Original Article

Independent Determinants of Stunting Among Children Under Five Years: A Case-Control Study Using Multivariable Analysis

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ABSTRACT

Background: Stunting is a chronic growth disorder caused by long-term nutritional deficiencies and repeated infections during the first 1,000 days of life. This study aimed to identify independent determinants of stunting among children under five years in the Yosomulyo Community Health Center, Metro City, Lampung, Indonesia.

Methods: An analytical observational study with an unmatched retrospective case-control design was conducted from May 6 to May 30, 2025. A total of 76 children (38 cases and 38 controls) were selected using purposive sampling. Data were collected through structured interviews and verified using Maternal and Child Health (MCH) handbooks and health records to minimize recall bias. Statistical analysis was performed using IBM SPSS Statistics version 26. Bivariate analysis was conducted using the Chi-square test, and multivariate analysis was performed using multiple logistic regression with the backward likelihood ratio method.

Results: Showed that maternal anemia during pregnancy, exclusive breastfeeding, history of diarrhea, and low birth weight (LBW) were independent determinants of stunting. Maternal anemia during pregnancy was associated with stunting (AOR = 2.76; 95% CI: 1.25–6.10; p = 0.001), exclusive breastfeeding (AOR = 4.86; 95% CI: 1.80–13.10; p = 0.001), history of diarrhea (AOR = 3.42; 95% CI: 1.54–7.61; p = 0.003), and low birth weight (AOR = 2.01; 95% CI: 1.10–3.67; p = 0.010).

Conclusion: stunting is influenced by both prenatal and postnatal factors, particularly maternal nutrition during pregnancy, infant feeding practices, and early-life health conditions. Strengthening maternal nutrition programs, promoting exclusive breastfeeding, preventing low birth weight, and controlling childhood infections are essential strategies for stunting prevention. Future research using larger multi-center prospective designs is recommended to confirm these findings and strengthen causal inference.

Keywords: Stunting; Child, Preschool; Breast Feeding; Anemia; Low Birth Weight; Risk Factors

Implications for Practice:

- Primary healthcare providers in resource-limited settings should strengthen early detection and management of maternal anemia during pregnancy through routine antenatal screening, risk stratification, nutritional counseling, appropriate iron–folic acid supplementation, and continuous maternal health monitoring. Considering that maternal anemia was identified as the most dominant determinant of stunting, these actions should be prioritized within standard antenatal care services.
- Healthcare workers and maternal–child health programs require structured

Implications for Practice:

professional training to improve competencies in preventing low birth weight and promoting exclusive breastfeeding. This includes capacity building in maternal nutrition assessment, breastfeeding counseling, early identification of high-risk pregnancies, and effective communication strategies to support optimal infant feeding practices during the first 1,000 days of life, particularly in community-based and resource-constrained settings.

- Local health authorities and policymakers should integrate these findings into updated clinical and public health guidelines for stunting prevention, emphasizing maternal anemia screening, low birth weight prevention, and exclusive breastfeeding promotion. Strengthening integrated maternal and child health interventions at the primary care level is essential to ensure effective implementation and to reduce the burden of stunting among children under five years of age in similar low-resource community settings.

Introduction

Stunting is a form of growth failure resulting from the cumulative effects of chronic nutritional deficiencies that occur from pregnancy until the first 24 months of life (KEMENKES RI, 2021). According to the World Health Organization (WHO), stunting is defined as a condition in which a child's length or height-for-age is below -2 standard deviations from the WHO Child Growth Standards median due to irreversible consequences of inadequate nutrition and/or recurrent or chronic infections during the first 1,000 days of life. This critical period, often referred to as the first 1,000 days of life (1,000 Days of Life) (WHO, 2025), represents a window of opportunity for optimal growth and development. Chronic undernutrition during this period increases the risk of stunting, weakens the immune system, and contributes to the development of non-communicable diseases later in life (KEMENKES RI, 2021).

Stunting remains a major global public health challenge because of its substantial impact on child survival, growth, and development. Stunting contributes to approximately 14.5% of child mortality and 12.6% of functional developmental disorders, including impaired brain development, delayed motor skills, and restricted mental growth (Agustina, 2022). Poor growth during fetal life and the first 1,000 days can lead to permanent growth deficits if postnatal environmental conditions fail to support adequate development. In the long term, stunting is associated with reduced cognitive performance, lower educational achievement, decreased productivity, and an increased risk of chronic diseases such as diabetes, obesity, cardiovascular disease, stroke, and cancer (Ayukarningsih & Inayati, 2025).

