

Digital Nutrition Education for Stunting Prevention Among Mothers of Toddlers in Community-Based Learning Environments

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ABSTRACT

This study examined the prevalence of stunting among children aged 24–59 months in Kabasaran Village, Bogor Regency, and investigated its associations with Low Birth Weight (LBW), maternal knowledge, and nutritional status. **The findings** are intended to inform priorities for maternal nutrition education. A cross-sectional study was conducted in July 2025 involving 93 mothers of toddlers recruited through accidental sampling. **Data were obtained** from structured questionnaires and Maternal and Child Health Books (KIA/KMS). Associations were analyzed using Pearson's chi-square or Fisher's exact test, with Odds Ratios (ORs) and 95% Confidence Intervals (CIs). Eighteen children (19.4%) were classified as stunted. **Stunting was** significantly associated with LBW history (OR = 20.36; 95% CI: 5.65–73.40), poor maternal knowledge (OR = 8.43; 95% CI: 2.50–28.48), and poor nutritional status (OR = 13.16; 95% CI: 3.97–43.61; all $p < 0.001$). Exclusive breastfeeding was reported for 65.6% of children, but its association with stunting was not tested. **The findings** identify maternal knowledge, birth-weight history, and nutritional status as relevant factors for local stunting-prevention planning. Maternal nutrition education may be supported by accessible digital learning materials, although the effectiveness of such technology was not evaluated in this study.

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1. INTRODUCTION

Malnutrition that lasts for a long time impairs physical growth and appears as stunting, a chronic condition. Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2020 on Child Anthropometric Standards classifies nutritional status by the Length-for-Age (PB/U) or Height-for-Age (TB/U) index and uses the terms stunted and severely stunted for short and very short stature [1]. In toddlers, who are children aged 0 to 60 months, classification follows World Health Organization (WHO) standards. A child is short when the Z-score lies between -3 SD and -2 SD, and very short when it falls below -3 SD [2, 3]. The global burden is large. A joint report of UNICEF, WHO, and the World Bank estimates that 148.1 million children under five years of age were stunted, which equals 22.3% of all children in this age group [4, 5]. Asia and Africa together account for more than 85% of these children. South Asia has the highest prevalence at 30.5%, followed by Southeast Asia at 26.4% and Latin America and the Caribbean at 11.5% [6, 7].

In Indonesia, stunting prevalence declined from 21.6% in 2022 to 21.5% in 2023 and 19.8% in 2024, but it is still above the national target of 14% [8]. West Java Province moved against this trend, with an increase from 20.2% in 2022 to 21.7% in 2023 [9]. Bogor Regency was reported to have reduced its prevalence from 27.6% in 2023 to 7.59% in the 2024 Indonesian Nutritional Status Survey (SSGI) [10, 11]. Even so, records of the Parungpanjang Community Health Center show 86 toddlers aged 12 to 60 months with a TB/U Z-score below -2 SD in 2024, and 22 of them lived in Kabasiran Village. District averages can therefore hide clusters at village level, and this is why Kabasiran Village was designated a stunting locus (*lokus stunting*). Stunting threatens the quality of human resources in a lower-middle-income country such as Indonesia. Body stature is closely related to work capacity, so nutrition from conception to two years of age matters greatly, and childhood stunting is projected to reduce productivity by up to 1.4% [12, 13]. Growth faltering builds up between conception and the second birthday, which makes early identification of modifiable determinants essential [14].

Determinants of stunting in Indonesia are well described at national level. Non-exclusive breastfeeding, premature birth, short birth length, low household socioeconomic status, and low maternal education are the most consistently supported [15, 16]. Local studies, however, usually examine these factors one at a time and in different settings, so their effect sizes cannot be compared within one population. Village programmes must divide limited resources among several targets, and they need to know which factors are most strongly associated with stunting in their own village. To our knowledge, few studies in the working area of the Parungpanjang Community Health Center have examined household, feeding, and nutritional status determinants together in one sample from a designated stunting locus. This study therefore estimates stunting prevalence among toddlers aged 24 to 59 months in Kabasiran Village, quantifies its association with LBW history, maternal knowledge, and nutritional status while describing exclusive breastfeeding coverage, and translates the findings into priorities for local action. The contribution is a locus-specific evidence base and not a new causal mechanism, and the limits of bivariate evidence are stated in the Discussion.

