

# Determinants and contextual barriers of childhood stunting in rural Indonesia: a mixed-methods study in Sengonwetan Village

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## Abstract

**Purpose:** Stunting continues to pose a significant child health burden in Indonesia, particularly in rural settings where healthcare access, maternal education, and dietary quality remain limited. Addressing these community-level determinants is crucial to accelerating progress in reducing stunting. This study aimed to identify the determinants and explore contextual barriers of childhood stunting among children under five in Sengonwetan Village, Grobogan Regency, Indonesia. **Methods:** A mixed-methods cross-sectional study was conducted in March 2025 involving 120 children aged 6–59 months selected through stratified random sampling. Anthropometric measurements followed World Health Organization standards. Household food security, dietary diversity, and maternal characteristics were assessed using structured questionnaires, while qualitative interviews explored contextual barriers. Quantitative data were analyzed using logistic regression, and qualitative data were analyzed thematically. **Results:** Stunting prevalence was 21.7%. Children of mothers with lower education had higher odds of being stunted (AOR 2.10; 95% CI 1.05–4.20). Household food insecurity (AOR 1.80; 95% CI 1.02–3.22) and low dietary diversity (AOR 1.95; 95% CI 1.10–3.48) were also associated with increased odds of stunting. Recurrent diarrheal episodes emerged as the strongest determinant (AOR 3.20; 95% CI 1.30–7.85). Qualitative findings highlighted limited dietary diversity, economic constraints, and inadequate sanitation as key contextual barriers. **Conclusion:** Childhood stunting in this rural setting is influenced by both measurable determinants and contextual barriers, particularly maternal education, household food security, dietary diversity, and recurrent infections. Integrated, community-based interventions that address both behavioral and structural factors are essential to accelerate reductions in stunting.

**Keywords:** child nutrition disorders; dietary diversity; food insecurity; rural health; stunting

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## INTRODUCTION

Childhood malnutrition, particularly stunting, remains a major public health challenge in Indonesia and many other low- and middle-income countries. Stunting reflects chronic undernutrition resulting from prolonged deficiencies in nutrient intake and health

conditions, with consequences extending beyond physical growth. It is associated with increased susceptibility to infections, impaired cognitive development, poorer educational attainment, and reduced productivity in adulthood, making it not only a health issue but also a critical development concern [1,2].

Despite ongoing national efforts, the burden of stunting in Indonesia remains substantial. The 2024 Indonesian Nutritional Status Survey (SSGI) reported a prevalence of 20.8%, which remains above the national target of 14% [3]. Although national trends show gradual improvement, reductions have been uneven across regions. Rural and underserved areas continue to bear a disproportionate burden, largely due to persistent inequalities in access to nutritious food, healthcare services, sanitation, and education. In Central Java, including Grobogan Regency, such disparities remain evident, reflecting structural constraints that may limit the effectiveness of national interventions at the local level [4].

Stunting is widely recognized as a multifactorial condition influenced by complex interactions among immediate and underlying determinants. Previous studies have consistently identified inadequate dietary diversity, poor sanitation, recurrent infections, low maternal education, and limited access to health services as key contributing factors [5-7]. In rural Indonesia, household food insecurity and suboptimal infant and young child feeding practices persist, with limited food variety and economic constraints affecting dietary adequacy. While maternal education plays an important role in shaping caregiving practices, its impact is often constrained by household conditions such as food availability and economic capacity, suggesting that knowledge alone is insufficient without structural support.

Despite the growing body of research on childhood stunting in Indonesia, most studies rely on large-scale national or regional datasets, which may mask important local variations. A multilevel analysis across Indonesia found that 473 out of 514 districts were classified as having high or very high stunting prevalence, highlighting widespread disparities at the district level [8]. However, such analyses are typically based on aggregated data and do not capture detailed conditions at the village level, where health programs are implemented.

In Indonesia, most research on stunting has focused on national or provincial trends, providing important insights into broad determinants and policy directions. However, such approaches often overlook variations at the village level, where programs are actually implemented. Although initiatives such as the Electronic Community-Based Nutrition Recording and Reporting system (E-PPGBM) have improved data collection, discrepancies between routine reporting and field conditions remain [9]. Moreover, while community-based platforms such as Posyandu (an integrated community health post) have been widely implemented, evidence of their effectiveness in

addressing household-level challenges and strengthening resilience remains limited [8]. In particular, there is a lack of research exploring how community empowerment strategies can be tailored to address the combined effects of maternal knowledge, household food access, and environmental health conditions in rural communities.

