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LOW BIRTH WEIGHT AS A KEY DETERMINANT OF CHILDHOOD STUNTING: A MATERNAL–NEONATAL RISK FACTORS ANALYSIS IN A STUNTING LOCUS AREA

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ABSTRACT

Background: Many studies have examined the effects of inadequate nutritional intake, showing an increased risk of infectious diseases, death, and obstacles to children's growth and development. According to the results of SSGI 2024, the prevalence of stunting among children under five was 19.8%; this figure remains far from the medium-term national target. This research aims to determine the determinants of stunting in a stunting-affected area.
Methods: A quantitative analytical study with a case-control approach was used in this study. The research was conducted in Buker Village, one of the stunting loci in Sampang Regency. The research subjects consisted of 35 stunted toddlers in the case group and 40 toddlers with normal nutritional status in the control group. Data analysis in this study included univariate analysis using frequency distributions, bivariate analysis using the chi-square test, and multivariate analysis using multiple logistic regression.
Results: The results showed that the most dominant factor associated with stunting was a history of low birth weight (LBW) OR 24,1 (95% CI: 2,573 – 226,647), which means that toddlers who were born with LBW had a 24,1 times higher chance of stunting.
Conclusion: This study identifies low birth weight as a key determinant of stunting, as affected infants face developmental vulnerabilities**.** Strengthening maternal nutrition, infection prevention, and postnatal growth monitoring is essential to mitigate long-term growth deficits. These findings emphasize the importance of integrating maternal nutrition programs with neonatal monitoring, particularly in high-burden settings, to effectively improve child growth outcomes.
Keywords: low birth weight, neonatal factors, stunting

INTRODUCTION

Malnutrition in childhood is often associated with deficiencies in certain vitamins and minerals, including those from both the micronutrient and macronutrient groups. In recent years, numerous studies have been conducted on the effects of inadequate nutritional intake, revealing an increased risk of infectious diseases, mortality, and hindrances to children's growth and development (Halimatunisa & Ikhssani, 2022). Chronic malnutrition that is not handled

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properly will result in children experiencing stunting. The problem of stunting starts in the womb and only becomes visible when the child reaches the age of two years (Kemenkes, 2025). Referring to Peraturan Menteri Kesehatan Nomor 25 Tahun 2014, child health efforts are carried out through health services that span from fetuses to teenagers, encompassing newborns, infants, toddlers, preschoolers, school-age children, and adolescents.

Based on the results of the Survey Status Gizi Indonesia (SSGI) 2024, the prevalence of stunting was 19.8% in children under five, down from 21.5% in 2023; however, this figure is still far from the medium-term national target. National prevalence has decreased but remains at a level that requires cross-sector intervention. Regionally, Provinsi Jawa Timur was recorded as having a slightly lower prevalence than the national average in the previous survey period, namely around 17.7% in 2023; however, this province remains the focus of program attention due to the large absolute burden and variations between districts/cities (Dinas KOMINFO Jatim, 2025). Secondary data from the Sampang Regency Health Office (2024) indicate that the prevalence of stunting in Sampang Regency was 17.2% in 2021, which remains higher than the national target of 14% set for 2024. Based on these data, Buker Village, located within the service area of the Jrengik Public Health Center, has been consistently designated as a stunting locus village for two consecutive years.

Stunting in toddlers in developing countries can be caused by genetic factors and environmental factors that are inadequate for optimal child growth and development. Factors that influence the incidence of stunting in developing countries are the risk of low birth weight (LBW), household income, and household sanitation hygiene (Apriluana & Fikawati, 2018). Previous evidence suggests that exclusive breastfeeding practices, history of infectious diseases, immunization status, maternal knowledge, and household economic conditions are key determinants associated with stunting among children under five years of age (Rauf et al., 2024).

Stunting appears as a form of failure to grow due to long-term malnutrition, especially during the critical period of the First 1,000 Days of Life. Therefore, prevention efforts must be highly focused during the First 1,000 Days of Life, including comprehensive maternal health and nutrition during pregnancy, as well as optimal care and feeding practices during the first 23 months of the child's life (Kemenkes, 2025). However, evidence examining the combined influence of maternal and neonatal factors on stunting remains limited, as most existing studies assess these determinants separately and predominantly at national or regional levels. Furthermore, research specifically conducted in villages designated as stunting loci is still scarce, despite their unique contextual vulnerabilities and prioritization in stunting reduction programs. This gap highlights the need for localized studies that integrate maternal and neonatal factors to better understand the determinants of stunting in high-burden stunting villages. This research aims to determine the determining factors of stunting in Buker as a stunting locus village in the working area of the Puskesmas Jrengik, Sampang Regency.

