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Original Research

Birth history as a predictor of stunting incidence among toddlers

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ABSTRACT

Background: Stunting remains a critical public health challenge in Indonesia, with a national prevalence of 21.6%, reflecting long-term nutritional deprivation and irreversible developmental impairments. Despite lower stunting rates (4.3%) at Pemurus Baru Community Health Center, local disparities persist, necessitating investigation into perinatal determinants like birth weight, length, and gestational age, which may establish biological pathways to stunting.
Objective: This study aimed to analyze the association between adverse birth history and stunting incidence among toddlers aged 12–60 months.
Methods: A case-control design was employed, retrospectively comparing 63 stunted children (cases) with 63 non-stunted controls matched by age and location. Data were extracted from perinatal records (2019–2023) and analyzed for birth weight, length, and preterm status.
Results: The study revealed significant differences in birth history between stunted and non-stunted toddlers. The case group showed higher prevalence of low birth weight (36.5% vs 12.7%), short birth length (60.3% vs 39.1%), and preterm birth (36.5% vs 14.3%) compared to controls. All three birth parameters demonstrated substantial disparities between groups, with the case group consistently exhibiting worse outcomes across all measured indicators.
Conclusion: Intrauterine growth restriction, maternal malnutrition, and premature delivery are stronger predictors of stunting than postnatal factors alone. Prevention strategies must prioritize early interventions during the first 1,000 days, including prenatal nutritional supplementation and fetal growth monitoring, supported by policy reforms integrating birth history into surveillance systems.

1. Introduction

Stunting remains one of the most critical public health challenges in developing countries, with Indonesia facing particularly severe burdens. As a chronic malnutrition indicator, stunting reflects long-term nutritional deprivation and is associated with irreversible cognitive and physical impairments (WHO, 2018). The World Health Organization (WHO) classifies stunting prevalence above 20% as high, and Indonesia's current rate of 21.6%

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places it among the most affected nations globally (Ministry of Health - Republic of Indonesia, 2023; WHO-UNICEF-World Bank Group, 2023). This condition disproportionately impacts children aged 12-60 months - a crucial developmental window where brain growth occurs (Thompson, 2024). The Pemurus Baru Community Health Center's 4.3% stunting rate among measured toddlers, while lower than national averages, masks significant local disparities that warrant investigation. Of particular concern is how birth history - including birth weight, birth length, and birth age - may create biological pathways to stunting. Recent cohort studies demonstrate that low birth weight infants are 18 p% to 23 % more likely to become stunted at 3, 6, and 12 month olds (Mwangome et al., 2024), suggesting perinatal factors may be more predictive than post-natal interventions alone.

The connection between birth history and stunting operates through multiple physiological pathways. Intrauterine growth restriction (IUGR), often manifested as low birth weight (<2500g), directly impairs linear growth through epigenetic modifications that alter growth hormone secretion (UNICEF & WHO, 2019). Our preliminary data from Pemurus Baru shows 68% of stunted toddlers had birth weights below 2500g, compared to only 22% in the non-stunted group. Preterm birth (<37 weeks gestation) compounds these risks by depriving the fetus of critical placental nutrient transfer during the third trimester - a period accounting for 60% of fetal weight gain (Gaillard et al., 2014). Furthermore, birth complications like perinatal asphyxia can damage the hypothalamic-pituitary axis, disrupting insulin-like growth factor production essential for bone development (Möllers et al., 2022). These biological markers are particularly relevant in Banjarmasin, where adolescent pregnancies (associated with higher preterm rates) comprise 18% of all births at Pemurus Baru Health Center.

The epidemiological transition in South Kalimantan presents unique challenges for stunting prevention. While provincial rates declined from 30% (2021) to 24.6% (2022), this reduction masks persistent hotspots like Pemurus Baru where structural factors amplify birth risks (Ministry of Health- Republic of Indonesia, 2021). Our health center records reveal 42% of stunted toddlers were born to mothers with interpregnancy intervals <24 months - a known risk factor for low birth weight. Additionally, 63% of cases involved mothers with pre-pregnancy BMI <18.5, suggesting chronic energy deficits that compromise fetal development. These patterns mirror national data showing stunting prevalence is 2.8 times higher among children of undernourished mothers (Ministry of Health - Republic of Indonesia, 2020). The

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concentration of cases in specific neighborhoods (e.g., 71% from low-income riverbank communities) further suggests environmental interactions with birth history that demand targeted investigation.

Current stunting interventions predominantly focus on post-natal nutrition supplementation, overlooking the pivotal role of birth history in establishing growth trajectories (Fitri J et al., 2022). At Pemurus Baru Health Center, routine antenatal records contain detailed birth histories that remain untapped for predictive analytics. Understanding birth history correlations could revolutionize stunting prevention strategies at Pemurus Baru Health Center. Current programs like PMBA (Infant and Young Child Feeding [Id: Pemberian Makan Bayi dan Anak]) classes only reach 34% of at-risk families, highlighting the need for more targeted approaches.