This gap is important because the success of public health interventions often depends on how well they are adapted to local contexts. Programs that are effective at the national level may not achieve the same outcomes at the village level if they do not account for local needs, resources, and constraints. Understanding how different determinants interact within specific communities is therefore essential for designing more effective and sustainable interventions. In rural settings such as Sengonwetan Village, where access to services and resources may be limited, community-based approaches that build local capacity and engagement may play a particularly important role.

Based on these considerations, this study was conducted to provide a context-specific understanding of childhood stunting in Sengonwetan Village, Kradenan Subdistrict, Grobogan Regency. The objectives of the study were to (1) assess the prevalence of stunting among children aged 6–59 months, (2) identify key contributing factors, including maternal education, household food security, dietary diversity, and infection history, and (3) explore opportunities for strengthening community-based nutrition interventions. By integrating quantitative and qualitative methods, this study aims to capture both measurable determinants and lived experiences within the community. The findings are expected to contribute to the development of more targeted and contextually appropriate strategies to reduce stunting, while also supporting broader efforts to improve child health outcomes in rural Indonesia.

## METHODS

### Study design and setting

This study employed a convergent parallel mixed-methods design, in which quantitative and qualitative data were collected simultaneously and independently, then merged during interpretation to provide a comprehensive understanding of childhood stunting [10-12]. The quantitative component consisted of a cross-sectional study using anthropometric measurements and structured questionnaire data. A cross-sectional design was selected because it allows simultaneous assessment of multiple determinants across a large number of participants within a limited timeframe and budget, making it particularly suitable

for community-based surveillance in resource-constrained rural settings. Although this design does not allow causal inference, it is widely used and accepted for generating hypotheses about determinants of nutritional status at the community level. The temporal limitation of this design is acknowledged in the study [10,11]. The qualitative component employed a phenomenological approach to explore the lived experiences and perceived barriers of caregivers and health workers regarding child nutrition and feeding practices. The study was conducted and reported in accordance with the STROBE guideline for observational studies and the SRQR guideline for qualitative research [10,11].

The research was carried out in Sengonwetan Village, Kradenan Subdistrict, Grobogan Regency, Central Java, Indonesia. This rural area was selected due to its persistently high stunting burden and limited availability of village-level data [13]. Data collection was conducted in March 2025, targeting children aged 6–59 months and their primary caregivers.

The study population included children aged 6–59 months who were permanent residents of Sengonwetan Village. The sample size was estimated using the Lwanga and Lemeshow (1991) formula for estimating a proportion, based on an expected stunting prevalence of 21% derived from the 2022 national nutritional status survey (SSGI), a 95% confidence level, and an absolute precision of 8%. This yielded a minimum required sample of 101 participants, which was rounded up to 120 to account for an estimated 15% non-response rate and to improve statistical precision. A total of 120 children were selected using stratified random sampling to ensure representation across neighborhood clusters (RT/RW). The sampling frame was derived from the village population registry, and participants were randomly selected within each stratum [14].

Inclusion criteria were children aged 6–59 months who had parents or primary caregivers who provided informed consent. Exclusion criteria included children with congenital anomalies or chronic conditions known to affect growth, such as congenital heart disease, cerebral palsy, or chronic kidney disease. For the qualitative component, purposive sampling was used to select participants with relevant experience and knowledge. A total of 10 participants were recruited for in-depth interviews (IDI), comprising 5 Community Health Volunteers (CHVs), 3 village midwives, and 2 community leaders. Sampling continued until thematic saturation was achieved [15].

## Data collection

Quantitative data collection included anthropometric measurements, household food security assessment, dietary diversity recall, and structured caregiver interviews. Anthropometric measurements (weight and length/height) were conducted according to the WHO Child Growth Standards [16] using calibrated equipment to ensure accuracy. Z-scores were computed using the WHO Anthro software [17].

Household food security was assessed using the Food Insecurity Experience Scale (FIES) and the Household Food Insecurity Access Scale (HFIAS) [17,18]. Dietary diversity was measured using a 24-hour dietary recall and classified according to WHO food groups to determine the Minimum Dietary Diversity for Children (MDD-C) [19,20]. Caregivers completed a structured questionnaire assessing knowledge, attitudes, and practices (KAP) related to infant and young child feeding, adapted from the UNICEF–Ministry of Health Indonesia IYCF survey [21]. Data on recent child morbidity, including diarrheal disease and respiratory tract infections, were collected using standardized DHS questionnaire modules. For the qualitative component, semi-structured interviews were conducted with selected participants to explore barriers related to feeding practices, sanitation, and access to health services. Interviews were conducted in Indonesian and Javanese by trained enumerators, audio-recorded with participant consent, and transcribed verbatim for analysis.