RESEARCH METHOD

This research uses a quantitative analytical survey design with a case-control approach. This design was chosen to study the relationship between exposure (a research factor) and disease incidence by comparing the case group and the control group. The research subjects involved all 35 stunted toddlers (TB/U <-2 SD based on the WHO curve) as the case group and 40 toddlers with normal nutritional status as the control group. The case group included all eligible stunted toddlers identified at Jrengik Primary Health Center using a total sampling method.

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The control group was selected at a ratio of approximately 1:1.5 to improve statistical power while accounting for the limited number of cases in the stunting locus village. The inclusion criteria for the case group were toddlers classified as stunted according to health center records at Jrengik Primary Health Center, and they had complete maternal and child health records. The control group consisted of toddlers with normal nutritional status, as determined by Posyandu growth monitoring data and complete health records. Toddlers with incomplete health records were excluded from the study.

The independent variables in this study were history of pregnancy anemia, mother's age at pregnancy, mother's education, history of prematurity, birth history, child's gender, breastfeeding, history of early complementary feeding, history of infection, and complete basic immunization. The dependent variable in this study is the incidence of stunting. Data on toddlers with stunting and normal nutrition were collected through secondary data from community health centers. Independent variable data was collected using interviews and secondary data from the KIA book. Data analysis in this study was conducted in three stages: univariate analysis using frequency distributions, bivariate analysis using the chi-square test, and multivariate analysis to determine the relationship between various risk factors and the incidence of stunting in toddlers, employing multiple logistic regression. Ethical approval for this research was obtained from the Universitas Kusuma Husada Research Ethics Committee with reference number 3243/UKH.L02/EC/IX/2025.

RESULT

Based on the primary data collected from 75 respondents at Buker, the frequency distribution for nutritional status, maternal factors, and neonatal factors is presented in Table 1 below.

Table 1. Frequency Distribution of Independent Variables

Criteria	Distribution	Frequency (n)	Percentage (%)
Toddlers Nutritional Status	Stunted	35	46,6
	Normal	40	53,4
Toddlers Gender	Male	39	52,0
	Female	36	48,0
Maternal Latest Education	Junior high school	43	57,3
	Senior high school	32	42,7
History of anemia in pregnancy	Anemia	30	40,0
	Normal	45	60,0
Maternal age	Risky	28	37,3
	Non-Risky	47	62,7
History of low birth weight	<2500	27	36,0
	>= 2500	48	64,0
History of premature birth	Premature	10	13,3
	Aterm	65	86,7
History of exclusive breastfeeding	Partial breastfeed	22	29,3
	Exclusive breastfeed	53	70,7
History of early complementary feeding	< 6 months	21	28,0

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Criteria	Distribution	Frequency (n)	Percentage (%)
	6 months	54	72,0
Children's History of Infection	Yes	25	33,3
	No	50	66,7
Immunization	Incomplete	19	25,3
	Complete	56	74,7

Based on nutritional status (TB/U), 40 children met the normal criteria (53.4%), and 35 were stunted (46.6%). Based on the children's gender, 39 (52%) of the toddlers were boys, and 36 (48%) were girls. The data showed that 43 mothers had completed junior high school (57.3%), while the remaining 32 mothers (42.7%) had attained a high school level of education. Based on Anemia status during pregnancy, there were 30 mothers with anemia (40%) and 45 people with normal Hb levels (60%). Based on maternal ages, there were 28 mothers in the risky age (37,3%) and 47 mothers in the healthy age (62,7%). Based on the history of birth weight, 27 toddlers with low birth weight were found (36 %), and 48 toddlers with normal birth weight were found (64%). Based on the history of premature birth, 10 toddlers were born at < 37 weeks of pregnancy (13,3%) and 65 toddlers were born at 37-40 weeks of pregnancy. Based on the history of exclusive breastfeeding, 21 toddlers were breastfeeding less than 6 months (28%), and 53 toddlers were exclusively breastfeeding (70,7%). Based on the history of early complementary feeding, 21 toddlers started complementary food before the recommended 6 months' time (28%), and 54 toddlers started complementary food after the recommended 6 months' time. Based on children's history of infections, 25 toddlers had a history of infections (33,3%), and 50 toddlers had no history of infections. Based on the history of immunization, 19 toddlers had not completed basic immunization status (25,3%), and 56 toddlers had completed basic immunization status (74,7%).

