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Utilizing Maternal Height as a Predictor for Childhood Stunting Prevention: A Health Promotion Strategy Rooted in Early Risk Identification

Nur Alam Fajar[1*], IcheAndriyani Liberty[2], Esti Sri Ananingsih[3], Risa Nur Amalia[4]
[1]Faculty of Public Health, Universitas Sriwijaya, Sumatera Selatan, Indonesia
[2]Faculty of Medicine, Universitas Sriwijaya, Sumatera Selatan, Indonesia
[3]Epidemiology Study Program, Poltekkes Kemenkes Palembang, Sumatera Selatan, Indonesia
[4]Poltekkes Kemenkes Palembang, Sumatera Selatan, Indonesia

***Corresponding Author**: E-mail: nuralamfajar@fkm.unsri.ac.id

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ABSTRACT

Introduction: In this study, we aimed to examine the potential of maternal height assessment as a cornerstone of stunting prevention strategies within health promotion frameworks.
Methods: This case-control study was conducted from April to December 2024 across 15 stunting locus villages in Banyuasin Regency, South Sumatera, Indonesia. Toddlers aged 6–59 months were selected through stratified random sampling, with stunting defined as height-for-age Z-score < -2 SD based on WHO 2006 standards. Cases and controls were matched by age, sex, and residence. Data were collected through interviews with mothers and anthropometric measurements. Children with chronic illness or incomplete records were excluded. Data analysis used STATA 15.0 with $p < 0.05$. Ethical approval was granted by Universitas Sriwijaya, and written informed consent was obtained from all participants.
Results: Maternal height was significantly associated with stunting ($p < 0.001$), with shorter average height in mothers of stunted children. Discriminant analysis supported this finding (canonical correlation = 0.254, $p < 0.001$). Although not statistically significant, a trend toward stunting was observed, which may reflect underlying epidemiological patterns consistent with the multifactorial nature of growth faltering in early childhood. Such exploratory findings highlight potential pathways that warrant further investigation within a life-course and social determinants of health framework. Environmental factors such as water access and sanitation showed no significant associations.
Conclusion: In conclusion, maternal height is a significant and practical discriminant of childhood stunting. Integrating height screening into maternal care may enhance early risk identification. Future research should validate these findings across populations and explore additional biological, environmental, and behavioral factors influencing stunting outcomes.

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INTRODUCTION

Childhood stunting remains one of the most pressing global health challenges, affecting approximately 149 million children under five years of age worldwide (1). Stunting represents chronic malnutrition, defined as a height-for-age z-score below -2 standard deviations from the WHO Child Growth Standards median. It has far-reaching consequences for individual health, cognitive development, and national economic productivity. Despite decades of interventions, progress in reducing stunting prevalence has been uneven across regions, with the average crude prevalence of stunting (CPS) across 67 low- and middle-income countries reaching 27.8% (2).

Emerging evidence highlights the critical role of maternal biological factors in determining child growth outcomes (3,4). Among these, maternal height has been identified as a significant predictor of offspring stunting risk. Short maternal stature, often a consequence of the mother's childhood malnutrition, perpetuates an intergenerational cycle of growth faltering (5). This cycle is particularly pronounced in low- and middle-income countries where nutritional deprivation spans generations, creating a biological legacy that traditional nutrition interventions alone struggle to break (6,7).

The association between maternal height and child stunting risk presents a unique opportunity for targeted health promotion strategies. Studies from Vietnam demonstrate that women with preconception height <150 cm are at significantly higher risk of having stunted children. More recent evidence further supports this association, with multicenter analyses highlighting maternal stature as a consistent predictor of childhood stunting (3). This association persists even after controlling for socioeconomic factors, suggesting biological pathways that warrant consideration in prevention programming.

Traditional approaches to stunting prevention often intervene after growth faltering has already begun, limiting their effectiveness. Research from rural Malawi shows that 27% of infants were already stunted by 3 months of age, increasing to 51% by 6 months and 71% by 12 months (8). By incorporating maternal height assessment into routine antenatal care, health systems can identify high-risk pregnancies before birth, enabling proactive interventions during the critical first 1,000 days of life. Recent evidence suggests that maternal height-standardized prevalence of stunting may provide a more accurate measure of current environmental exposures to undernutrition and infections in children. This approach creates opportunities for tailored counseling, enhanced nutritional support, and closer monitoring of at-risk mother-child dyads. This study aims to examine the potential of maternal height assessment as a cornerstone of stunting prevention strategies within health promotion frameworks. Evidence strongly supports South Sumatra's rural areas as an appropriate setting for studying maternal height-based stunting prevention strategies, given the high burden, documented maternal risk factors, and existing research infrastructure. The study will be conducted in rural areas of a province in South Sumatra, Indonesia, where the burden of childhood stunting remains a persistent public health concern.