Stunting was defined as a height-for-age z-score (HAZ) below  $-2$  standard deviations from the WHO Child Growth Standards median, classified as stunted ( $<-2$  SD) versus normal ( $\geq-2$  SD) [16]. Maternal education was categorized as low (primary school or below,  $\leq 6$  years of formal education) and high (secondary school or above,  $\geq 7$  years), consistent with the Indonesian national education classification. Household food security was assessed using the Household Food Insecurity Access Scale (HFIAS) and classified as food-secure or food-insecure based on validated cut-off scores [18]. Dietary diversity was measured using a 24-hour dietary recall and classified according to the WHO Minimum Dietary Diversity for Children (MDD-C), with  $\geq 5$  food groups out of 8 indicating adequate dietary diversity [19]. Recurrent diarrhea was defined as two or more episodes of diarrhea in the preceding 3 months, as reported by the caregiver using the standardized DHS morbidity module [22].

To ensure data quality, standardized and previously validated instruments were used. Anthropometric tools

were calibrated regularly, and data collectors received training prior to fieldwork to minimize measurement and interviewer bias. The FIES, HFIAS, and IYCF-based questionnaires have been widely applied in similar settings, supporting their validity and reliability. For qualitative data, credibility was enhanced through triangulation across multiple data sources and participant groups, as well as careful coding and review of emerging themes. To minimize recall bias when collecting dietary diversity and morbidity data, interviews were conducted using standardized, structured questionnaires with specific time-reference anchors (e.g., “within the past 24 hours” for dietary recall and “within the past three months” for diarrheal episodes). Trained enumerators probed systematically, using food models and locally familiar food names to assist recall. Cross-checking across multiple informants within the same household was performed where possible. These strategies have been shown to improve the accuracy of retrospective dietary and morbidity data in community-based settings.

#### Data analysis

Quantitative data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26 [23]. Descriptive statistics were used to summarise participant characteristics and key variables. Logistic regression analysis was conducted to examine associations between stunting and potential determinants, including maternal education, household food security, dietary diversity, and child morbidity [24]. Variables for inclusion in the multivariable logistic regression model were selected based on theoretical relevance and bivariate significance at  $p < 0.25$ . Potential confounders were assessed through a hierarchical conceptual framework adapted from the UNICEF model of malnutrition determinants. Variables that showed a significant change in the odds ratio of the primary determinants (>10%) upon removal were retained in the final model. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test.

Qualitative data were analyzed using thematic analysis [25]. Transcripts were coded inductively, and key themes related to caregiving practices, environmental conditions, and access to health services were identified. Quantitative and qualitative findings were integrated during interpretation to provide a more comprehensive understanding of the study context. Consistent with the convergent parallel mixed-methods design, quantitative results were first analyzed independently, followed by thematic analysis of qualitative transcripts. Findings from both strands were then compared and merged in a joint display to identify areas of convergence, complementarity, and divergence, thereby providing a more comprehensive understanding of the determinants and contextual barriers of stunting in this community.

## RESULTS

Table 1 presents the characteristics of the qualitative informants recruited for in-depth interviews (IDI), including their role, sex, years of experience, educational background, and interview duration. A total of 120 children aged 6–59 months were included in this study. The prevalence of stunting was 21.7% ( $n=26$ ), underweight 14.2% ( $n=17$ ), and wasting 9.2% ( $n=11$ ). Stunting was more prevalent among boys (24.1%) than among girls (19.3%), and among children aged 24–59 months (26.3%) than among those aged 6–23 months (15.4%). Table 2 presents the distribution of maternal, household, and child-related characteristics by stunting status. Stunting was more prevalent among children whose mothers had lower levels of education ( $n=20$ ; 28.6%) compared to those with higher maternal education ( $n=6$ ; 12.0%), with a statistically significant difference ( $p=0.021$ ). Children from food-insecure households had a higher prevalence of stunting ( $n=22$ ; 25.6%) than those from food-secure households ( $n=4$ ; 11.8%;  $p = 0.034$ ).

