytic design using a case-control approach. The study was conducted from March to July 2023 in the Dolok Sanggul District. A total of 240 children under 5 years of age were included in the study, comprising 120 stunted children (case group) and 120 non-stunted children (control group). Participants were selected using a simple random sampling technique from the population of registered children under five. Data were collected through structured interviews with mothers and anthropometric measurements using standardized instruments. Statistical analysis included descriptive and bivariate analyses, with the Chi-square test used to assess the association between risk factors and stunting at  $\alpha = 0.05$ .

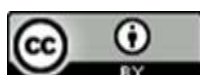
**Results:** Several factors were significantly associated with stunting incidence. Low birth weight ( $p = 0.040$ ), lack of exclusive breastfeeding ( $p = 0.030$ ), inadequate complementary feeding ( $p < 0.001$ ), poor maternal knowledge ( $p = 0.003$ ), and low household economic status ( $p < 0.001$ ) were significantly related to stunting among children under five. However, maternal education level was not significantly associated with stunting ( $p = 0.301$ ).

**Conclusion:** Stunting among children under five is influenced by multiple maternal, child, and socioeconomic factors. Interventions aimed at improving maternal nutrition, promoting exclusive breastfeeding, strengthening complementary feeding practices, and enhancing maternal knowledge are essential to prevent stunting. In addition, policies that address socioeconomic disparities and improve access to health services are crucial for sustainable stunting reduction.

**Keywords:** Child nutrition, Complementary feeding, Exclusive breastfeeding, Low birth weight, Stunting.



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## INTRODUCTION

Stunting remains one of the most persistent public health challenges affecting children under five years of age in low- and middle-income countries (Abdullah et al., 2025). The condition reflects chronic undernutrition during the most critical periods of growth and development, particularly during the first 1000 days of life (Adrizain et al., 2024). Children who experience stunting are more likely to face impaired cognitive development, reduced school performance, and increased risk of morbidity and mortality later in life (Asefa et al., 2024). At the population level, stunting also contributes to reduced human capital and long-term economic productivity. Despite global efforts to reduce its prevalence, stunting continues to affect millions of children worldwide, particularly in Asia and Africa (Debebe et al., 2026).

Indonesia remains among the countries with a high stunting burden. National surveys indicate that although the prevalence of stunting has declined in recent years, the rate remains above the threshold considered a public health concern (Dessie et al., 2025). Regional disparities further complicate the problem, with several provinces reporting higher prevalence rates than the national average. In North Sumatra Province, for example, the Indonesian Nutritional Status Survey reported a prevalence of 21.1% in 2022, indicating that stunting remains a significant nutritional and developmental problem among children under five (Endrinikapoulos et al., 2026). These findings highlight the urgent need for targeted interventions grounded in evidence on the underlying determinants of stunting (Erfini et al., 2025).

Previous studies have identified multiple determinants contributing to stunting in early childhood. Maternal factors such as low education, inadequate knowledge of child nutrition, and poor maternal health during pregnancy have been shown to influence child growth outcomes (Fajrunni'mah et al., 2026). Child-related factors, including low birth weight, lack of exclusive breastfeeding, and inappropriate complementary feeding practices, also play a critical role in determining nutritional status (Garina et al., 2024). In addition, socioeconomic conditions such as household income, food security, and access to health services influence the availability and quality of nutrition for young children. These multidimensional determinants indicate that stunting is not solely a nutritional problem but also a complex interaction of biological, behavioral, and social factors (Gaston et al., 2024).

Although numerous studies have examined the determinants of stunting in Indonesia, many have focused primarily on national-level analyses or cross-sectional designs that provide limited ability to examine risk associations between exposure and outcome (Hairuddin et al., 2026). Furthermore, evidence regarding the relative contribution of maternal knowledge, infant feeding practices, and socioeconomic status to stunting in specific districts remains limited. Local-level evidence is crucial because the determinants of stunting may vary across regions, depending on regional socioeconomic conditions, health service availability, and cultural feeding practices (Matovu et al., 2026).