Based on global estimates, the prevalence of child stunting was reported at 26.4% in 2012 and 23.2% in 2024, Stunting affect millions of children under five years of age. More than half of these children lived in Asia, while the remainder were concentrated in Africa. Indonesia remains one of the countries with a high burden of stunting and has the second-highest prevalence in Southeast Asia after Timor-Leste, with an estimated prevalence of 31% (WHO 2025). Based on the 2023 Indonesian Health Survey (SKI), the prevalence of stunting among children under five years of age in Indonesia was approximately 21.5%, indicating that about one in five children under five was affected by stunting. In Lampung Province, the prevalence of stunting among children under five was recorded at 14.9% (SKI, 2023).

In Lampung Province, stunting remains a significant public health concern. The prevalence declined from 18.5% in 2021 to 15.2% in 2022 but increased slightly to 15.9% in 2024 after reaching 14.9% in 2023 (Lampung Provincial Health

Office, 2023). In Metro City, the prevalence increased from 9.3% in 2021 to 10.4% in 2022, placing the city among the areas with a relatively high burden of stunting in the province. Within Metro City, the Yosomulyo Community Health Center has consistently reported a high number of stunting cases. In 2021, the prevalence reached 11% (181 cases among 1,643 children under five), remained at 11% in 2022, and although the number of cases decreased, the area continued to experience a considerable burden of stunting. In 2023, Yosomulyo ranked as the third highest contributor to stunting cases in Metro City (Metro City Health Office, 2022).

The etiology of stunting is multifactorial and involves interactions between maternal, child, environmental, and socioeconomic factors. Theoretically, this condition can be explained using the UNICEF conceptual framework of malnutrition, which highlights the interrelationship between immediate causes (inadequate dietary intake and infectious diseases), underlying causes (food insecurity, inadequate care practices, and poor health services), and basic causes (socioeconomic and structural factors) (Firrahmawati et al., 2023). In addition, Barker's Fetal Origins Hypothesis explains how intrauterine nutritional disturbances, such as maternal anemia, may program long-term metabolic and growth outcomes, including low birth weight and subsequent stunting. These pathways demonstrate the causal chain linking maternal anemia, low birth weight, infection, breastfeeding practices, and child growth failure (P2PTM Kemenkes RI, 2018).

Several studies have reported significant associations between these factors and stunting. Sampe et al., (2020) found that children who did not receive exclusive breastfeeding were 61 times more likely to experience stunting than those who were exclusively breastfed (p = 0.000). Sutriyawan et al., (2020) reported that children with a history of infectious diseases had a sevenfold higher risk of stunting compared with those without such a history (p = 0.000). Kamilia, (2019) demonstrated a significant association between low birth weight and stunting, suggesting that intrauterine growth restriction contributes to subsequent growth faltering (p = 0.000). Furthermore, another study found that maternal education was significantly associated with stunting (p = 0.003), although family income was not significantly related to stunting occurrence (Sari & Zelharsandy, 2020).

However, previous studies have primarily examined these factors individually rather than simultaneously evaluating their independent effects, leading to inconsistencies in findings across different populations. For example, associations between diarrhea and stunting, as well as breastfeeding practices and maternal factors, vary between studies due to differences in study design, population characteristics, and healthcare access. In developed countries, stunting is relatively rare due to stronger health systems and better maternal nutrition, whereas in Indonesian settings, persistent disparities in socioeconomic conditions, antenatal care coverage, and infant feeding practices contribute to a higher and more heterogeneous burden of stunting. This highlights the need for context-specific evidence on independent determinants.

From a practical perspective, identifying these determinants provides essential input for strengthening maternal and child health services at the primary healthcare level, improving antenatal screening, reinforcing breastfeeding promotion programs, and guiding local health policy interventions targeting the first 1,000 days of life. Therefore, this study aimed to determine the factors associated with stunting among children under five years of age in the Yosomulyo Community Health Center, Metro City, Lampung, Indonesia, to identify the independent determinants of stunting using multiple logistic regression analysis, and to determine the most dominant factor associated with stunting among the study population. Specifically, this study seeks to quantify the independent effects of maternal anemia, low birth weight, infectious history, and infant feeding practices on stunting in a community-based Indonesian setting.