The study is consistent with Sustainable Development Goal (SDG) 2 target 2.2, SDG 3, Presidential Regulation Number 72 of 2021 on the Acceleration of Stunting Reduction, and the national target of 14% in the National Medium-Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional*, RPJMN). It also concerns health education, because many of the determinants examined here depend on what mothers know and how they are supported at the posyandu. A preliminary survey in June 2025 at the community health center found that Kabasiran Village contributed 22 of 86 stunted toddlers, and that four of ten toddlers measured by TB/U were stunted. Their mothers reported LBW, poor nutritional status, no exclusive breastfeeding, early introduction of complementary food, and limited knowledge of nutrition, symptoms, and the impact of stunting.

2. LITERATURE REVIEW

The WHO conceptual framework groups stunting determinants into household and family factors, inadequate complementary feeding, breastfeeding practices, and infection or nutritional status [17]. Family factors include maternal knowledge, chronic energy deficiency during pregnancy, and LBW. Complementary feeding factors involve cultural aspects and feeding methods, and the remaining domains concern exclusive breastfeeding and comorbid illness [18]. In the short term stunting disturbs metabolism, physical growth, intelligence, and brain development. In the long term it lowers immunity, academic achievement, and cognitive ability, raises the risk of diabetes, obesity, heart disorders, cancer, and stroke, and reduces productivity in adulthood [1]. National countermeasures include optimizing maternal nutrition, 90 iron-Folic Acid (IFA) tablets during pregnancy, Early Initiation of Breastfeeding (*Inisiasi Menyusu Dini*, IMD), exclusive breastfeeding, complementary feeding (MP-ASI) from six months, immunization, vitamin A distribution, growth monitoring at integrated health posts (posyandu), and Clean and Healthy Living Behavior (*Perilaku Hidup Bersih dan Sehat*, PHBS) [19, 20].

Low birth weight is defined as a birth weight below 2,500 g and results from environmental, maternal, and fetal factors that interact with one another [21, 22]. Badjuka found LBW in 35.2% of toddlers, a stunting prevalence of 19.8%, and a significant relationship between LBW and stunting ($p = 0.021$) [23], and similar relationships have been described in other districts [24, 25]. Growth impairment that begins in the womb often continues into childhood, immature organs make catch-up growth difficult, and failed catch-up growth is regarded as the main route from LBW to stunting [26]. LBW infants are also more vulnerable to chronic disease, cognitive disorders, and neonatal death, with higher costs of care [27]. Premature birth and short birth

length are among the most consistent determinants in Indonesia [28].

Maternal knowledge was significantly related to stunting ($p < 0.001$) in the studies of Resti [29], Lugina [30, 31], and Dakhi [32]. Good knowledge was found in 74.8% of mothers in the study of Lugina and in 65.8% in the study of Dakhi. Knowledge shapes habits and perceptions of illness and healthy living and strengthens a mother's confidence in caregiving [33]. A mother's ability to choose food, understand its nutritional value, keep the home hygienic, and plan meals depends on her nutritional understanding, which also influences the availability and variety of food in the household [34]. Nutritional literacy in turn is shaped by education, exposure to information, and experience [35]. Beal and colleagues highlight maternal education rather than knowledge scores as a consistent determinant, which suggests that knowledge may act partly through education, socioeconomic status, and caregiving practice [36].

The Ministry of Health defines exclusive breastfeeding as giving breast milk alone, without other fluids or solid food, until six months of age, with continued breastfeeding up to two years [1]. Migang reported exclusive breastfeeding coverage of 69.4% and a relationship between breastfeeding history and the nutritional status of children under two ($p = 0.013$) [37]. Khoiriyah reported coverage of 68.5% and a significant relationship with stunting ($p = 0.002$) [38]. Breast milk is the first intake after birth and supports growth, development, and later nutritional status [39]. Its calcium is absorbed more efficiently than that of formula milk, which favors linear growth [40]. Non-exclusive breastfeeding is among the most consistent determinants in Indonesian evidence [41].

Nutritional status is the physical condition that results from food intake and the use of nutrients by the body, and toddlers remain vulnerable to deficiency despite their rapid growth [39]. Good nutritional status was found in 74.2% of toddlers by Sumardilah and Rahmadi [42], in 65.2% by Desyanti and Nindya with a significant relationship to stunting ($p = 0.010$) [33], and in 67.5% by Naskhah ($p = 0.001$) [43]. Long-standing shortages of energy, protein, vitamins A and D, calcium, zinc, and iron impair long bone growth and tissue development [39, 43]. Infection and undernutrition reinforce each other, because diarrhea and acute respiratory infection (ARI) are more frequent in undernourished children [1]. For public health classification, de Onis and colleagues regard a prevalence from 10% to below 20% as medium and from 20% to below 30% as high [44].