The lack of context-specific evidence represents an important research gap in efforts to design effective interventions to prevent stunting (Merera et al., 2026). Without understanding the dominant risk factors within a particular community, policies and programs may fail to address the most influential determinants of child growth failure. Therefore, empirical studies that examine multiple risk factors simultaneously and compare stunted and non-stunted children are needed to strengthen the evidence base for targeted public health interventions. This study offers a novel contribution by examining the association between maternal, child, and socioeconomic factors and the incidence of stunting among children under five in Dolok Sanggul District using

a case-control design. By comparing children who experience stunting with those who do not, the study provides stronger analytical evidence on the local risk factors contributing to chronic growth failure. The findings are expected to support more effective community-based interventions, particularly those focusing on maternal knowledge, infant feeding practices, and socioeconomic vulnerability.

Therefore, the objective of this study is to analyse the risk factors associated with stunting among children under 5 years of age in Dolok Sanggul District. Specifically, the study examines the relationship between low birth weight, exclusive breastfeeding, complementary feeding practices, maternal education, maternal knowledge, and household economic status and the occurrence of stunting.

## RESEARCH METHODOLOGY

### Study Design

This study employed an observational analytic design using a case-control approach. The case-control design was selected because it allows for the identification and comparison of exposure to potential risk factors between children under five who experienced stunting (cases) and those who did not (controls). This design is appropriate for examining multiple determinants of relatively prevalent outcomes, such as stunting, in community settings.

### Setting and Participants

The study was conducted in Dolok Sanggul District, Humbang Hasundutan Regency, North Sumatra, Indonesia. Data collection was carried out from March to July 2023. The study population consisted of all children under 5 years of age registered in the local health services' working area, totalling approximately 1,300 children. Based on health center records, 406 children were identified as experiencing stunting. The inclusion criteria were: (1) children aged 0–59 months, (2) residing in Dolok Sanggul District during the study period, and (3) having complete maternal and child health records. Exclusion criteria included children with congenital growth abnormalities, chronic illnesses, or incomplete anthropometric data. The sample size was determined using a case-control sampling approach. A total of 240 children were included in the study: 120 with stunting (case group) and 120 without stunting (control group). Participants were selected using a simple random sampling technique from the eligible population list.

### Variables and Measurement

The dependent variable in this study was the incidence of stunting among children under five years of age. Stunting was defined as a height-for-age z-score (HAZ) below  $-2$  standard deviations according to the WHO Child Growth Standards. Independent variables included low birth weight (LBW), exclusive breastfeeding, complementary feeding practices, maternal education, maternal knowledge, and household economic status. Low birth weight was defined as a birth weight of less than 2,500 grams. Exclusive breastfeeding refers to infants who receive only breast milk, without any additional food or drink, during the first 6 months of life. Complementary feeding refers to the provision of additional food to infants after the age of six months. Maternal education was categorized into lower education (primary or junior high school) and higher education (senior high school or above). Maternal knowledge regarding child nutrition and stunting was assessed using a structured questionnaire. Household economic status was determined based on monthly household income categories. Primary data were collected through structured interviews with mothers using observation sheets and questionnaires. Children's height was measured using a roll meter.

## Data Collection

Data collection was conducted by trained research assistants under the supervision of the research team. Interviews with mothers were conducted using standardized questionnaires to collect information on breastfeeding practices, complementary feeding, maternal education, maternal knowledge, and household economic status. Anthropometric measurements were conducted according to standard procedures to ensure accuracy and consistency. Quality control procedures included training enumerators, calibrating measurement instruments, and cross-checking completed questionnaires to minimize data entry errors.

## Data Analysis

Data analysis was performed using statistical software. Descriptive statistics were used to summarize respondent characteristics, including frequency distributions and percentages. Bivariate analysis was conducted using the Chi-square test to examine the association between the independent variables and stunting incidence. The strength of association was presented as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was determined at  $\alpha = 0.05$ .

## Ethical Approval

This study received ethical approval from the Health Research Ethics Committee of Universitas Sari Mutiara Indonesia. The ethical clearance certificate number is 184/F/KEP/USM/VIII/2023. Before participation, informed consent was obtained from the mothers or caregivers of all children involved in the study. Participants were informed about the purpose of the research, confidentiality of their data, and their right to withdraw from the study at any time without consequences.