Methods

Study Design

This study employed an analytical observational study using an unmatched retrospective case-control design. The case-control approach is used to identify factors associated with a specific outcome by comparing individuals with the condition of interest (cases) and those without the condition (controls). In this study, stunting status was identified first, and prior exposure to potential risk factors was subsequently assessed to determine their association with stunting.

This study was conducted in the working area of the Yosomulyo Community Health Center, Metro City, Lampung Province, Indonesia. Data collection was carried out from 6 May to 30 May 2025. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for case-control studies, and a completed STROBE checklist is available as supplementary material. A participant flow diagram describing identification, screening, eligibility assessment, and inclusion in the final analysis is presented in **Figure 1.**

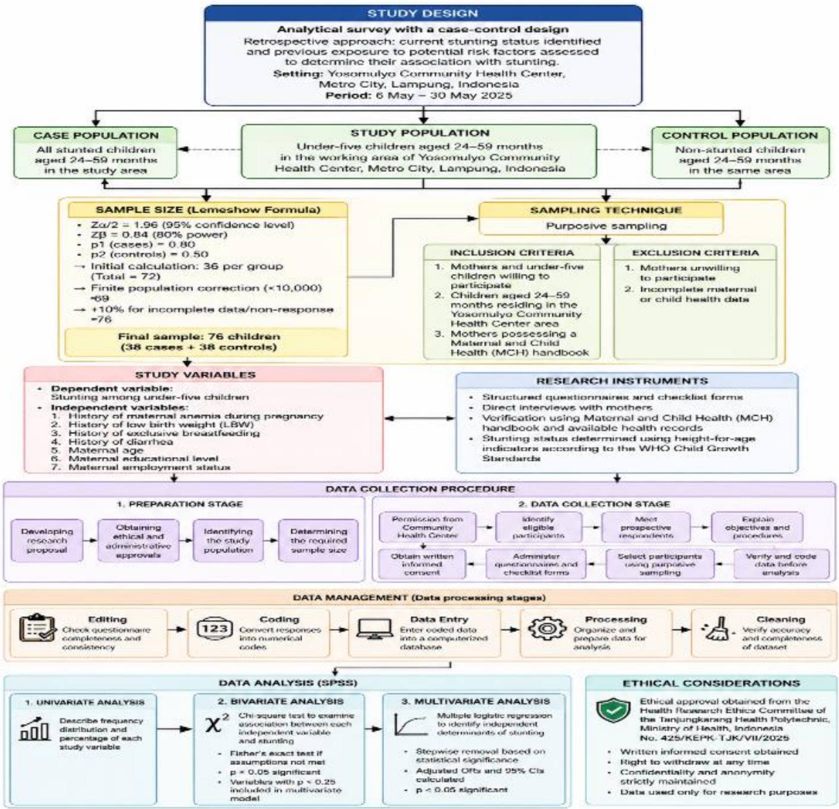

Figure 1. Study Design

Participants

The study population consisted of children aged 24–59 months residing in the working area of the Yosomulyo Community Health Center, Metro City, Lampung, Indonesia. The case population included all stunted children aged 24–59 months, while the control population comprised non-stunted children of the same age range residing within the same community.

The sample size was calculated using the Lemeshow formula for unmatched case-control studies comparing two proportions (Lemeshow et al., 1990). The assumptions included a 95% confidence level ($Z\alpha/2$ = 1.96), 80% statistical power ($Z\beta$ = 0.84), an estimated proportion of non-exclusive breastfeeding among cases of 0.80, and among controls of 0.50 (Fauzy, 2019).

The initial calculation yielded a minimum sample size of 36 participants per group (72 participants total). Because the target population was fewer than 10,000 individuals, a finite population correction was applied, resulting in a minimum required sample size of 69 participants. An additional 10% was added to account for potential non-response or incomplete data, resulting in a final sample size of 76 participants.The final study sample consisted of 76 participants, including 38 stunted children (cases) and 38 non-stunted children (controls).