The four determinants are linked to one another. LBW reflects impaired fetal growth and limits later catch-up growth [2]. Maternal knowledge shapes feeding decisions including exclusive breastfeeding, and inadequate breastfeeding is a direct cause of poor nutritional status in the first two years of life. We therefore expected that LBW history (H1), poor maternal knowledge (H2), and poor nutritional status (H3) would each be associated with a higher likelihood of stunting among toddlers aged 24 to 59 months. Exclusive breastfeeding coverage is described here, but its association with stunting was not tested. These hypotheses concern association only, and the pathway above is an interpretive framework and not a tested causal model.

3. METHODS

This section describes how the study was designed and carried out. It covers the setting, the population and sampling procedure, the instruments and definitions of the variables, the ethical procedures, and the statistical methods used for analysis.

3.1. Study Design, Setting, and Sample

This quantitative analytic study used a cross-sectional design and was conducted in Kabasiran Village, Parungpanjang Subdistrict, Bogor Regency, in July 2025. The village lies within the working area of the Parungpanjang Community Health Center, where toddlers continue to experience stunting together with the risk factors described above. The independent variables were LBW history, maternal knowledge, and nutritional status, and exclusive breastfeeding history was described. The dependent variable was stunting among toddlers aged 24 to 59 months. The population consisted of 1,155 mothers of toddlers in this age group who were registered in Kabasiran Village. The sample size was calculated with the Slovin formula at a 10% margin of error:

$$n = \frac{N}{1 + Ne^2} = \frac{1155}{1 + 1155(0.1)^2} \approx 92.03, \quad (1)$$

where N is the population size and e is the margin of error. The calculated value of 92.03 was rounded up to the next whole respondent, giving 93 mothers. Respondents were recruited by accidental sampling among mothers who were present at the posyandu or health facility during data collection and who met the inclusion criteria. These criteria were being the mother of a toddler aged 24 to 59 months, living in Kabasiran Village, and being

willing to participate. Slovin's formula assumes simple random sampling and is not based on an expected effect size or on statistical power, and accidental sampling is a non-probability method. The calculation therefore served only as a pragmatic minimum sample size and does not make the sample representative of the village. The precision actually achieved is shown by the confidence intervals reported in the Results: with 18 stunted toddlers, the 95% CI of prevalence spans about 16 percentage points and the intervals of the ORs are wide.

3.2. Instruments, Variables, and Ethics

Data were collected with a structured questionnaire on respondent characteristics, birth weight history, maternal knowledge of stunting, and exclusive breastfeeding history. Anthropometric data were taken from the Maternal and Child Health Book/Growth Monitoring Card (*Kesehatan Ibu dan Anak, KIA / Kartu Menuju Sehat, KMS*). Stunting was determined from TB/U Z-scores calculated against the 2020 WHO Child Growth Standards adopted in Ministry of Health Regulation Number 2 of 2020. A child was classified as stunted when the Z-score was below -2 SD and as normal otherwise [1]. A toddler was classified as LBW when birth weight was below 2,500 g. Maternal knowledge of the definition, causes, and prevention of stunting was scored from the structured questions and divided into good and poor. Breastfeeding was classified as exclusive when the infant received only breast milk, without other fluids or solid food, during the first six months of life [1, 11]. Nutritional status was classified as good or poor using anthropometric Z-score criteria. The study followed the ethical principles described in the Declarations.

3.3. Statistical Analysis

Univariate analysis described the frequency of each variable, and the 95% CI of stunting prevalence was calculated with the Wilson method. Bivariate analysis examined the association of each of the three independent variables with stunting in 2×2 tables. Expected cell counts were checked first. Pearson's chi-square test was used when all expected counts were at least 5, and Fisher's exact test was used when any expected count was below 5. The strength of association was expressed as an Odds Ratio (OR) with a 95% Confidence Interval (CI) based on the Woolf method. The Prevalence Ratio (PR) is also reported, with a 95% CI based on the log method, because the OR overstates relative risk when the outcome is common. All estimates are crude (unadjusted). Multivariable logistic regression was not fitted because the number of stunted toddlers was too small for stable estimates. All 93 respondents had complete data on every variable, so no case was excluded and no imputation was needed. Statistical significance was set at $p < 0.05$, and all analyses were done in SPSS.

4. RESULTS AND DISCUSSION

This section presents the results of the univariate and bivariate analyses and then discusses them against the literature reviewed earlier. The univariate results describe the sample, the bivariate results test the association of each determinant with stunting, and the discussion interprets these findings and states the limitations of the study.