# RESULT

**Table 1.** Characteristics of Respondents (n = 240)

| Variable                | Category        | n   | %    |
|-------------------------|-----------------|-----|------|
| Child age (months)      | 0–11            | 41  | 17.1 |
|                         | 12–23           | 72  | 30.0 |
|                         | 24–35           | 44  | 18.2 |
|                         | 36–47           | 63  | 26.1 |
|                         | 48–59           | 40  | 16.6 |
| Sex                     | Male            | 132 | 55.0 |
|                         | Female          | 108 | 45.0 |
| Low birth weight        | Yes             | 63  | 26.2 |
|                         | No              | 177 | 73.8 |
| Exclusive breastfeeding | Yes             | 91  | 37.9 |
|                         | No              | 149 | 62.1 |
| Supplementary feeding   | Yes             | 96  | 40.0 |
|                         | No              | 144 | 60.0 |
| Maternal education      | Lower           | 137 | 57.1 |
|                         | Higher          | 103 | 42.9 |
| Maternal knowledge      | Good            | 114 | 47.5 |
|                         | Poor            | 126 | 52.5 |
| Economic status         | > IDR 2,000,000 | 98  | 40.8 |
|                         | < IDR 2,000,000 | 142 | 59.2 |

The descriptive results indicate that stunting risk may be influenced by multiple maternal, child, and socioeconomic characteristics. A considerable proportion of children did not receive exclusive breastfeeding and lived in households with relatively low economic status, which are potential contributors to poor nutritional outcomes.

Bivariate analysis was conducted using the Chi-square test to assess the association between the independent variables and stunting incidence. Table 2 shows that low birth weight, exclusive breastfeeding, complementary feeding, maternal knowledge, and household economic status were significantly associated with stunting among children under five. However, maternal education was not significantly associated with stunting.

**Table 2.** Association between Risk Factors and Stunting Incidence

| Variable                | Category        | Stunting n (%) | Non-Stunting n (%) | OR   | 95% CI    | p-value |
|-------------------------|-----------------|----------------|--------------------|------|-----------|---------|
| Low birth weight        | Yes             | 39 (16.2)      | 24 (10.0)          | 4.84 | 1.06–3.46 | 0.040   |
| Exclusive breastfeeding | No              | 81 (33.8)      | 96 (40.0)          | 5.11 | 0.32–0.92 | 0.030   |
|                         | Yes             | 54 (22.5)      | 37 (15.4)          |      |           |         |
| Supplementary feeding   | No              | 66 (27.5)      | 83 (34.6)          | 50.1 | 0.07–0.23 | 0.000   |
|                         | Yes             | 21 (8.8)       | 75 (31.2)          |      |           |         |
| Maternal education      | No              | 99 (41.2)      | 45 (18.8)          | 1.18 | 0.71–1.97 | 0.301   |
|                         | Lower           | 71 (29.6)      | 66 (27.5)          |      |           |         |
| Maternal knowledge      | Higher          | 49 (20.4)      | 54 (22.5)          | 9.62 | 0.26–0.74 | 0.003   |
|                         | Good            | 45 (18.8)      | 69 (28.8)          |      |           |         |
| Economic status         | Poor            | 75 (31.2)      | 51 (21.2)          | 33.3 | 0.11–0.35 | 0.000   |
|                         | > IDR 2,000,000 | 27 (11.2)      | 71 (29.6)          |      |           |         |
|                         | < IDR 2,000,000 | 93 (38.8)      | 49 (20.4)          |      |           |         |

The Chi-square analysis demonstrated several statistically significant determinants of stunting. Children with low birth weight were significantly more likely to experience stunting compared with those with normal birth weight ( $p = 0.040$ ). Similarly, lack of exclusive breastfeeding and inadequate complementary feeding practices were significantly associated with increased risk of stunting. Maternal knowledge also showed a significant association, indicating that children of mothers with poor knowledge had higher odds of stunting. Household economic status was another strong determinant, with children from lower-income households experiencing a higher prevalence of stunting. However, maternal education level was not significantly associated with stunting incidence ( $p = 0.301$ ).