**Table 1. Characteristics of qualitative informants Sengonwetan Village, 2025**

No	Role / Occupation	Sex	Years of experience (years)	Educational background	Interview duration (minutes)
1	Community Health Volunteer	Female	8	Senior High School	45
2	Community Health Volunteer	Female	5	Senior High School	40
3	Community Health Volunteer	Female	12	Senior High School	50
4	Community Health Volunteer	Female	7	Diploma III in Midwifery	45
5	Community Health Volunteer	Female	10	Senior High School	42
6	Village Midwife	Female	9	Diploma III in Midwifery	55
7	Village Midwife	Female	6	Diploma III in Midwifery	50
8	Village Midwife	Female	14	Bachelor of Midwifery	60
9	Community Leader	Male	15	Senior High School	40
10	Community Leader	Male	11	Bachelor of Social Sciences	45

**Note:** All interviews were conducted in Bahasa Indonesia and audio-recorded with informed consent. Interview duration ranged from 40 to 60 minutes

Similarly, children with inadequate dietary diversity (<5 food groups) had a higher prevalence of stunting (n=24; 24.5%) than those with adequate diversity (n=2; 9.1%; p=0.029). The highest stunting prevalence was observed among children with a history of recurrent diarrhea (n=17; 32.7%) compared with those without (n=9; 13.2%), with the strongest association among all variables assessed (p = 0.008) (Table 2).

**Table 2. Characteristics of respondents and bivariate analysis of factors associated with stunting (n = 120)**

Variable	Stunted n (%)	Normal n (%)	p-value
<b>Maternal education</b>			
Low ( $\leq$ primary)	20 (28.6)	50 (71.4)	0.021
High ( $\geq$ secondary)	6 (12.0)	44 (88.0)	
<b>Household food security</b>			
Insecure	22 (25.6)	64 (74.4)	0.034
Secure	4 (11.8)	30 (88.2)	
<b>Dietary diversity</b>			
< 5 food groups	24 (24.5)	74 (75.5)	0.029
$\geq$ 5 food groups	2 (9.1)	20 (90.9)	
<b>History of recurrent diarrhea</b>			
Yes	17 (32.7)	35 (67.3)	0.008
No	9 (13.2)	59 (86.8)	

The multivariable logistic regression analysis in Table 3 identified four independent determinants of stunting after mutual adjustment for confounders. Children of mothers with lower educational attainment had significantly higher odds of stunting (AOR = 2.10; 95% CI: 1.05–4.20; p = 0.038). Household food insecurity was also independently associated with stunting (AOR = 1.80; 95% CI: 1.02–3.22; p = 0.041). Children with inadequate dietary diversity had significantly higher odds of stunting (AOR = 1.95; 95% CI: 1.10–3.48; p = 0.025). Recurrent diarrhea was the strongest determinant, with affected children having more than three times the odds of being stunted (AOR = 3.20; 95% CI: 1.30–7.85; p = 0.012). The Hosmer–Lemeshow goodness-of-fit test confirmed adequate model fit (p = 0.47), and the model explained approximately 23% of the variance in stunting (Nagelkerke  $R^2$  = 0.23).

All four determinants retained in the final model — maternal education, household food security, dietary diversity, and recurrent diarrhea — were statistically significant and mutually adjusted for potential confounders, consistent with a hierarchical UNICEF conceptual framework of malnutrition determinants. To complement the quantitative findings, Table 2 illustrates the variation in stunting prevalence across key determinants. The visual pattern shows consistently higher proportions of stunting among children from food-insecure households, those with inadequate dietary diversity, and particularly those

**Table 3. Logistic regression analysis of factors associated with stunting**

Variables	AOR	95% CI	p-value
Maternal education (low)	2.10	1.05–4.20	0.038
Household food insecurity	1.80	1.02–3.22	0.041
Low dietary diversity	1.95	1.10–3.48	0.025
Recurrent diarrhea	3.20	1.30–7.85	0.012

with a history of recurrent diarrhea. This figure demonstrates how multiple risk factors tend to cluster within the same groups of children, further emphasizing the cumulative nature of these determinants.

The qualitative findings provide additional context to understand these patterns better. Mothers with lower levels of education often described limited knowledge regarding appropriate complementary feeding practices [26]. Many reported relying on simple, repetitive meals dominated by staple carbohydrates, with limited inclusion of protein sources or micronutrient-rich foods. Some mothers also expressed uncertainty about portion sizes and feeding frequency, particularly for younger children. These findings suggest that knowledge gaps may contribute to suboptimal feeding practices, though broader constraints often shape them.