4.1. Univariate Analysis Results

Table 1 shows the distribution of stunting among the 93 toddlers. Every table in this section is based on all 93 respondents, because no data were missing. Most toddlers (75, or 80.6%) had normal height for age, and stunting was found in 18 toddlers (19.4%, 95% CI 12.6 to 28.5).

Table 1. Frequency Distribution of Stunting in Toddlers Aged 24–59 Months ($n = 93$)

Incidence of Stunting	Frequency (f)	Percentage (%)
Stunting	18	19.4
Normal	75	80.6
Total	93	100.0

The prevalence of 19.4% means that about one in five toddlers aged 24 to 59 months in the sample was shorter than expected for age. This is roughly one stunted child for every four children with normal height, so stunting is a common problem in this village and not an isolated one. The figure also serves as the baseline outcome against which the three determinants are compared in the bivariate analysis. Table 2 shows LBW

history. Most toddlers were born with normal weight (68, or 73.1%), and 25 toddlers (26.9%) had a history of LBW.

Table 2. Frequency Distribution of LBW Birth History in Toddlers Aged 24–59 Months ($n = 93$)

History of LBW Birth	Frequency (f)	Percentage (%)
LBW	25	26.9
Not LBW	68	73.1
Total	93	100.0

More than one in four toddlers (26.9%) had a history of LBW. A birth weight below 2,500 g signals restricted growth before birth, so these children began life with less nutritional reserve than their peers. The size of this group matters because the bivariate analysis below shows that LBW has the strongest link with stunting. Table 3 shows maternal knowledge. Fifty-seven mothers (61.3%) had good knowledge of stunting and 36 mothers (38.7%) had poor knowledge.

Table 3. Frequency Distribution of Maternal Knowledge Among Mothers of Toddlers Aged 24–59 Months ($n = 93$)

Maternal Knowledge	Frequency (f)	Percentage (%)
Poor	36	38.7
Good	57	61.3
Total	93	100.0

Most mothers had good knowledge, but almost four in ten (38.7%) did not. Poor knowledge here means limited understanding of the definition, causes, and prevention of stunting. A group of this size shows that nutrition information has not reached every mother, and it defines the audience for educational activities at the posyandu. Table 4 shows exclusive breastfeeding history. Sixty-one toddlers (65.6%) had been exclusively breastfed and 32 toddlers (34.4%) had not.

Table 4. Frequency Distribution of Exclusive Breastfeeding History in Toddlers Aged 24–59 Months ($n = 93$)

History of Exclusive Breastfeeding	Frequency (f)	Percentage (%)
Not exclusively breastfed	32	34.4
Exclusively breastfed	61	65.6
Total	93	100.0

About one in three toddlers (34.4%) did not receive exclusive breastfeeding during the first six months. This means that many infants were given other fluids or food before the recommended age, which can reduce their intake of the protective components of breast milk. The table only describes feeding history and does not show whether this group had more stunting. Table 5 shows nutritional status. Most toddlers had good nutritional status (74, or 79.6%), and 19 toddlers (20.4%) had poor nutritional status.

Table 5. Frequency Distribution of Nutritional Status in Toddlers Aged 24–59 Months ($n = 93$)

Nutritional Status	Frequency (f)	Percentage (%)
Poor nutritional status	19	20.4
Good nutritional status	74	79.6
Total	93	100.0

Poor nutritional status affected one in five toddlers (20.4%), a share close to that of stunting. The similar size of the two groups does not mean that they consist of the same children, and the bivariate analysis below shows how far they overlap.

For every determinant the lower risk category was the majority. Even so, a substantial group of mothers (38.7%) had poor knowledge and more than a third of toddlers (34.4%) had not been exclusively breastfed. Figure 1 presents these distributions graphically.