The findings of this study indicate that stunting among children under five in Dolok Sanggul District is influenced by multiple interrelated maternal, child, and socioeconomic factors. Descriptive analysis showed that a considerable proportion of children did not receive exclusive breastfeeding and lived in households with relatively low economic status, conditions that may contribute to inadequate nutritional intake during early childhood. The bivariate analysis showed that several variables were significantly associated with stunting incidence. Children with a history of low birth weight were more likely to experience stunting compared with those born with normal birth weight, indicating the importance of maternal health and fetal growth during pregnancy. Infant feeding practices also played a critical role. Children who did not receive exclusive breastfeeding and those who were not provided with appropriate complementary feeding had significantly higher odds of stunting, emphasizing the importance of optimal feeding practices during the first two years of life. Maternal knowledge regarding nutrition and child health was another significant determinant. Children of mothers with poor knowledge had a

greater likelihood of experiencing stunting, suggesting that awareness and understanding of proper nutrition influence caregiving behavior. Household economic status was also strongly associated with stunting, reflecting the role of financial capacity in accessing nutritious food and health services. Overall, these results highlight that stunting is a multifactorial condition requiring integrated interventions targeting maternal education, infant feeding practices, and socioeconomic improvement.

## DISCUSSION

This study examined several maternal, child, and socioeconomic determinants of stunting among children under 5 years of age in Dolok Sanggul District. The findings demonstrate that stunting is influenced by multiple interrelated factors rather than a single determinant. The results of the bivariate analysis indicate that low birth weight, exclusive breastfeeding, complementary feeding practices, maternal knowledge, and household economic status were significantly associated with stunting. Among these factors, infant feeding practices and household economic status showed particularly strong associations with stunting incidence (Mgomezulu et al., 2025).

These findings reinforce the understanding that early-life conditions play a critical role in shaping children's growth trajectories. Children born with low birth weight were found to have a higher likelihood of experiencing stunting compared with those born with normal birth weight (Mitra et al., 2025). Similarly, children who did not receive exclusive breastfeeding or adequate complementary feeding were more likely to develop chronic growth failure. Maternal knowledge regarding nutrition also emerged as an important determinant, suggesting that caregivers' understanding of child nutrition influences feeding behavior and health practices (Mulatu et al., 2025). In addition, children from low-income households were more vulnerable to stunting due to limited access to nutritious food and health services (Mwale et al., 2026).

From a conceptual perspective, the findings of this study can be interpreted within the UNICEF conceptual model of child malnutrition. This model explains that stunting arises from a complex interaction between immediate causes (inadequate dietary intake and disease), underlying causes (household food insecurity, inadequate care practices, and limited access to health services), and basic structural causes such as poverty and socioeconomic inequality (Nduwayezu et al., 2025). Low birth weight represents a biological vulnerability that originates during the prenatal period. Inadequate maternal nutrition during pregnancy and poor antenatal care can lead to restricted fetal growth, thereby increasing the risk of impaired linear growth during infancy and early childhood (Orimadegun et al., 2025). Children born with low birth weight often experience physiological limitations in nutrient absorption and immune function, making them more susceptible to infections and nutritional deficiencies that contribute to chronic growth failure (Pasha et al., 2025).

Infant feeding practices, particularly exclusive breastfeeding and appropriate complementary feeding, represent critical determinants of early childhood nutrition (Rosyada et al., 2026). Breast milk provides essential nutrients, antibodies, and bioactive

components that support immune development and optimal growth. Inadequate breastfeeding practices or delayed introduction of complementary foods can result in insufficient energy and micronutrient intake during the period of rapid growth (Sada et al., 2025). Consequently, children who do not receive appropriate feeding practices are more vulnerable to long-term nutritional deficits. Maternal knowledge also plays a key role in shaping child nutrition outcomes (Safitri et al., 2025). Caregivers with greater knowledge of nutrition and child health are more likely to adopt appropriate feeding practices, maintain hygiene, and seek timely health services. Conversely, limited knowledge may lead to suboptimal feeding patterns and delayed responses to childhood illnesses, increasing the risk of chronic malnutrition (Sundjaya et al., 2025).

Household economic status represents a broader structural determinant that influences the availability and accessibility of nutritious foods (Supadmi et al., 2024). Families with limited financial resources often face constraints when purchasing a variety of nutrient-rich foods. Economic hardship may also limit access to healthcare services and sanitation facilities, further increasing children's vulnerability to undernutrition (Wand et al., 2024). The findings of this study are consistent with a growing body of international research demonstrating that stunting is strongly associated with early-life nutritional conditions and socioeconomic disparities (Wanka et al., 2025). Several studies conducted in low- and middle-income countries have reported that low birth weight is a significant predictor of stunting in early childhood. Similar findings have been documented across South Asia and Sub-Saharan Africa, where children born with low birth weight have substantially higher odds of linear growth faltering. The relationship between exclusive breastfeeding and stunting has also been widely reported in previous studies. Evidence from global nutrition research indicates that exclusive breastfeeding during the first six months of life is associated with improved growth outcomes and reduced risk of infectious diseases. Likewise, appropriate complementary feeding practices after six months of age are essential to meet increasing nutritional demands during infancy.