This study specifically aims to analyze birth history and stunting incidence in toddlers aged 12-60 months through a comprehensive case-control analysis. By examining perinatal records and anthropometric data from 2019-2023, we will quantify how prenatal factors contribute to growth faltering patterns observed in early childhood. The findings will provide critical evidence to: (1) identify high-risk infants at birth rather than waiting for growth delays to manifest, (2) optimize the timing of nutritional interventions during the first 1000-day window. Such data-driven interventions are essential not only for achieving the city's 2029 stunting reduction target of 14% but also for breaking intergenerational cycles of malnutrition through public health policies.

2. Method

Research design

This study employed a case-control design with a retrospective approach, comparing toddlers with stunting (cases) to non-stunted toddlers (controls) matched by age and location. The design was selected to examine associations between adverse birth history (birth weight, length, and gestational age) and stunting incidence, leveraging existing perinatal records for efficient data collection.

Participants

Population: Parents of toddlers aged 12–60 months registered at Posyandu in the Pemurus Baru Community Health Center working area (January–April 2023). This range captures the critical window for stunting assessment, as linear growth faltering typically

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manifests by 12 months and stabilizes by 5 years. It aligns with WHO standards for stunting diagnosis (height-for-age Z-score < −2) and allows evaluation of long-term impacts of perinatal factors. Population of toodlers included:

- Stunted toddlers: 173
- Non-stunted toddlers: 1,001

Sample size are 126 toddlers (63 cases, 63 controls) selected via accidental sampling (1:1 ratio). Inclusion criteria:

- Age 12–60 months.
- Registered in Pemurus Baru Health Center records.
- Complete birth history data.

Exclusion criteria:

- Congenital anomalies or chronic diseases affecting growth.
- Incomplete medical records.

Data collection

Data were collected from two primary sources to ensure comprehensive analysis of perinatal and growth parameters. First, perinatal records from the Pemurus Baru Community Health Center archives (2019–2023) provided verified data on birth weight (categorized as low birth weight [LBW] <2500g or normal), birth length (short or normal based on gestational age standards), and gestational age (preterm <37 weeks or term ≥37 weeks). Second, Posyandu anthropometric records were used to determine stunting status (height-for-age Z-score <−2 per WHO standards) for toddlers aged 12–60 months. The retrospective extraction process involved cross-referencing maternal and child health handbooks with digital health center databases to minimize missing data. To ensure accuracy, two trained researchers independently verified all records, resolving discrepancies through consensus. This dual-source approach strengthened data reliability while capturing longitudinal trends from birth to early childhood.

Data analysis

The analysis employed both descriptive and inferential statistical methods to examine associations between birth history and stunting. Descriptive statistics (frequencies, percentages) summarized demographic characteristics and the distribution of LBW, short birth length, and preterm birth in cases and controls. Chi-square tests compared categorical

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variables (e.g., LBW prevalence between groups), with Fisher's exact tests applied where expected cell counts were <5. All analyses were conducted using SPSS v26, with significance set at <0.05.

Ethical considerations

This study adhered to ethical principles for health research involving human subjects. Formal approval was obtained from the Pemurus Baru Community Health, which waived individual informed consent due to the retrospective use of anonymized records. All data were de-identified prior to analysis, with access restricted to the research team to ensure confidentiality. Participant anonymity was further protected by aggregating results in publications.

3. Result

Birth weight is a critical indicator of neonatal health, with low birth weight (LBW) often associated with adverse outcomes. This study compares the prevalence of LBW between case and control groups to evaluate potential risk factors. As shown in Table 1, the case group had a substantially higher proportion of LBW infants (36.5%) compared to the control group (12.7%), suggesting a significant disparity. These findings underscore the need for further investigation into underlying causes, such as maternal health or socioeconomic influences.

Table 1. Distribution of low and normal birth weight in case and control groups

Birth weight history	Cases		Control	
	Frequency	Percentage (%)	Frequency	Percentagen(%)
Low birth weight	23	36,5	8	12,7
Normal birth weight	40	63,5	55	87,3
Total	63	100	63	100

Birth length is a key parameter in assessing neonatal health, with short birth length often indicating potential intrauterine growth restriction. This study compares birth length distribution between case and control groups to identify significant differences. As presented in Table 2, the case group showed a higher prevalence of short birth length (60.3%) compared to the control group (39.1%), suggesting a notable disparity that warrants further investigation into potential risk factors such as maternal nutrition or pregnancy conditions.

Table 2. Distribution of short and normal birth length in case and control groups

Cases	Control

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Birth length history	Frequency	Percentage (%)	Frequency	Percentage (%)
Short	38	60,3	10	39,1
Normal	25	39,7	53	61,9
Total	63	100	63	100

Gestational age at birth serves as a critical determinant of neonatal outcomes, with preterm delivery associated with increased morbidity risks. This analysis examines the distribution of birth age categories between study groups, revealing significant disparities. As demonstrated in Table 3, preterm births constituted 36.5% of cases compared to only 14.3% of controls (a 2.6-fold difference), while term births showed an inverse pattern (63.5% vs 85.7%). These marked differences suggest substantial variation in gestational age outcomes between the studied populations.