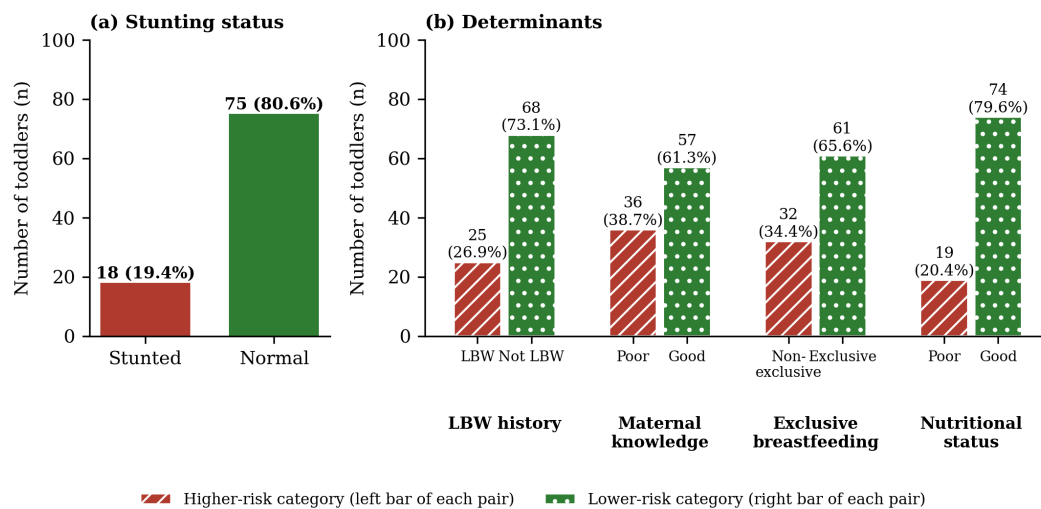


Figure 1. Distribution of (a) stunting status and (b) the four determinants among toddlers aged 24 to 59 months ($n = 93$). Hatched bars, higher-risk category, dotted bars, lower-risk category

Panel (a) of Figure 1 shows that normal toddlers outnumbered stunted toddlers by more than four to one, and panel (b) shows, for each determinant, the higher-risk category (hatched bar, left) next to the lower-risk category (dotted bar, right). The higher-risk category was largest for maternal knowledge and exclusive breastfeeding. The prevalence of 19.4% lies at the upper end of the medium band of the WHO-based classification. Because the 95% CI extends into the high band, a high prevalence in the village cannot be ruled out.

4.2. Bivariate Analysis Results

All estimates in this subsection are crude (unadjusted). Expected counts were below 5 in one cell for LBW history (minimum 4.84) and nutritional status (minimum 3.68), so Fisher's exact test was used for these two variables. All expected counts for maternal knowledge were at least 5 (minimum 6.97), so Pearson's chi-square test was used. Table 6 shows the association between LBW history and stunting. Among the 25 LBW toddlers, 14 (56.0%) were stunted, while among the 68 toddlers without LBW only 4 (5.9%) were stunted. The association was significant ($p < 0.001$) with an OR of 20.36 (95% CI 5.65 to 73.40) and a PR of 9.5 (95% CI 3.5 to 26.2).

Table 6. Relationship Between LBW Birth History and Stunting in Toddlers Aged 24–59 Months

LBW History	Stunted, n (%)	Normal, n (%)	Total	p-value	OR (95% CI)	PR (95% CI)
LBW	14 (56.0)	11 (44.0)	25	< 0.001 ^a	20.36 (5.65–73.40)	9.5 (3.5–26.2)
Not LBW	4 (5.9)	64 (94.1)	68		1.00 (ref.)	1.00 (ref.)
Total	18 (19.4)	75 (80.6)	93			

The table shows a clear gradient. More than half of the LBW toddlers were stunted, compared with about one in seventeen of those born at normal weight. The odds of stunting among LBW toddlers were about 20 times those of toddlers without LBW. Because the OR is larger than the PR, the more cautious reading is that stunting was about 9.5 times as common in the LBW group. Fourteen of the 18 stunted toddlers (77.8%) had a history of LBW, which shows how common this background is among stunted children here, although the wide interval means that the exact size of the effect is uncertain.

Table 7 shows the association between maternal knowledge and stunting. Stunting was found in 14 of 36 toddlers (38.9%) whose mothers had poor knowledge and in 4 of 57 toddlers (7.0%) whose mothers had good knowledge. The association was significant (chi-square 14.36, df 1, $p < 0.001$) with an OR of 8.43 (95% CI 2.50 to 28.48) and a PR of 5.5 (95% CI 2.0 to 15.5).

Table 7. Relationship Between Maternal Knowledge and Stunting in Toddlers Aged 24–59 Months

Maternal Knowledge	Stunted, n (%)	Normal, n (%)	Total	p-value	OR (95% CI)	PR (95% CI)
Poor	14 (38.9)	22 (61.1)	36	< 0.001 ^b	8.43 (2.50–28.48)	5.5 (2.0–15.5)
Good	4 (7.0)	53 (93.0)	57		1.00 (ref.)	1.00 (ref.)
Total	18 (19.4)	75 (80.6)	93			

Stunting prevalence was about five times higher among toddlers of mothers with poor knowledge than among those of mothers with good knowledge (38.9% versus 7.0%). The association is weaker than that of LBW, but it rests on a test whose assumptions were fully met because all expected counts were at least 5. Fourteen of the 18 stunted toddlers (77.8%) had mothers with poor knowledge, which stands out because this group made up only 38.7% of the sample.