Economic limitations were frequently mentioned as a major barrier. Several caregivers explained that while they understood the importance of providing diverse and nutritious foods, financial constraints limited their ability to do so. Time constraints were also highlighted, especially among mothers who were responsible for both household tasks and income-generating activities. These factors often led to reliance on readily available, less diverse food options. One mother of a stunted child described this constraint directly:

*“We eat whatever is available; sometimes it is just rice and tempeh. We can’t afford to buy vegetables or fish every day.” — Mother of a stunted child, aged 28 years old*

From the perspective of health workers, recurrent diarrheal diseases were described as a common issue, particularly during certain seasons. Limited access to clean water and suboptimal sanitation practices were identified as contributing factors. Health workers also noted that while community health services such as Posyandu were available, attendance and engagement varied among families. This suggests that access to services alone may not be sufficient without consistent utilization and community participation. A Community Health Volunteer reflected on sanitation conditions in the village:

*“Many children frequently get diarrhea because the well water here is not clean, and not every household has a latrine.” — Community Health Volunteer, female, aged 35 years old*

The qualitative findings corroborated and contextualized the quantitative results across three major themes: (1) limited maternal knowledge of appropriate complementary feeding practices; (2)

economic and time constraints as barriers to dietary diversity; and (3) inadequate WASH conditions contributing to recurrent diarrheal disease among children in Sengonwetan Village. To facilitate the integration of findings from both data strands, Table 4 presents a joint display that juxtaposes the quantitative results with corresponding qualitative themes and representative verbatim quotes for each determinant of stunting.

**Table 4. Joint Display: integration of quantitative and qualitative findings on determinants of childhood stunting in Sengonwetan Village**

Determinant	Quantitative result (AOR; 95% CI; p-value)	Qualitative theme	Representative verbatim quote
Maternal education	AOR = 2.10; 95% CI: 1.05–4.20; p = 0.038 Children of mothers with low education had 2.1× higher odds of stunting	Limited maternal knowledge of complementary feeding practices and nutrition	<i>“I didn’t know what else to feed my child besides plain rice and vegetables.” — Mother, 24 years</i>
Household food insecurity	AOR = 1.80; 95% CI: 1.02–3.22; p = 0.041 Food-insecure households had 1.8× higher odds of stunting	Economic constraints limiting access to diverse and nutritious foods	<i>“We eat whatever is available; sometimes it’s just rice and tempeh. We can’t afford to buy vegetables or fish every day.” — Mother, 28 years</i>
Dietary diversity	AOR = 1.95; 95% CI: 1.10–3.48; p = 0.025 Children with <5 food groups had 1.95× higher odds of stunting	Time constraints and reliance on monotonous, low-cost foods	<i>“I’m busy with work, so I just cook simple meals. The child just eats whatever is around.” — Mother, 31 years</i>
Recurrent diarrheal	AOR = 3.20; 95% CI: 1.30–7.85; p = 0.012 Children with recurrent diarrheal had 3.2× higher odds of stunting (strongest determinant)	Inadequate WASH conditions: contaminated water and limited latrine access	<i>“Many children frequently get diarrhea because the well water here is not clean, and not every household has a latrine.” — Community Health Volunteer, 35 years</i>

**Note:** AOR = Adjusted Odds Ratio; CI = Confidence Interval. Convergence indicates alignment between quantitative and qualitative findings for all four determinants.

## DISCUSSION

This study identified four independent determinants of childhood stunting in Sengonwetan Village: low maternal education (AOR = 2.10), household food insecurity (AOR = 1.80), inadequate dietary diversity (AOR = 1.95), and recurrent diarrhea (AOR = 3.20). These findings are consistent with the UNICEF conceptual framework of malnutrition, which recognizes the interactions among immediate, underlying, and basic causes of undernutrition [1]. Maternal education was a significant determinant, as mothers with lower educational attainment may have had constrained access to nutrition information, limiting their ability to adopt recommended complementary feeding practices and to seek healthcare promptly [5,7,8].

These findings align with prior Indonesian evidence, which consistently identifies maternal education, sanitation, and exposure to infections as key determinants of stunting [5-8,27]. Importantly, this study adds village-level mixed-methods evidence that is

largely absent from the existing literature. Integrating quantitative determinants with qualitative contextual barriers revealed that even when food is nominally available, economic constraints and limited caregiving knowledge prevent adequate dietary diversity—a nuance that quantitative analysis alone cannot capture.