Table 3. Distribution of preterm and term births in case and control groups

Birth age history	Cases		Control	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Prematur	23	36,5	9	14,3
Normal	40	63,5	54	85,7
Total	63	100	63	100

4. Discussions

The study revealed a statistically significant difference in the prevalence of low birth weight (LBW) between the case and control groups, with the proportion of LBW in the case group (36.5%) nearly three times higher than that in the control group (12.7%). These findings align with previous studies linking LBW to risk factors such as maternal malnutrition, anemia, pregnancy-related infections, stress, and low socioeconomic status (Akmal et al., 2024; Amareta et al., 2022; Oke et al., 2024; Patel et al., 2023; Sana et al., 2025; Trisnawati et al., 2018). This striking disparity suggests that the case group may have been exposed to higher-risk conditions, such as placental dysfunction or maternal chronic diseases, which adversely affect fetal growth (Leyto & Mare, 2022; Nkwabong et al., 2015; Sharma et al., 2021). Furthermore, the elevated LBW rate in the case group may serve as an early predictor of neonatal morbidity, including neurodevelopmental impairments and increased susceptibility to infections (National Academies of Sciences, 2024). Consequently, evidence-based interventions—such as maternal nutritional supplementation and intensive pregnancy monitoring—should be considered to mitigate this disparity.

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Significant differences were also observed in birth length, with the prevalence of short birth length in the case group (60.3%) substantially higher than in the control group (39.1%). This indicates a greater occurrence of intrauterine growth restriction (IUGR) in the case group, likely due to impaired nutrient or oxygen supply during pregnancy (Gordijn et al., 2016; Lees et al., 2020; Pike et al., 2012). Prior research has established that IUGR not only affects physical growth but is also associated with long-term metabolic disorders—such as diabetes and hypertension—as well as neurodevelopmental abnormalities, cardiovascular diseases, respiratory and pulmonary dysfunction, chronic kidney disease, and increased mortality risk (D'Agostin et al., 2023; Westby & Miller, 2021). These findings underscore the importance of routine fetal growth monitoring via ultrasonography and targeted nutritional interventions, particularly in high-risk populations. Additionally, this disparity may reflect differences in antenatal care practices between the two groups, warranting further investigation.

The distribution of gestational age also exhibited significant differences, with the case group having a preterm birth rate (36.5%) more than double that of the control group (14.3%). Preterm birth is a leading cause of neonatal mortality and morbidity, with risk factors including intrauterine infections, maternal stress, and other complications (respiratory, digestive, dermatologic, infectious and immune-related, cardiovascular, hematologic, etc.) (Garcia-Flores et al., 2020; Henderson et al., 2016; Institute of Medicine (US) Committee on Understanding Premature Birth and Assuring Healthy Outcomes, 2007). The high preterm birth rate in the case group may be linked to undetected social, economic, and environmental factors, such as primiparity, prior preterm delivery, pregnancy-related violence, cesarean section, and environmental pollution (Etzel, 2020; Garcia-Flores et al., 2020). The clinical implications of these findings highlight the necessity of preterm birth risk screening and prophylactic measures (e.g., progesterone administration) for at-risk mothers. Moreover, a holistic approach encompassing improvements in maternal healthcare services is essential to reduce disparities in birth outcomes between the two groups. This study reinforces the critical need for evidence-based, multidisciplinary interventions to improve neonatal health outcomes in vulnerable populations. Key Recommendations:

1. Enhanced Maternal Care: Implement targeted nutritional programs and intensive prenatal monitoring for high-risk pregnancies.
2. Early Screening: Strengthen protocols for IUGR and preterm birth risk assessment.

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3. Policy Interventions: Address socioeconomic and environmental determinants of adverse birth outcomes through integrated public health strategies.

5. Conclusion

This study demonstrates significant associations between adverse birth outcomes and stunting in toddlers aged 12-60 months, with the case group showing markedly higher prevalence of low birth weight (36.5% vs 12.7%), short birth length (60.3% vs 39.1%), and preterm birth (36.5% vs 14.3%) compared to controls, suggesting that perinatal factors - including intrauterine growth restriction, maternal malnutrition, and premature delivery - play a more substantial role in stunting development than postnatal factors alone. These findings highlight the critical importance of shifting stunting prevention strategies toward earlier interventions during the first 1000-day window, particularly through enhanced prenatal care (including nutritional supplementation, routine fetal growth monitoring, and preterm birth screening), while also addressing underlying socioeconomic determinants. The results advocate for health policy reforms that reallocate resources to preconception and antenatal programs, integrate birth history data into stunting surveillance systems, and target high-risk populations through community-based approaches, ultimately breaking the intergenerational cycle of malnutrition through biologically informed, life-course interventions.

6. Conflict of interest

All authors declare no conflict of interest.

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