Table 8 shows the association between nutritional status and stunting. Stunting was found in 11 of 19 toddlers (57.9%) with poor nutritional status and in 7 of 74 toddlers (9.5%) with good nutritional status. The association was significant ($p < 0.001$) with an OR of 13.16 (95% CI 3.97 to 43.61) and a PR of 6.1 (95% CI 2.7 to 13.7).

Table 8. Relationship Between Nutritional Status and Stunting in Toddlers Aged 24–59 Months

Nutritional Status	Stunted, n (%)	Normal, n (%)	Total	p-value	OR (95% CI)	PR (95% CI)
Poor	11 (57.9)	8 (42.1)	19	< 0.001 ^a	13.16 (3.97–43.61)	6.1 (2.7–13.7)
Good	7 (9.5)	67 (90.5)	74		1.00 (ref.)	1.00 (ref.)
Total	18 (19.4)	75 (80.6)	93			

Stunting prevalence was 57.9% among toddlers with poor nutritional status and 9.5% among those with good nutritional status. Eleven of the 18 stunted toddlers (61.1%) also had poor nutritional status, so the two conditions overlap but are not identical, and 7 stunted toddlers had good nutritional status. This partial overlap suggests that nutritional status captures part of the problem but cannot replace height-for-age measurement.

Stunting was common in this sample, so the ORs are much larger than the prevalence ratios, and the PR is the more conservative measure of relative risk. The confidence intervals are wide because only 18 children were stunted and some cells were small, so the estimates give the direction and rough size of each association but not a precise effect. Figure 2 shows the stunting prevalence within each category of the three tested determinants, with 95% Wilson confidence intervals and the corresponding OR.

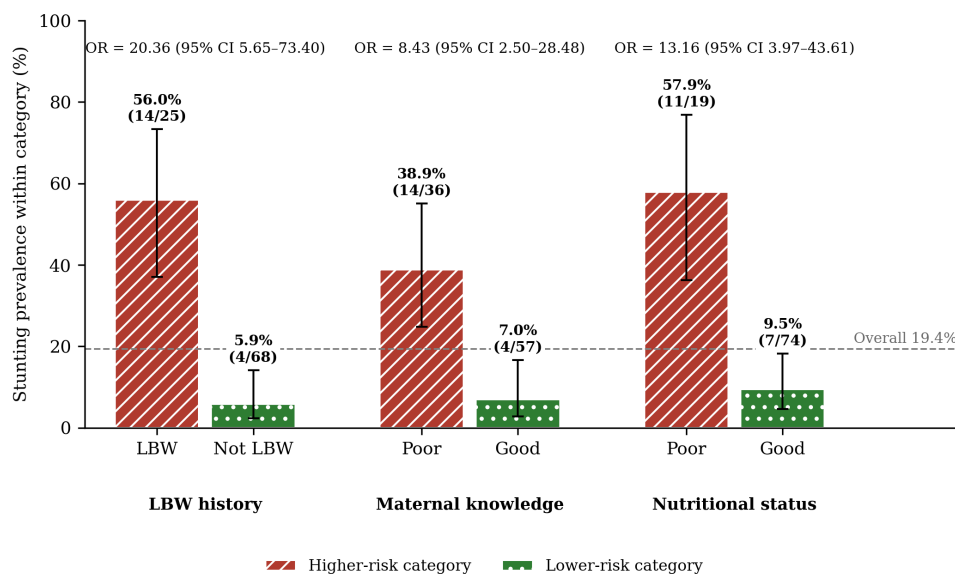


Figure 2. Stunting prevalence by LBW history, maternal knowledge, and nutritional status (n = 93). Error bars: 95% Wilson CI. Dashed line: overall prevalence.

In every comparison the prevalence in the higher-risk category was well above the overall prevalence of 19.4%, and the prevalence in the lower-risk category was well below it. The confidence intervals of the two categories do not overlap in any of the three comparisons. The gap was widest for LBW history and nutritional status, and it was smaller but still clear for maternal knowledge.

4.3. Discussion

The stunting prevalence of 19.4% is close to the 19.8% reported by Badjuka and the national estimate for 2024, but it is far above the 7.59% district figure cited in the Introduction. This is consistent with the designation of Kabasiran as a stunting locus and with the view that district averages can hide local clusters. These comparisons are only indicative, because the sources differ from this study in population, design, period, and measurement. The national and district figures come from population surveys of children under five years with probability sampling, whereas this study used a non-probability sample of mothers attending the posyandu or health facility in July 2025, aged 24 to 59 months, with heights taken from KIA/KMS records. Badjuka's study was conducted in a different setting and year. A similar number therefore does not mean equal prevalence, and the gap with the district figure may reflect these differences as well as a true local excess. Two further cautions are needed. The sample came from mothers who attended the posyandu or health facility, so the prevalence cannot be generalized to the whole village. In addition, stunting that continues beyond the first two years affects cognitive development, chronic disease risk, and adult productivity, and it helps to pass poverty from one generation to the next. These consequences support early and convergent intervention.