Studies conducted in several regions of Indonesia have similarly highlighted the importance of maternal knowledge and socioeconomic conditions in determining children's nutritional status. Research from both rural and urban communities suggests that mothers with greater nutritional knowledge are more likely to implement appropriate feeding practices and maintain healthier childcare behaviours. While the overall findings of this study are broadly consistent with previous research, some variations in the magnitude of associations between specific determinants and stunting are observed. For example, the strong association between complementary feeding practices and stunting observed in this study may reflect local variations in food availability, cultural feeding practices, and access to health information within the study area.

Similarly, the lack of a statistically significant association between maternal education and stunting in this study differs from some previous studies that have identified maternal education as a strong predictor of child nutritional status. One possible explanation is that maternal education does not automatically translate into adequate

nutritional knowledge or caregiving practices. In certain contexts, mothers with relatively higher formal education may still have limited access to practical nutrition information or resources necessary to support optimal child growth. These differences highlight the importance of contextual factors in shaping nutritional outcomes. Determinants of stunting may vary across geographic areas depending on cultural practices, economic conditions, and the availability of public health services.

### **Strengths and Limitations**

This study provides valuable insights into the determinants of stunting at the community level using a case-control research design, which allows for comparison between children who experience stunting and those who do not. The use of multiple variables representing maternal, child, and socioeconomic factors also provides a more comprehensive understanding of the multidimensional nature of stunting.

However, several limitations should be considered when interpreting the results. First, the case-control design cannot establish causal relationships between exposure and outcome. Second, some variables were based on mothers' self-reported information, which may introduce recall bias. Third, the study was conducted in a single district, which may limit the generalizability of the findings to other regions with different socioeconomic or cultural characteristics. Despite these limitations, the findings contribute to the growing body of evidence regarding the multifactorial determinants of stunting and highlight the importance of integrated interventions that address biological, behavioral, and socioeconomic factors simultaneously.

## **CONCLUSION**

This study aimed to analyse risk factors associated with stunting among children under 5 years of age in Dolok Sanggul District. The findings indicate that several determinants significantly contribute to the occurrence of stunting, including low birth weight, lack of exclusive breastfeeding, inadequate complementary feeding practices, poor maternal knowledge, and low household economic status. These results demonstrate that stunting is a multifactorial condition influenced by biological factors, caregiving practices, and socioeconomic circumstances. Among the identified determinants, infant feeding practices and household economic status play a critical role in shaping children's nutritional outcomes. Children who were not exclusively breastfed or who did not receive appropriate complementary feeding were more likely to experience impaired growth. Similarly, children born with low birth weight and those from low-income households faced a higher risk of developing chronic growth failure.

These findings suggest that effective stunting prevention requires integrated interventions focusing on the first 1000 days of life. Strengthening maternal nutrition during pregnancy, promoting exclusive breastfeeding, improving complementary feeding practices, and enhancing maternal knowledge through community-based education programs are essential strategies. In addition, policies that improve household economic resilience and access to health services are necessary to sustainably reduce the burden of stunting.

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authors also thank all mothers and caregivers who participated in this study and contributed valuable information.

### Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

### Ethical Considerations

This study was conducted in accordance with the ethical principles for research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Sari Mutiara Indonesia with approval number 184/F/KEP/USM/VIII/2023. Before data collection, informed consent was obtained from the mothers or primary caregivers of all participating children. Participants were informed about the purpose of the study, the procedures involved, the confidentiality of their data, and their right to withdraw from the study at any time without consequences. All collected data were anonymized and used solely for research purposes.

### Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to ethical and privacy considerations.

### Authors' Contributions

Rinawati Sembiring: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Henny Syapitri: Methodology, Investigation, Data curation, Writing – review & editing.

Marthalena Simamora: Investigation, Data collection, Validation.

Agnes Purba: Data curation, Formal analysis, Visualization.

Ivan Elisabeth Purba: Investigation, Resources, Project administration.

Asima Sirat: Validation, Writing – review & editing.

Irna Nursanti: Supervision, Methodological review, Writing – review & editing.

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