The table below presents data regarding the relationship between maternal and neonatal factors and nutritional status among respondents

Table 2. Factors influencing stunting among toddlers

Variable	Nutritional Status				OR (95% CI)	*p-value*
	Stunting		Normal			
	n	%	n	%		
Toddlers Gender						
Male	16	42,1	22	57,9	1,195 (0,474 – 3,014)	0,888
Female	14	37,8	23	62,2		
Maternal Latest Education						
Junior High School	13	31,0	29	69,0	0,422 (0,164 – 1,086)	0,117
Senior High School	17	51,5	16	48,0		
Anemia in pregnancy						
Anemia	20	62,5	12	37,5	5,5 (2,011 – 15,046)	0,001
Normal	10	23,3	33	76,7		
Maternal Age						
< 18 or >35	18	72,0	7	28,0	8,143 (2,744 – 24,167)	0,000
18 - 35	12	24,0	38	76,0		
History of Low Birth Weight						
Yes	15	93,8	1	6,2	44,000 (5,349 – 361,965)	0,000
No	15	25,4	44	74,6		

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Variable	Nutritional Status				OR (95% CI)	*p-value*
	Stunting		Normal			
	n	%	n	%		
History of preterm birth						
Yes	15	48,4	16	51,6	1,813 (0,708 – 4,643)	0,315
No	15	34,1	29	65,9		
Exclusive Breastfeeding						
Yes	12	26,1	34	73,9	4,636 (1,709 – 12, 576)	0,004
No	18	62,1	11	37,9		
Early Complimentary Feeding						
Yes	13	59,1	9	40,9	3,059 (1,095 – 8,543)	0,055
No	17	32,1	36	67,9		
History of Infection						
Yes	11	57,9	8	42,1	2,678 (0,923 – 7,772)	0,116
No	19	33,9	37	66,1		
Immunization	19	33,9	37	66,1		
Yes	11	57,9	8	42,2	1,656 (0,653 – 5,352)	0,100
No						

Table 2 showed that stunted toddlers were higher in mothers with anemia during pregnancy (62,5%) compared to mothers without anemia during pregnancy (37,8%). The results of statistical tests showed there was an association between history of anemia and stunting in toddlers (OR = 5,5; 95% CI: 2,011 – 15,046; p = 0,01).

Stunted toddlers were higher in mothers who conceived at an age <18 years old or >35 years old (72%) compared to mothers who conceived at an age 18 – 35 years old (24%). The results of statistical tests showed there was an association between maternal age and stunting in toddlers (OR = 8,143; 95% CI: 2,744 – 24,167; p = 0,000).

Stunted toddlers were higher in toddlers who were born with low birth weight (93,8%) compared to toddlers who were born with normal birth weight (25,4%). The results of statistical tests showed there was an association between low birth weight and stunting in toddlers (OR = 44,000; 95% CI: 5,349 – 361,965; p = 0,000).

Stunted toddlers were higher in toddlers who were not exclusively breastfed (62,1%) compared to toddlers who were exclusively breastfed (26,1%). The results of statistical tests showed that there was a relationship between exclusive breastfeeding and stunting in toddlers (OR = 4,636; 95% CI: 1,709 – 12,576; p = 0,04)

Table 3 presents the results of the multivariate multiple logistic regression analysis examining factors associated with stunting, including anemia in pregnancy, maternal age, history of low birth weight, and exclusive breastfeeding.

Table 3. Multiple logistic regression multivariate analysis of determinants of stunting factors

Variable	OR	95% CI	*P value*
Anemia in pregnancy	4,6	1,210 – 17,192	0,025
Maternal Age	3,7	0,876 – 15, 975	0,075
History of Low Birth Weight	24,1	2,573 – 226,647	0,004
Exclusive Breastfeeding	5	1,279 – 19,047	0,21

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Multivariate analysis is performed to determine the independent variable that is most dominantly related to the dependent variable. The results showed that the most dominant factor associated with stunting was a history of low birth weight, OR 24.1 (95% CI: 2.573 – 226.647), which means that toddlers who were born with low birth weight had a 24.1 times higher chance of stunting compared to toddlers who were born with normal birth weight.