The proportion of LBW (26.9%) is lower than the 35.2% reported by Badjuka but still high, which shows that low birth weight remains a real problem in this community. LBW had the strongest association with stunting (OR 20.36), in line with earlier studies and with the mechanism of persistent growth restriction and failed catch-up growth described in the Literature Review. The hypothesis that poor nutrient absorption and recurrent infection in LBW children lead to later growth disorders is therefore supported in direction. Three limits apply. The study could not separate preterm birth from growth restriction in the womb, which call for different prevention. The LBW proportion depends on how birth weight was obtained, so measurement error is possible. The confidence interval is also very wide, so the true effect may be much smaller or larger than the estimate. Even so, the size of the association makes antenatal care an important point for prevention.

Good knowledge in 61.3% of mothers is slightly lower than the 65.8% and 74.8% reported by Dakhi and Lugina, and 38.7% of mothers still had poor knowledge. Toddlers of mothers with poor knowledge had 8.43 times the odds of stunting, which agrees with the significant results of Resti, Lugina, and Dakhi. Mothers who know more are likely to feed their children appropriately, keep the home clean, monitor growth regularly, and prevent infection. Mothers who know less may not understand the nutritional needs of toddlers or the importance of exclusive breastfeeding. This interpretation should be made with care. Knowledge does not always become behaviour, and knowledge is closely linked to maternal education and household resources, which were not measured here, so confounding is likely. The direction of the relationship is also uncertain, because mothers of children already identified as stunted may have received counselling at the posyandu. Such counselling would raise their knowledge after the fact and could weaken the observed association. The finding shows that nutrition education is a clear need, especially for mothers who have not yet joined posyandu counselling.

Exclusive breastfeeding coverage of 65.6% is slightly lower than the 69.4% and 68.5% reported by Migang and Khoiriyah, and 34.4% of toddlers were not exclusively breastfed. Success in exclusive breastfeeding depends on adequate knowledge, support from health workers, and access to early initiation and rooming-in. Because the association between breastfeeding and stunting was not tested, no conclusion about its effect can be drawn from this study. The group that was not exclusively breastfed is still large enough to need early feeding support, since giving other food or fluids before six months can displace breast milk, weaken protection against infection, and increase exposure to diarrhea and ARI. Breastfeeding history was recalled about one and a half to four and a half years after the exposure period, so recall error is also a concern.

Good nutritional status in 79.6% of toddlers is higher than the 65.2% to 74.2% reported by Desyanti and Nindya, Naskhah, and Sumardilah and Rahmadi. This suggests that most toddlers in the sample received reasonably adequate nutrition. Toddlers with poor nutritional status had 13.16 times the odds of stunting, which agrees with the literature on shortages of energy, protein, and micronutrients and on the two-way link between infection and undernutrition. In this study nutritional status was measured at the same time as stunting, so it is better seen as a correlate than as an earlier cause. The two conditions may share causes or overlap, and

the association should not be read as nutritional status causing stunting unless they are defined by different indicators and measured in the right order.

Taken together, the findings fit the pathway outlined in the Literature Review, in which impaired fetal growth limits catch-up growth, maternal knowledge shapes early feeding, inadequate breastfeeding raises the risk of infection and nutrient deficiency, and these factors appear as poor nutritional status and linear growth faltering. This pathway remains an interpretation and not a tested model. The determinants are probably correlated, so each unadjusted OR may partly reflect the others. Multivariable logistic regression would address this problem, but 18 stunted toddlers and three predictors give only 6 events per variable, which is below the common rule of ten and would produce unstable estimates. The unadjusted results are therefore reported. A larger multi-site sample is needed to estimate independent effects after adjusting for maternal education, household income, maternal height, sanitation, and history of infection.