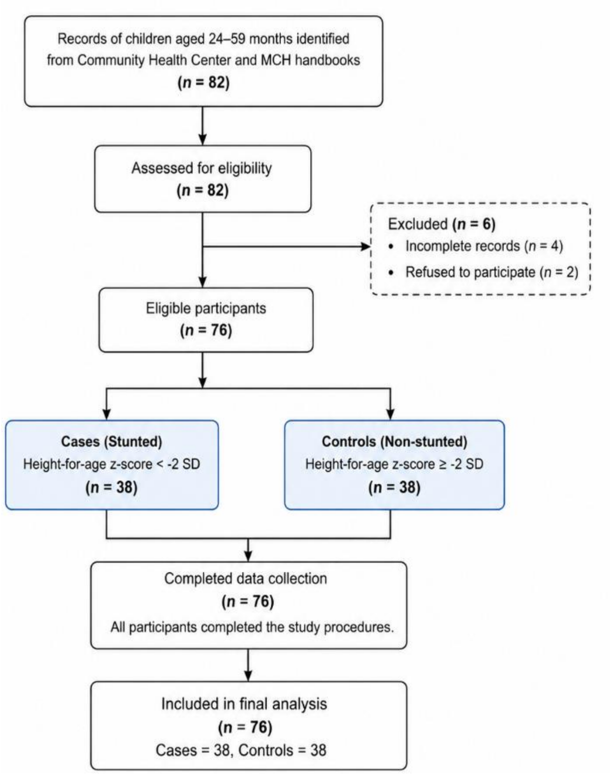

Figure 2. Flowchart of Participant Selection

Purposive sampling was employed to recruit participants who met the predefined inclusion and exclusion criteria. Eligible participants were mothers who were willing to participate and provide informed consent, had children aged 24–59 months residing within the Yosomulyo Community Health Center catchment area, and possessed a Maternal and Child Health (MCH) handbook. Mothers were excluded if they declined participation, had incomplete maternal or child health records, or if their children lacked the anthropometric data required to determine stunting status.

Participant recruitment was conducted in several stages. Initially, anthropometric records from the community health center and MCH handbooks were reviewed to identify potentially eligible children. Subsequently, children were classified according to height-for-age z-scores based on the WHO Child Growth Standards. Children with height-for-age z-scores below

−2 standard deviations were categorized as cases (stunted), whereas those with normal height-for-age were classified as controls (non-stunted). Mothers of eligible children were then contacted and invited to participate in the study.

A total of 82 mother–child pairs were assessed for eligibility. Six participants were excluded due to incomplete health records (n = 4) or refusal to participate (n = 2). Consequently, 76 mother–child pairs were enrolled, comprising 38 cases and 38 controls. All enrolled participants completed the study procedures, resulting in a response rate of 92.7%. No participants withdrew after enrollment, and no loss to follow-up occurred during data collection (**Figure 2**).

Instruments

Data were collected using a structured questionnaire and a verification checklist developed based on the study objectives and relevant literature on determinants of stunting. The questionnaire comprised seven domains: child characteristics, history of diarrhea, exclusive breastfeeding practices, birth history and low birth weight, maternal anemia during pregnancy, maternal sociodemographic characteristics (age, education, and employment), and household and health service information. In total, the questionnaire contained 38 closed-ended items with categorical response options.

The instrument was adapted from previously validated questionnaires and relevant literature to suit the local context. Content validity was evaluated by experts in maternal and child health and public health research, followed by a pilot test among mothers with characteristics similar to the study population. Item validity was assessed using item-total correlation, while reliability testing demonstrated acceptable internal consistency with a Cronbach's alpha coefficient greater than 0.70.

Data were collected through face-to-face interviewer-administered interviews conducted by trained research assistants. Questionnaire responses were cross-verified using information recorded in the Maternal and Child Health (MCH) handbook and available health records to improve data accuracy and minimize recall bias. A copy of the questionnaire is provided in the Supplementary Material.

The dependent variable was stunting status. The independent variables included history of diarrhea, maternal anemia during pregnancy, exclusive breastfeeding, low birth weight (LBW), maternal age, maternal education, and maternal employment. Stunting status was determined using height-for-age z-scores based on the WHO Child Growth Standards. Children with height-for-age z-scores below −2 standard deviations were classified as stunted, whereas those with height-for-age z-scores ≥ −2 standard deviations were classified as non-stunted. Independent variables were operationalized as binary or categorical variables according to predefined study classifications.

Data Collection

Data collection was conducted by trained health research assistants under the supervision of the principal investigator. Before field implementation, all enumerators participated in training sessions covering study objectives, research ethics, interview techniques, questionnaire administration, data verification procedures, and quality assurance protocols.