DISCUSSION

Factors Influencing Stunting Among Toddlers

Anemia in Pregnancy

Maternal nutrition is a critical determinant of fetal development, neonatal health, and long-term child growth and wellbeing. One of the major nutritional issues affecting fetal outcomes is maternal anemia. The World Health Organization defines anemia in pregnancy as a hemoglobin concentration below 11 g/dL in the first and third trimesters, or below 10.5 g/dL in the second trimester (World Health Organization, 2019). Reduced hemoglobin levels during pregnancy compromise the maternal blood's capacity to deliver adequate oxygen and nutrients to the fetus, thereby increasing the risk of intrauterine growth restriction, low birth weight, and a higher likelihood of subsequent stunting in early childhood (Susanti et al., 2024). This relationship is further supported by evidence indicating that iron deficiency during pregnancy disrupts placental function, thereby reducing nutrient transfer to the fetus and compromising fetal well-being throughout gestation (Sangkhae et al., 2023).

Maternal Age

Maternal age at pregnancy and childbirth serves as an important indicator of both biological and social capacity in meeting the demands of gestation and postpartum care. Mothers in childhood and adolescence often lack full physical and psychological maturity to undergo the processes of pregnancy and delivery. Immaturity of the reproductive system—particularly the uterus and placenta—among adolescent mothers restricts the transfer of oxygen and nutrients to the fetus, thereby increasing the likelihood of stunting (Ogawa et al., 2019). This is consistent with findings that reported that mothers who conceive and give birth before the age of 20 face a significantly higher risk of having stunted children (Laksono et al., 2022). Conversely, older maternal age (>35 years) is also associated with elevated biological risks that may compromise fetal growth. Women in this age group experience declining reproductive function, reduced uteroplacental blood flow, and heightened susceptibility to gestational hypertension, gestational diabetes, and preterm birth. These conditions contribute to low birth weight and intrauterine growth restriction (IUGR), both of which are strong predictors of childhood stunting (Huang et al., 2023).

History of Low Birth Weight

Low-birth-weight (LBW) infants represent a clinical manifestation of impaired intrauterine fetal growth. LBW is defined as a birth weight below 2500 grams, regardless of gestational age, and these infants are more susceptible to infectious diseases and medical complications due to the immaturity of vital organ systems (Afian et al., 2021). Previous studies have indicated that impaired organ development and its related complications constitute critical biological mechanisms underlying the association between low birth weight and an elevated risk of stunting in later childhood (Gabain et al., 2023). Recurrent or persistent infections during early life, such as Salmonella, rotavirus, intestinal parasitic infections, and respiratory

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tract infections, decrease dietary intake, elevate metabolic demands, and compromise intestinal structure and function through environmental enteric dysfunction (EED). This condition reduces the efficiency of macro- and micronutrient absorption required for optimal linear growth. The combined burden of repeated infections and gastrointestinal dysfunction has been empirically demonstrated to contribute to the biological trajectory leading to stunting, particularly among children with a history of LBW (Grillo et al., 2022).

Exclusive Breastfeeding

Exclusive breastfeeding ensures optimal nutrient intake during early life and has been consistently demonstrated to support adequate infant nutrition. Human milk contains essential bioactive components, including growth-related hormones such as IGF-1, lactoferrin, human milk oligosaccharides (HMOs), and various cytokines, which contribute to intestinal mucosal maturation, enhance nutrient absorption, and reduce intestinal inflammation. These mechanisms collectively protect infants from enteric dysfunction, a condition that can impair nutrient uptake and ultimately lead to growth faltering (Budge et al., 2019). Additionally, the presence of secretory immunoglobulin A (sIgA) in breast milk offers crucial immunological protection against gastrointestinal and respiratory infections. Consistent with prior research, infants who are not exclusively breastfed are more likely to experience diarrheal and respiratory infections, with a two- to threefold increase in risk, which subsequently contributes to a higher likelihood of stunting (Hossain & Mihrshahi, 2022).