Evidence from low- and middle-income settings consistently demonstrates that multi-component programs combining nutrition counseling, food support, sanitation improvements, and women’s empowerment are more effective than single-component approaches [28-32]. The qualitative findings of the present study reinforce this evidence: economic barriers, time constraints, and poor WASH conditions simultaneously constrained caregiving quality and dietary diversity, underscoring the inadequacy of isolated interventions and the need for convergent, multi-sectoral programming at the village level. The role of infectious disease in perpetuating growth faltering was strongly demonstrated in this study, with recurrent diarrhea emerging as the strongest independent determinant (AOR = 3.20). Repeated infections contributed to nutrient loss, reduced

appetite, and impaired nutrient absorption [33,34], consistent with pathways described in the environmental enteric dysfunction literature. Qualitative data corroborated these findings, with Community Health Volunteers identifying contaminated water and limited latrine access as primary drivers of diarrheal disease in the community. Addressing infectious disease burden, therefore, requires coordinated investments in WASH infrastructure alongside nutritional interventions [35-37].

These findings are directly relevant to Indonesia's national stunting reduction strategy (Stranas Stunting 2018–2024) [38,39], which prioritizes multi-sectoral convergence at the village level. However, qualitative evidence from this study reveals persistent implementation gaps: Posyandu attendance was inconsistent across families, and coordination among the health, education, and WASH sectors at the village level remained limited. Strengthening Posyandu capacity to deliver integrated, multi-component nutrition services — and ensuring meaningful cross-sector coordination — is essential for translating national commitments into measurable improvements in child nutritional status at the community level [30,40].

This study contributes village-level mixed-methods evidence that simultaneously quantifies determinants of stunting and contextualizes barriers through qualitative inquiry—an approach rarely applied at this scale in rural Indonesian settings. Future research should employ longitudinal designs to capture temporal dynamics, including seasonal variations in food security and infection burden that cross-sectional assessment cannot detect. Intervention research should also evaluate integrated Posyandu-based programs that concurrently address maternal education, dietary diversity, and WASH.

Regarding the transferability of these findings, Sengonwetan Village is a rural, agrarian community characterized by predominantly subsistence and smallholder livelihoods, limited access to food markets offering diverse food options, constrained use of formal health services, moderate levels of maternal education, and a stunting burden that exceeds the national average. These characteristics are common across many rural villages in Central Java and similar low-resource settings in Indonesia. Accordingly, the findings of this study are most applicable to other rural villages sharing comparable socioeconomic profiles, ecological conditions, and community health infrastructure. Practitioners and policymakers are encouraged to assess the similarity of their local context — particularly regarding the food environment, access to sanitation, and health service

coverage — before applying these findings to inform local programming.

Several limitations should be acknowledged when interpreting the findings of this study. The cross-sectional design limits the ability to establish causal relationships and does not capture temporal dynamics, such as seasonal fluctuations in food security or disease exposure [30]. Data on dietary intake and morbidity were based on maternal recall, which may introduce recall bias and affect the accuracy of reported information [22]. Although the qualitative component provided important contextual insights, it may not fully represent all perspectives within the community, particularly those of more marginalized groups [41]. In addition, the study was conducted in a single rural village, which may limit the generalisability of the findings to other settings with different socioeconomic or cultural characteristics [30]. Despite these limitations, the study provides valuable local evidence. It contributes to a more nuanced understanding of the complex, context-specific determinants of stunting, highlighting the importance of integrated, community-based approaches to addressing this persistent public health challenge.

## CONCLUSION

This study highlights that childhood stunting in Sengonwetan Village remains a significant public health concern, despite ongoing improvements in food security and community-based health services. The findings indicate that stunting is influenced by a combination of maternal, household, and environmental factors. Maternal education plays an important role in shaping caregiving practices, while household food security and dietary diversity determine the ability to meet children's nutritional needs. In addition, recurrent infections continue to contribute to growth faltering, suggesting that improvements in nutrition alone may not be sufficient unless underlying health and environmental conditions are addressed.