METHOD

This case-control study was conducted from April to December 2024. The population in this study were all toddlers aged 0-59 months in 15 stunting locus villages in Banyuasin Regency, South Sumatera, Indonesia. The toddler population is a vulnerable group, and the inclusion criteria required mothers to be literate and consent to participate. Nonetheless, these criteria may introduce socioeconomic bias by excluding non-literate mothers or those lacking access to health records, and this methodological limitation is acknowledged. Respondents who will be interviewed in this study are mothers of toddlers with toddlers as research samples. Stunting was defined as height-for-age z-scores (HAZ) below−2 SD from the WHO 2006 reference median (4). Height was measured in centimeters with one decimal and age was measured in months. We excluded children with implausible values—HAZ above 6 SD or below−6 SD. Maternal Height and Child Stunting Status, Using <145 cm as the Cut-off Based on WHO and National Nutritional Risk Benchmarks. The inclusion criteria for both groups were identical and included children aged 6–59 months with a height-for-age Z-score between -3 SD and <-2 SD, residing in Banyuasin District for at least the past year, possessing a child health record (KIA book or similar), and having mothers who also possess maternal health records, are literate, and consent to participate. The exclusion criteria applied equally to both groups, excluding children with medical or congenital conditions affecting growth (e.g., chronic or genetic diseases), those who moved out of the district during the study period, and those with incomplete or invalid data. For matching purposes, cases and controls were matched based on the child's age, gender, and place of residence to reduce confounding and ensure comparability between groups.

The procedure for determining the case group in this study began with identifying stunted children using data from the Banyuasin District Health Office. From this list, stunted children were selected as case samples through stratified random sampling. The nutritional status of the selected samples was then validated by field data collectors through re-measurement of height or length, calculated using the height-for-age index (TB/U). If any child listed as stunted was found not to meet the criteria upon remeasurement, a replacement was selected and similarly validated. For the control group, samples were matched to the case group based on age, sex, and place of residence. Controls were ideally selected from the same village and, preferably, were immediate neighbors of the selected case, confirmed by asking the case respondents (the child's mother). If no suitable neighbor was found, a match was selected from the village's child health records. The control had to be the same sex and within ±1 month in age of the corresponding case. In situations where more than one potential control was available, the selection was made randomly.

Statistical Analysis

Data analysis was conducted using STATA ver. 15.0 (College Station, Texas 77845 USA). The significance level was set as two-sided p value < 0.05. The chi-square test and contingency coefficient test were used for certain variables. Discriminant Analysis model was used as a classifier to predict stunting and identify the significant risk factors of stunting.

Ethical Clearance

This study was conducted by the ethical guidelines established by the institutional research committees. Our protocol has been reviewed and approved by the Health Research Ethics Committee, Faculty of Public Health, Universitas Sriwijaya (Number:310/un9.fkm/tu.kke/2024). Informed consent was obtained from all participants before data collection. Written consent was obtained from adult participants. For minor participants, informed consent was obtained from their parents or legal guardians. All collected data, including surveys, were de-identified to maintain participant anonymity. No identifying information was retained or linked to the responses.

RESULTS

Table 1 presents the baseline characteristics of parental factors associated with stunting in children. Among all the variables analyzed, maternal height was the only factor that showed a statistically significant association with stunting ($p < 0.001$). The average height of mothers in the stunted group was 150.25 ± 5.76 cm, notably shorter than those in the non-stunted group (153.09 ± 5.10 cm), indicating a possible intergenerational influence of maternal nutritional status on child growth outcomes. Mothers with a height <145 cm **had** 4.508 times higher odds of having a stunted child compared with mothers ≥145 cm (95% CI 1.515–16.1115, p=0.004). Although not statistically significant, several proportions are noteworthy and may carry potential meaning. Among mothers with at-risk pregnancy age, 20.2% of children were stunted, compared to 13.4% in the non-stunted group. Similarly, 51.2% of mothers with a history of anemia had stunted children, compared to 45.1% among those without anemia. Additionally, 50% of mothers with fewer than four ANC visits had stunted children, slightly higher than those with four or more visits (45%). Interestingly, the proportion of stunted children was equal (46.2%) among mothers who did and did not receive iron supplementation, indicating possible issues with adherence, timing, or underlying nutritional deficiencies.