Determinant Factors of Stunting

The present study identified a history of low birth weight as the most influential determinant of stunting. This strong association can be explained by the range of biological disadvantages that low-birth-weight infants face from the moment they are born. Low birth weight is a marker of suboptimal intrauterine development and is closely linked to maternal nutritional status, the quality of antenatal care, maternal health conditions, and broader socioeconomic factors (Arabzadeh et al., 2024). As a result of these prenatal constraints, LBW infants typically enter early life with limited nutrient reserves, immature organ and gastrointestinal function, and weakened immune capacity, all of which hinder their ability to sustain normal growth during the critical first 1,000 days. These vulnerabilities mirror the physiological profile seen in infants affected by intrauterine growth restriction, who show reduced metabolic adaptation and elevated susceptibility to postnatal growth impairment (Okwaraji et al., 2024). Consistent with previous evidence, infants born weighing less than 2,500 grams have been shown to experience a two- to threefold higher risk of early growth faltering compared with their normal-birth-weight counterparts (Ogawa et al., 2019).

One of the most critical physiological challenges observed in low-birth-weight infants is their increased vulnerability to infections. Due to an immature immune system and reduced antibody production, LBW infants exhibit a higher susceptibility to recurrent infections, including respiratory tract infections, diarrheal diseases, and systemic infections. Such repeated infections elevate metabolic demands, suppress appetite, and impair nutrient absorption, ultimately contributing to malnutrition and subsequent linear growth failure (Özdemir, 2020).

In addition, gastrointestinal immaturity represents an important biological pathway linking LBW to stunting. Low-birth-weight infants frequently present with underdeveloped digestive function, including inadequate intestinal motility, insufficient digestive enzyme production, and incomplete mucosal integrity. These factors lead to suboptimal absorption of essential

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macro and micronutrients required for growth (Robert M. Kliegman & Joseph St. Geme, 2020). Nutrient deficiencies during the critical window of the first 1,000 days of life can result in long-term growth deficits.

Over time, the early physiological disadvantages associated with low birth weight translate into measurable growth deficits. Children born with LBW often begin early childhood with lower height-for-age scores and continue to face nearly double the risk of stunting between 24 and 59 months (Hartantio et al., 2023). These postnatal growth challenges are rooted in prenatal constraints, as inadequate maternal nutrition during pregnancy has been shown to impair fetal development and contribute to low birth weight. Early growth impairment within the first two months of life further limits an infant's potential to achieve optimal linear growth. As a result, low-birth-weight infants are substantially more likely to fall short of optimal linear growth by 12 months compared with their normal-birth-weight peers, thereby increasing their susceptibility to stunting in later childhood (Rahmawati Hamzah & Khairun Nisa Mokodompit, 2022).

Ensuring adequate maternal nutrition through interventions such as balanced energy and protein supplementation, as well as consistent iron–folic acid intake, remains essential in high-risk settings. Enhancing the quality and coverage of early, comprehensive antenatal care, including systematic monitoring for pregnancy complications, can further reduce the likelihood of low birth weight and its associated health consequences. In stunting-locus villages, where structural vulnerabilities are more evident, community-level measures, including strengthened Posyandu functions, routine village nutrition surveillance, and focused maternal counseling, are critical for lowering LBW prevalence and interrupting the intergenerational transmission of growth faltering (Hartantio et al., 2023).

CONCLUSION

This study highlights low birth weight as a major determinant of stunting. Infants born with low birth weight face substantial challenges during the critical first 1000 days of life, including limited nutrient reserves, underdeveloped organ systems, compromised gastrointestinal function, and recurrent infectious episodes, all of which collectively hinder optimal linear growth. These findings underscore the importance of implementing early, multidimensional interventions, including enhanced maternal nutritional management, strengthened infection-control measures, and systematic postnatal growth monitoring, to mitigate the long-term developmental impacts of low birth weight and reduce the risk of stunting. Importantly, they underscore the need for stronger policy integration of maternal nutrition programs with routine neonatal growth monitoring, particularly in high-burden areas, to more effectively prevent stunting and support optimal child growth outcomes.

RECOMMENDATIONS

Further investigations with larger and adequately powered samples are necessary to confirm the consistency of the observed relationship between low birth weight and stunting. To better inform policy development, future work should also adopt longitudinal approaches that explore the biological and environmental pathways connecting these conditions throughout the first 1000 days. Moreover, studies assessing the impact of community-driven initiatives and multisectoral programs, such as integrated maternal nutrition services, enhanced neonatal growth surveillance, and strengthened primary healthcare systems, will be crucial for shaping effective and scalable strategies to reduce stunting in high-risk areas.

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