This study has several limitations. The cross-sectional design cannot show the order of events, so the associations do not prove causation. Accidental sampling at the posyandu or health facility may cause selection bias because attending mothers can differ from those who did not attend, and the Slovin calculation does not make the sample representative. The study covered one village in the area of one health center, which limits generalization. Only bivariate analysis was done, so all ORs and PRs are crude, and confounding among the determinants and by unmeasured factors such as maternal education, household income, sanitation, and preterm birth cannot be excluded, and the small number of stunted children produced wide confidence intervals. Birth weight, knowledge, and breastfeeding history came from maternal report and may be affected by recall and social desirability bias. Nutritional status and stunting may overlap in how they were measured, because both were derived from KIA/KMS anthropometry at the same visit, which could inflate their association. The association between exclusive breastfeeding and stunting was not tested, so its role in this population remains unknown. Finally, some cells were sparse, and this is why Fisher's exact test was used when expected counts were below 5.

5. MANAGERIAL IMPLICATIONS

These findings can guide managers of stunting programmes at the Puskesmas, village, and district levels in line with Presidential Regulation Number 72 of 2021 and SDG 2 and 3. The associations are unadjusted and come from a non-probability sample, so they indicate where to focus and not how large the effect of an intervention will be. The percentages from this sample should not be used as village baselines, and the baselines for monitoring should come from routine posyandu and antenatal records. Because poor maternal knowledge was associated with stunting, the Puskesmas nutrition officer and posyandu cadres should hold nutrition education with practical feeding demonstrations at every posyandu each month, since knowledge alone may not change behaviour. A proposed target is that at least 75% of mothers reach good knowledge within 12 months, monitored with the same questionnaire repeated and the number of sessions held and mothers attending. Education could also be supported by simple digital media such as short videos and message reminders shared by health cadres, which may help reach mothers who miss face-to-face sessions.

The strong association with LBW history shows that antenatal care is an important point of intervention. The village midwife and the Puskesmas maternal and child health programme should aim for at least 90% of pregnant women to receive six or more antenatal visits and 90 iron-folic acid tablets, and for all high-risk pregnancies to be referred early. Antenatal coverage, IFA tablet coverage, referrals made, and LBW births per quarter in village records can serve as indicators. Growth monitoring at the posyandu should be used for early detection and prompt referral. Posyandu cadres and the Puskesmas nutrition officer should measure all registered toddlers every month and refer every toddler with a TB/U Z-score below -2 SD within one month. The share of toddlers measured, the share of stunted toddlers referred on time, and stunting prevalence at 24 to 59 months in routine data, compared with the national target of 14%, can be used for evaluation. Support for exclusive breastfeeding should stay part of routine counselling by midwives and cadres, and the share of infants exclusively breastfed to six months in routine records can be tracked, although its association with stunting was not tested here. At district level, the designation of Kabasaran as a stunting locus justifies giving priority in the budget to antenatal care and maternal nutrition education within the national convergent programme. The District Health Office and the village government can track the budget lines allocated and spent on these activities and review the indicators above each year. The targets in this section are proposals to be agreed with the Puskesmas and village government.

6. CONCLUSIONS

Among 93 toddlers aged 24 to 59 months in Kabasiran Village, 18 (19.4%) were stunted, 73.1% had no history of LBW, 65.6% had been exclusively breastfed, 79.6% had good nutritional status, and 61.3% of mothers had good knowledge. LBW history (OR 20.36, 95% CI 5.65 to 73.40), poor maternal knowledge (OR 8.43, 95% CI 2.50 to 28.48), and poor nutritional status (OR 13.16, 95% CI 3.97 to 43.61) were each significantly associated with stunting ($p < 0.001$). These unadjusted estimates give local evidence for the national stunting acceleration agenda and SDG 2 and 3, and they point to antenatal care and maternal nutrition education as priorities in Kabasiran Village.

Because of the cross-sectional design, accidental sampling, and bivariate analysis, the findings show association and not causation. Health workers are advised to strengthen antenatal care, nutrition counselling for mothers, and growth monitoring at the posyandu. Future studies should use probability sampling, a larger multi-site sample, validated instruments, and multivariable analysis, preferably with a prospective design, to test the association of exclusive breastfeeding with stunting and to estimate the independent effect of each determinant. Studies that evaluate technology-assisted nutrition education for mothers would also be useful.

7. DECLARATIONS

7.1. About Authors

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7.2. Author Contributions

Validation was conducted by: AR Conceptualization was completed by: PW The methodology was developed by: ZH Formal analysis was performed by: OM Writing, review, and editing were carried out by: LS Visualization was completed by: AR All authors, including: PW, ZH, OM, and LS, have reviewed and approved the final version of the manuscript.

7.3. Data Availability Statement

The corresponding author may provide the data from this study upon request.

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The research, writing, and/or publishing of this work were all done without financial assistance from the authors.

7.5. Declaration of Competing Interest

The authors state that none of their known conflicting financial interests or personal connections could have had an impact on the work that was published in this publication.

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