Following informed consent, mothers were interviewed using the structured questionnaire. Information obtained during interviews was cross-checked against the Maternal and Child Health (MCH) handbook and available health records to minimize recall bias and improve data accuracy.

To ensure data quality, completed questionnaires were reviewed daily by the research team. Data consistency checks and verification procedures were performed by comparing questionnaire responses with documentary records whenever available. Any discrepancies were clarified immediately with participants or verified using health records. All study data were coded, anonymized, and entered into password-protected electronic databases accessible only to the research team.

Data Analysis

Data were entered and analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Univariate analysis was performed to summarize the distribution of study variables using frequencies and percentages.

Bivariate associations between each independent variable and stunting status were examined using the Chi-square test. Fisher's exact test was applied when the assumptions for the Chi-square test were not satisfied. Crude odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to estimate the strength of associations. Variables with p-values < 0.25 in the bivariate analysis were considered candidates for inclusion in the multivariable model.

Multivariable logistic regression analysis was performed using the Backward Likelihood Ratio (Backward LR) method to identify independent determinants of stunting. Candidate variables were entered into the initial model and sequentially removed based on statistical significance until the final model was obtained. Prior to model development, multicollinearity was assessed using tolerance values and variance inflation factors (VIF), with tolerance values > 0.10 and VIF values < 10 indicating the absence of problematic multicollinearity. Adjusted odds ratios (AORs), 95% confidence intervals (CIs), and corresponding p-values were reported for the final model. Statistical significance was set at p < 0.05.

All questionnaires and documentary records were complete following data verification. Consequently, no missing data were identified in the final dataset, and no imputation procedures were required.

Ethical Considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Health Research Ethics Committee of the Tanjungkarang Health Polytechnic, Ministry of Health, Indonesia (Ethical Approval No. 425/KEPK-TJK/VII/2025). Written informed consent was obtained from all participating mothers prior to data collection after they had been fully informed about the study objectives, procedures, potential risks, and benefits. Participant confidentiality and anonymity were strictly maintained throughout the study.

Results

Table 1. Distribution of Study Variables (n=76)

Variable	Category	n (%)
Child's sex	Male	39 (51.3)
	Female	37 (48.7)
Child's age (months)	24–35	33 (43.4)
	36–47	24 (31.6)
	48–59	19 (25.0)
History of diarrhea	Yes	31 (40.8)
	No	45 (59.2)
History of low birth weight (LBW)	Yes	38 (50.0)
	No	38 (50.0)
Maternal anemia during pregnancy	Yes	33 (43.4)
	No	43 (56.6)
Exclusive breastfeeding	No	32 (42.1)
	Yes	44 (57.9)
Maternal age	<20 or >35 years	30 (39.5)
	20–35 years	46 (60.5)
Maternal education	Low	34 (44.7)
	High	42 (55.3)

Variable	Category	n (%)
Maternal employment	Employed	29 (38.2)
	Unemployed	47 (61.8)
Total		76 (100.0)

Table 1 illustrates the distribution of study variables among the 76 children under five years of age included in the study. Slightly more than half of the children were male (51.3%), while 48.7% were female. The largest age group was 24–35 months (43.4%), followed by 36–47 months (31.6%) and 48–59 months (25.0%). Regarding child health history, 40.8% of the children had experienced diarrhea, and 50.0% had a history of low birth weight (LBW). Maternal anemia during pregnancy was reported in 43.4% of respondents, while 42.1% of children did not receive exclusive breastfeeding. In terms of maternal characteristics, most mothers were aged 20–35 years (60.5%). More than half had a higher level of education (55.3%), and 61.8% were unemployed or homemakers.

Table 2. Analysis and Selection of Candidate Variables for Multiple Logistic Regression

Variable	Crude OR	*p*-value	Included
History of diarrhea	14.3	<0.001	Yes
Maternal anemia during pregnancy	18.48	<0.001	Yes
Exclusive breastfeeding	11.556	<0.001	Yes
Low birth weight (LBW)	3.698	0.011	Yes
Maternal age (<20 or >35 years)	2.451	0.054	Yes
Maternal education (low vs high)	3.127	0.039	Yes
Maternal employment (employed vs unemployed)	2.864	0.016	Yes

Table 2 illustrates the results of bivariate analysis between independent variables and stunting status. Maternal anemia during pregnancy showed the strongest association with stunting (OR = 18.48), followed by history of diarrhea (OR = 14.30) and exclusive breastfeeding status (OR = 11.56). Low birth weight also showed a significant association (OR = 3.70). Maternal age, education, and employment status met the inclusion criterion ($p < 0.25$) and were therefore included in the multivariable logistic regression model.