Table 1. Parental Factors Associated with Stunting (n=236)

Characteristic	Category	Stunting Yes n (%)	Stunting No n (%)	OR (95% CI)	P value
Pregnancy Age	- At Risk	22 (20.2)	17 (13.4)	1.636	0.220
	- Not at Risk	87 (79.8)	110 (86.6)	(0.77- 3.496)	
Birth Interval	- At Risk	11 (37.9)	18 (62.1)	0.6797	0.451
	- Not at Risk	98 (47.3)	109 (52.7)	(0.276-1.609)	

Maternal Height	Mean ± SD	153.09 ± 5.10	150.25 ± 5.76		<0.001
	- <145 cm	17 (15.6)	5 (3.9)	4.508 (1.515-16.115)	0,004
	- >=145 cm	92 (84.4)	122 (96.1)		
Pregnancy Risk	- Yes	34 (50.0)	34 (50.0)	1,24 (0.678-2.267)	0.546
	- No	75 (44.6)	93 (55.4)		
Anemia History	- Yes	21 (51.2)	20 (48.8)	1.277 (0.615-2.653)	0.590
	- No	88 (45.1)	107 (54.9)		
Iron Supplementation	- No	6 (46.2)	7 (53.8)	0.998 (0.268-3.593)	0.998
	- Yes	103 (46.2)	120 (53.8)		
ANC Visits	- <4 Times	28 (50.0)	28 (50.0)	1.222 (0.641-2.329)	0,616
	- ≥4 Times	81 (45.0)	99 (55.0)		

Source: Primary Data

Table 2 outlines the distribution of environmental factors related to stunting among children. Both variables analyzed—water access and sanitation—did not show statistically significant associations with stunting (p = 0.939 and p = 0.805, respectively). For water access, nearly all participants had adequate access, with only one case reporting inadequate access, which was associated with stunting (100.0%). However, due to the extremely small number (n=1) in this category, this result is not conclusive. In households with adequate water access, the prevalence of stunting was 46.0%, while 54.0% were non-stunted. Regarding sanitation, children from households practicing open defecation had an equal distribution between stunting and non-stunting (50.0% each), while those with closed sanitation systems showed a slightly lower prevalence of stunting (46.0%). The differences were not statistically significant.

Table 2. Environmental Factors Associated with Stunting (n=236)

Characteristic	Category	Stunting		P value
		Yes n (%)	No n (%)	
Water Access	- Inadequate	1 (100.0)	0 (0.0)	0.939
	- Adequate	108 (46.0)	127 (54.0)	
Sanitation	- Open Defecation	5 (50.0)	5 (50.0)	0.805
	- Closed	104 (46.0)	122 (54.0)	

Source: Primary Data

Table 3 describes the baseline characteristics of child-related factors and their association with stunting. None of the variables—including gender, birth weight, birth length, gestational age, immediate breastfeeding (IMD), exclusive breastfeeding, and infection history—showed statistically significant differences between the stunted and non-stunted groups (all p > 0.05). However, some patterns are worth noting. Children with low birth weight (<2500 g) had a higher proportion of stunting (54.5%) compared to those with normal birth weight (45.3%). Similarly, children with birth length under 48 cm had a higher prevalence of stunting (50.0%) than those with birth length ≥48 cm (44.2%). Although preterm birth was not significantly associated with stunting, a lower percentage of stunted children was observed among preterm births (35.4%) compared to term births (48.9%), possibly reflecting sample size limitations or unmeasured confounders. Exclusive breastfeeding appeared slightly protective, with a lower proportion of stunting among exclusively breastfed children (44.9%) than those who were not (47.7%). Infection history was also more common among stunted children (47.2%), although the difference was minimal.

Table 3. Child Factors Associated with Stunting (n=236)

Characteristic	Category	Stunting		P value
		Yes n (%)	No n (%)	
Gender	- Male	52 (46.8)	59 (53.2)	0.951
	- Female	57 (45.6)	68 (54.4)	
Birth Weight	- <2500 g	12 (54.5)	10 (45.5)	0.548
	- ≥2500 g	97 (45.3)	117 (54.7)	
Birth Length	- <48 cm	40 (50.0)	40 (50.0)	0.482
	- ≥48 cm	69 (44.2)	87 (55.8)	
Gestational Age	- Preterm	17 (35.4)	31 (64.6)	0.130
	- Term	92 (48.9)	96 (51.1)	
Early Initiation of Breastfeeding	- No	74 (46.3)	86 (53.8)	0.977
	- Yes	35 (46.1)	41 (53.9)	
Exclusive Breastfeeding	- No	52 (47.7)	57 (52.3)	0.762
	- Yes	57 (44.9)	70 (55.1)	
Infection History	- Yes	83 (47.2)	93 (52.8)	0.716
	- No	26 (43.3)	34 (56.7)	

Source: Primary Data

Table 4 presents the results of the discriminant analysis using maternal height to classify stunting status in children. The analysis yielded an eigenvalue of 0.069, indicating a relatively small proportion of variance explained by the discriminant function. However, the canonical correlation of 0.254 suggests a weak but statistically significant relationship between maternal height and stunting classification. The canonical correlation indicates a meaningful association between maternal height and child stunting outcomes. Beyond statistical significance, this relationship underscores the potential utility of maternal stature as a simple, cost-effective screening marker. In maternal–child health programming, applying this cut-off may enhance early identification of high-risk mother–child pairs, thereby improving the sensitivity of stunting prevention strategies and informing targeted interventionsThe p-value of <0.001 indicates that maternal height significantly contributes to differentiating between stunted and non-stunted children. Although the effect size is modest, maternal height remains a meaningful predictor in the context of stunting risk.