These findings have important implications for public health programs at the community level. Efforts to reduce stunting should move beyond isolated interventions and adopt more integrated, community-based approaches. Specifically, the following actions are recommended: (1) strengthening the capacity of Posyandu to deliver comprehensive nutrition counselling, growth monitoring, and responsive feeding education, ensuring trained Community Health Volunteers can support caregivers with practical, evidence-based guidance; (2) promoting the consumption of locally available, nutrient-dense foods through community food demonstration programmes and home gardening

initiatives to improve dietary diversity without requiring additional household expenditure; (3) improving household water, sanitation, and hygiene (WASH) conditions — including access to clean water and household latrines — to reduce the burden of recurrent diarrheal infections that directly impair child growth; and (4) integrating maternal literacy and nutrition education into existing community platforms, including Posyandu, PKK groups, and village health forums, to address knowledge gaps that limit optimal caregiving practices. Empowering communities and enhancing the capacity of local health workers are essential to ensure sustainability and program effectiveness. Tailoring interventions to local contexts and fostering cross-sector collaboration will be critical to accelerating reductions in stunting in rural areas such as Sengonwetan and similar settings in Indonesia.

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#### Author's contributions

F.A.: conceptualized the study, conducted data collection and analysis, and drafted, revised, and finalized the manuscript. D.Y.M.: contributed to data interpretation and manuscript revision. A.R.L.: provided critical input on study design, analytical approach, and intellectual content. All authors read and approved the final manuscript.

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#### Data availability

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

#### Ethics statement

This study was approved by the Health Research Ethics Committee of STIKES Karya Husada Semarang (Approval No: 047/KEPK-SKH/III/2025). Written informed consent was obtained from all participants prior to data collection. Participation was voluntary, and all information was kept confidential and used solely for research purposes.

#### Conflicts of interest

The authors declare that there are no conflicts of interest related to this study.

#### Use of artificial intelligence (AI)

Portions of this manuscript were edited using Perplexity to improve grammar, clarity, and overall readability. Reference management was conducted using Mendeley. All AI-assisted content was carefully reviewed and validated by the authors. The authors take full responsibility for the accuracy, originality, and integrity of the final manuscript.

## REFERENCES

1. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*. 2013;382(9890):427–51.
2. World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization; 2006. Available from: [\[Website\]](#)
3. de Onis M, Branca F. Childhood stunting: a global perspective. *Maternal & Child Nutrition*. 2016;12(S1):12–26.
4. Ministry of Health, Republic of Indonesia. Survei status gizi Indonesia (SSGI) 2024 [dalam angka]. Jakarta: Ministry of Health, Republic of Indonesia; 2024. Available from: [\[Website\]](#)
5. BPS Grobogan. Kabupaten Grobogan dalam angka 2023. Central Java: Statistics Indonesia; 2023. Available from: [\[Website\]](#)
6. Beal T, Tumilowicz A, Sutrisna A, Izwardy D, Neufeld LM. A review of child stunting determinants in Indonesia. *Maternal & Child Nutrition*. 2018;14(4):e12617.
7. Akombi BJ, Agho KE, Hall JJ, Merom D, Astell-Burt T, Renzaho AMN. Stunting, Wasting and Underweight in Sub-Saharan Africa: a systematic review. *International Journal of Environmental Research and Public Health*. 2017;14(8):863.
8. Johnson RB, Onwuegbuzie AJ, Turner LA. Toward a definition of mixed methods research. *Journal of Mixed Methods Research*. 2007;1(2):112–33.
9. Creswell JW, Clark VLP. Designing and conducting mixed methods research. 3rd ed. Thousand Oaks: Sage Publications; 2017.
10. Grobogan Health Office. Grobogan District Health Profile 2022. Grobogan: Dinas Kesehatan Kabupaten Grobogan; 2022.
11. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77–101.
12. Maxwell JA. Qualitative research design: an interactive approach. 3rd ed. Thousand Oaks: Sage