Before multivariate analysis, multicollinearity diagnostics were performed. All variables showed tolerance values > 0.10 and variance inflation factor (VIF) values < 10, indicating no significant multicollinearity among predictors.

Table 3 Initial Logistic Regression Model

Variable	Adjusted OR (Exp(B))	95% CI	p-value
History of diarrhea	1.03	0.10–11.8	0.995
Maternal anemia during pregnancy	1.05	0.08–13.2	0.994
Exclusive breastfeeding	1.04	0.07–15.5	0.995
Low birth weight	1.02	0.06–16.0	0.996
Maternal age	1.01	0.05–18.0	0.996
Maternal education	1	0.04–20.1	0.999
Maternal employment	1	0.03–22.5	0.999

Multiple logistic regression using the Backward Likelihood Ratio method.

Table 3 presents the initial multivariable logistic regression model including all candidate variables. The results show that none of the variables were statistically significant in the initial full model. The estimated odds ratios were close to 1 with very wide confidence intervals, indicating instability of the model and possible quasi-complete separation due to sparse data distribution. Therefore, this model was not interpreted for inference purposes but was used as a baseline for variable reduction.

Table 4. Stepwise Elimination Process

Variable Removed	Approximate OR	Reason
Maternal education	1	p-value > 0.25
Maternal employment	1	Non-significant
Maternal age	1.01	Non-significant

Backward stepwise logistic regression.

Table 4 illustrates the backward stepwise logistic regression procedure. Maternal education was the first variable removed due to its lack of statistical significance, followed by maternal employment and maternal age. The approximate odds ratios close to 1.0 indicate that these variables had minimal effect on stunting risk after controlling for other predictors. The final model retained only variables that demonstrated meaningful independent associations with stunting.

Table 5. Final Multiple Logistic Regression Model and Ranking of Independent Determinants of Stunting

Rank	Variable	Adjusted OR (AOR)	95% CI	p-value
1	Maternal anemia during pregnancy	2.76	1.25–6.10	0.001
2	Exclusive breastfeeding	4.86	1.80–13.10	0.001
3	History of diarrhea	3.42	1.54–7.61	0.003
4	Low birth weight (LBW)	2.01	1.10–3.67	0.01

Multiple logistic regression using the backward likelihood ratio (Backward LR)

Table 5 presents the final multiple logistic regression model identifying independent determinants of stunting. Maternal anemia during pregnancy, non-exclusive breastfeeding, history of diarrhea, and low birth weight remained significantly associated with stunting after adjustment for other variables. Children who were not exclusively breastfed had 4.86 times higher odds of stunting (AOR = 4.86; 95% CI: 1.80–13.10; p = 0.001). A history of diarrhea increased the odds of stunting by 3.42 times (AOR = 3.42; 95% CI: 1.54–7.61; p = 0.003). Maternal anemia during pregnancy was associated with a 2.76-fold increase in the odds of stunting (AOR = 2.76; 95% CI: 1.25–6.10; p = 0.001), while low birth weight increased the odds by 2.01 times (AOR = 2.01; 95% CI: 1.10–3.67; p = 0.010).

Discussion

This study identified four independent determinants of stunting among children under five years in the Yosomulyo Community Health Center area: maternal anemia during pregnancy, exclusive breastfeeding, history of diarrhea, and low birth weight (LBW). These findings highlight the multifactorial nature of stunting, involving both prenatal and postnatal determinants that interact throughout the first 1,000 days of life. Consistent with the UNICEF conceptual framework, stunting arises from a combination of immediate causes such as infection and inadequate dietary intake, as well as underlying factors related to maternal health and childcare practices (UNICEF, 2020).

The findings can be interpreted using Barker's Developmental Origins of Health and Disease (DOHaD) theory, which explains that adverse intrauterine conditions permanently affect fetal development and increase susceptibility to growth failure later in life (Rebecca Gowland, 2022). In addition, the UNICEF conceptual framework of malnutrition emphasizes that stunting results from immediate, underlying, and basic causes, including maternal nutrition, infant feeding practices, and household conditions (UNICEF, 2020)

A prospective cohort study conducted at the Sikumana Primary Health Center found a significant association between third-trimester maternal anemia and LBW, with a moderate correlation strength (r = 0.304) (Putra et al., 2026). Similarly, a retrospective case–control study in Indonesia reported a significant relationship between maternal anemia and LBW, highlighting the importance of improving maternal care and strengthening anemia prevention strategies during pregnancy Maternal anemia during pregnancy is a significant determinant of adverse neonatal outcomes, particularly low birth weight (LBW), as demonstrated by numerous studies and systematic reviews. The biological mechanism underlying this association involves reduced hemoglobin levels, which impair the transport of oxygen and nutrients from the mother to the fetus, thereby restricting fetal growth and development (Pangesti et al., 2025).

Evidence from systematic reviews and meta-analyses further supports these findings, consistently linking maternal anemia to an increased risk of LBW, preterm birth, and neonatal morbidity (Prasetyo et al., 2022). For example, a meta-analysis conducted in Sub-Saharan African countries reported that women who experienced anemia during pregnancy were significantly more likely to deliver LBW infants (AOR = 3.37) (Belete et al., 2025). Another systematic review identified third-trimester maternal anemia as a critical determinant of birth weight, emphasizing the importance of routine hemoglobin monitoring throughout pregnancy (Prasetyo et al., 2022). Furthermore, a comprehensive meta-analysis found that maternal anemia increased the risk of LBW by 1.65 times, in addition to elevating the risks of preterm birth and perinatal mortality (Jung et al., 2019).

Exclusive breastfeeding was found to be protective against stunting. Breast milk provides optimal nutrition and immunological protection that reduces infection risk and supports growth. Exclusive breastfeeding also prevents exposure to contaminated food and water, reducing gastrointestinal infections that contribute to malnutrition. These findings align with WHO recommendations that emphasize exclusive breastfeeding for the first six months of life (WHO, 2025). Exclusive breastfeeding was reported in 57.9% of children, while 42.1% did not receive exclusive breastfeeding. Breast milk provides complete nutrients and protective immunological factors that support optimal growth and reduce susceptibility to infections during infancy. Adequate breastfeeding practices are therefore considered an important strategy for preventing (Hossain & Mihrshahi, 2022).

The relationship between diarrhea and stunting in children has been well documented in numerous studies, highlighting the significant impact of recurrent diarrheal episodes on child growth and development. Diarrhea disrupts nutrient absorption, increases nutrient losses, and contributes to chronic intestinal inflammation, all of which are important mechanisms leading to impaired linear growth and stunting (Rochmawati, 2025). In Peru, diarrhea was associated with reduced gut microbial diversity, which in turn was linked to growth faltering, suggesting that alterations in the intestinal microbiota may mediate the adverse effects of diarrhea on child growth (Rouhani et al., 2020).

A meta-analysis further confirmed that children under five with a history of diarrhea had a 1.21-fold higher risk of stunting compared with those without such a history (Firmansyah et al., 2023). In Indonesia, findings have been mixed. While some studies reported no significant association between a history of infectious diseases and stunting (Kereh et al., 2025), others identified diarrhea as a significant contributor to stunting, particularly during the first two years of life, a critical period for growth and development (Aba, 2025). Additional evidence from the MAL-ED cohort study demonstrated that specific diarrheal enteropathogens, particularly Shigella and Campylobacter, have substantial negative effects on linear growth. These findings emphasize the importance of reducing children's exposure to enteric pathogens as part of comprehensive strategies to prevent stunting and promote optimal growth (Rogawski et al., 2018).

The implications of addressing maternal anemia during pregnancy, exclusive breastfeeding, history of diarrhea, and low birth weight (LBW) are crucial for reducing stunting In low-resource settings. Maternal anemia is a strong risk factor for stunting, with studies showing markedly increased odds of stunted growth among children born to anemic mothers (Wahyuningsih et al., 2024). It reflects inadequate maternal nutrition and poor oxygen delivery to the fetus, leading to impaired fetal growth, LBW is also a key determinant of stunting, with evidence indicating a higher risk of growth failure among LBW children due to intrauterine growth restriction and reduced nutritional reserves (Joiner et al., 2025). Exclusive breastfeeding has a generally protective role, although findings are mixed; some studies report no significant association with stunting, while others show that non-exclusive breastfeeding increases risk due to inadequate nutrient intake during early life (Raing et al., 2023). History of diarrhea contributes to stunting by impairing nutrient absorption and increasing nutrient losses during repeated infections, emphasizing the importance of infection prevention in child health strategies (Rochmawati, 2025)..