- Publications; 2013.
13. UN Global Pulse; UNICEF Indonesia; Ministry of Health, Republic of Indonesia. Assessing the implementation of Indonesia's national nutrition information system (e-PPGBM). Jakarta: UN Global Pulse; 2023. Available from: [[Website](#)]
  14. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. Geneva: World Health Organization; 1991.
  15. Patton MQ. Qualitative research and evaluation methods. 4th ed. Thousand Oaks: Sage Publications; 2015.
  16. Ballard T, Kepple AW, Cafiero C. The food insecurity experience scale: development of a global standard for monitoring hunger worldwide. Rome: FAO; 2013. Available from: [[Website](#)]
  17. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide (v.3). Washington, D.C.: FHI 360/FANTA; 2007. Available from: [[Website](#)]
  18. World Health Organization. Indicators for assessing infant and young child feeding practices: definitions and measurement methods. Geneva: World Health Organization and UNICEF; 2021. Available from: [[Website](#)]
  19. UNICEF, Ministry of Health of Indonesia. Infant and Young Child Feeding (IYCF) practices survey. Jakarta: UNICEF Indonesia; 2014. Available from: [[Website](#)]
  20. Food and Agriculture Organization, FHI 360. Minimum dietary diversity for women: a guide to measurement. Rome: FAO; 2016. Available from: [[Website](#)]
  21. The DHS Program. Demographic and Health Survey interviewer's manual. Rockville: ICF International; 2016.
  22. IBM Corp. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.; 2019.
  23. Manandhar DS, Osrin D, Shrestha BP, Mesko N, Morrison J, Tumbahangphe KM, et al. Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial. *The Lancet*. 2004;364(9438):970–79.
  24. Prost A, Colbourn T, Seward N, Azad K, Coomarasamy A, Copas A, et al. Women's groups practising participatory learning and action to improve maternal and newborn health in low-resource settings: a systematic review and meta-analysis. *The Lancet*. 2013;381(9879):1736–46.
  25. Hosmer DW, Lemeshow S, Sturdivant RX. Applied logistic regression. 3rd ed. New York: Wiley; 2013.
  26. Peltó GH, Armar-Klimesu M. Balancing nurturance, cost and time: complementary feeding in Accra, Ghana. *Maternal & Child Nutrition*. 2011;7(5):66–81.
  27. Mahmudiono T, Sumarmi S, Rosenkranz RR. Household dietary diversity and child stunting in East Java, Indonesia. *Asia Pacific Journal of Clinical Nutrition*. 2017;26(2):317–25 .
  28. Torlesse H, Cronin AA, Sebayang SK, Nandy R. Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health*. 2016;16:669.
  29. Titley CR, Ariawan I, Hapsari D, Muasyaroh A, Dibley MJ. Determinants of the stunting of children under two years old in Indonesia: a multilevel analysis of the 2013 Indonesia Basic Health Survey. *Nutrients*. 2019;11(5):1106.
  30. Checkley W, Buckley G, Gilman RH, Assis AM, Guerrant RL, Morris SS, et al. Multi-country analysis of diarrhoea and childhood stunting. *International Journal of Epidemiology*. 2008;37(4):816–30.
  31. Morrison J, Thapa R, Hartley S, Osrin D, Manandhar M, Tumbahangphe K, et al. Understanding how women's groups improve maternal and newborn health in Makwanpur, Nepal: a qualitative study. *International Health*. 2010;2(1):25–35.
  32. Ruel MT, Alderman H, Maternal and Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition?. *The Lancet*. 2013;382(9891):536–51.
  33. Smith LC, Haddad L. Explaining child malnutrition in developing countries: a cross-country analysis. Washington, DC: International Food Policy Research Institute (IFPRI); 2000.
  34. Victora CG, Adair L, Fall C, et al. Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet*. 2008;371(9609):340–57.
  35. Gillespie S, Menon P, Kennedy AL. Scaling up impact on nutrition: what will it take?. *Advances in Nutrition*. 2015;6(4):440–51.
  36. Semba RD, de Pee S, Sun K, Sari M, Akhter N, Bloem MW. Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. *The Lancet*. 2008;371(9609):322–8.
  37. Freeman MC, Garn JV, Sclar GD, Boisson S, Medlicott K, Alexander KT, et al. The impact of sanitation on infectious disease and nutritional status: a systematic review and meta-analysis. *International Journal of Hygiene and Environmental Health*. 2017; 220(6):928–49.
  38. Fereday J, Muir-Cochrane E. Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme

- development. *International Journal of Qualitative Methods*. 2006;5(1):80–92.
39. National Development Planning Agency (Bappenas). National strategy to accelerate stunting reduction 2018–2024. Jakarta: Bappenas; 2018. Available from: [[Website](#)]
40. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for
41. improvement of maternal and child nutrition: what can be done and at what cost?. *The Lancet*. 2013; 382(9890):452–77.
42. Rah JH, Sukotjo S, Badgaiyan N, Cronin AA, Torlesse H. Improved sanitation is associated with reduced child stunting amongst Indonesian children under 3 years of age. *Maternal & Child Nutrition*. 2020;16 (S2):e12741.