These findings highlight the importance of strengthening integrated maternal and child health interventions, including iron supplementation during pregnancy, antenatal care monitoring, promotion of exclusive breastfeeding, prevention and management of childhood diarrhea, and early detection of LBW infants. Evidence suggests that improving maternal nutrition during the first 1,000 days of life is one of the most effective strategies for preventing stunting. This study contributes to the literature by integrating prenatal and postnatal determinants of stunting within a single analytical model in a community-based Indonesian setting.

The theoretical novelty lies in demonstrating how Barker's DOHaD theory and the UNICEF conceptual framework complement each other in explaining stunting risk. The practical novelty of this study is the identification of maternal anemia, diarrhea, breastfeeding practices, and LBW as concurrent determinants that should be addressed through integrated interventions at the primary healthcare level. The findings reinforce a life-course approach to stunting prevention, emphasizing that interventions must begin before birth rather than focusing only on postnatal factors.

Overall, stunting in this population is driven by a combination of maternal nutritional status during pregnancy, birth outcomes, infant feeding practices, and infectious disease exposure. These findings support both Barker's theory and the UNICEF conceptual framework, emphasizing that effective stunting prevention requires interventions spanning the prenatal, neonatal, and early childhood periods.

Implications and limitations

This study highlights that stunting is influenced by both prenatal and postnatal factors, particularly maternal anemia during pregnancy, exclusive breastfeeding, and low birth weight, underscoring the importance of a life-course approach to stunting prevention beginning from pregnancy through early childhood. These findings strengthen the conceptual understanding that maternal nutrition and antenatal care, alongside infant feeding practices, play central roles in child growth outcomes, and support integrated public health strategies such as anemia prevention, iron supplementation, breastfeeding promotion, and early identification of low birth weight in primary healthcare settings, especially in low-resource areas. However, the findings should be interpreted with caution due to several limitations, including the single-center design, relatively small sample size, potential recall bias, and the absence of some important variables such as socioeconomic status, dietary diversity, sanitation, and parental anthropometry, which may have led to residual confounding. Therefore, future studies with larger, multi-site populations and more comprehensive determinants are needed to strengthen external validity and confirm these associations.

Relevance to Practice

This study provides practical implications for strengthening stunting prevention at the primary healthcare level through integrated interventions across the first 1,000 days of life. Key actions include routine antenatal screening and effective management of maternal anemia through iron supplementation and nutritional counseling, as well as strengthening breastfeeding support programs to promote and sustain exclusive breastfeeding practices. In addition, preventive strategies to reduce low birth weight should be prioritized through improved maternal nutrition and quality antenatal care. Healthcare workers, particularly nurses and midwives, play a central role in early identification of at-risk pregnancies and continuous health education for mothers, while community health centers should integrate maternal and child health services with growth monitoring and health promotion activities. These evidence-based approaches can inform policy development and improve targeted stunting prevention strategies in resource-limited settings.

Conclusion

This study identified maternal anemia during pregnancy, exclusive breastfeeding, and low birth weight as key determinants of stunting among children under five years of age in the Yosomulyo Community Health Center, Metro City, Lampung, Indonesia. These findings highlight that stunting is largely influenced by factors originating before birth and during early infancy, emphasizing the importance of strengthening maternal health and nutrition interventions during pregnancy as a primary prevention strategy. Accordingly, efforts to reduce stunting should prioritize early detection and management of maternal anemia, promotion of optimal breastfeeding practices, and prevention of low birth weight through improved antenatal care and maternal nutritional support. Future research is recommended to employ larger, multi-center prospective study designs to better establish temporal relationships and strengthen evidence on the causal pathways of stunting.

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CrediT Authorship Contributions Statement

Islamiyati Islamiyati: Conceptualization, Methodology, Supervision, Project Administration, Writing – Original Draft, Writing – Review & Editing.

Sadiman Sadiman: Methodology, Validation, Investigation, Resources, Data Curation, Supervision.

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Conflicts of Interest

There is no conflict of interest.

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