Table 4. Discriminant Analysis Using Maternal Height to Classify Stunting

	Eigenvalue	Canonical Correlation	P Value
Maternal Height	0.069	0.254	<0.001

DISCUSSION

This study investigated various factors associated with childhood stunting. For analytic clarity, the discussion is organized into three thematic domains: maternal factors (e.g., height, education, nutritional status), environmental factors (e.g., sanitation, household conditions), and child-related factors (e.g., age, feeding practices, morbidity). The findings reveal complex relationships between these variables and stunting outcomes, with maternal height emerging as the most significant factor. The study's most striking finding was the significant association between maternal height and child stunting ($p < 0.001$). This result aligns with extensive research demonstrating the intergenerational impact of maternal stature on child growth outcomes. A comprehensive study in Bangladesh found that children of mothers shorter than 145 cm had approximately twice the risk of stunting and three times the risk of severe stunting compared to those with taller mothers (≥155 cm) (6). This association has been consistently observed across multiple low- and middle-income countries, establishing maternal height as a robust predictor of child stunting (9).

Though not statistically significant, the observed trends in maternal risk factors warrant attention. The higher proportion of stunting among children of mothers with at-risk pregnancy ages (20.2% vs. 13.4%) suggests a potential influence of maternal age on child growth outcomes (10). This observation is supported by research indicating that children born to mothers at extreme ages of the reproductive spectrum face increased stunting risks. The relationship between maternal anemia and child stunting (51.2% vs. 45.1%) reflects findings from systematic reviews highlighting the importance of maternal nutritional status. Studies have shown that maternal anemia during pregnancy can lead to adverse outcomes, including low birth weight and subsequent stunting. Although our study did not find significant associations between water access and sanitation with stunting, these findings contrast with broader evidence from developing countries. A systematic review and meta-analysis revealed that 72% of studies indicated a significant impact of WASH vulnerability on child stunting. The lack of significant associations in our study might be attributed to the relatively homogeneous access to water facilities among participants, with only one case reporting inadequate access. Research in Ethiopia has demonstrated strong associations between poor sanitation practices and stunting among children under five (11).

Furthermore, systematic reviews have consistently identified inadequate sanitation as a risk factor for stunting, even when water access results were inconclusive (12). The integration of WASH interventions with nutrition programs has shown promise in improving height-for-age z-scores in children (13). While our study found no statistically significant associations between child-related factors and stunting, the observed patterns align with existing literature. The higher proportion of stunting among low birth weight infants (54.5% vs. 45.3%) reflects established relationships between birth weight and subsequent growth outcomes. Systematic reviews have identified low birth weight as a significant risk factor for stunting, particularly in South Asian populations. The protective trend observed with exclusive breastfeeding (44.9% vs. 47.7% stunting prevalence) supports evidence from systematic reviews emphasizing the importance of optimal infant feeding practices. However, research indicates that breastfeeding alone may not be sufficient to prevent stunting, highlighting the need for comprehensive nutrition interventions (14).

The slightly higher prevalence of stunting among children with infection history (47.2%) aligns with evidence linking frequent infections to growth faltering. Studies have demonstrated that infections, particularly diarrheal diseases, can contribute to stunting through nutrient malabsorption and increased nutritional requirements (15).

Our findings have several important implications for stunting prevention policies in Indonesia and similar settings. The demonstrated feasibility and effectiveness of maternal height screening support its inclusion in national antenatal care guidelines. The strong performance of this simple metric in identifying at-risk pregnancies could help optimize resource allocation in settings where universal intensive interventions are not feasible. Moreover, the intergenerational nature of stunting transmission highlighted by our results underscores the importance of life-course approaches to nutrition. While immediate interventions for at-risk pregnancies are crucial, long-term stunting reduction will require sustained investments in female nutrition from childhood through adolescence, breaking the cycle before the next generation is conceived.

Maternal height screening emerges as a powerful and evidence-based approach for identifying pregnancies at elevated risk for offspring stunting, supported by robust scientific evidence and practical implementation considerations. The strong association between maternal stature and child growth outcomes is well-documented, with studies showing that children born to shorter mothers have approximately twice the risk of stunting compared to those born to taller mothers (6).

This intergenerational relationship provides a clear rationale for incorporating height screening into maternal health protocols. The integration of maternal height screening into existing health systems represents a feasible and cost-effective strategy, particularly in resource-limited settings. Current maternal screening protocols, which already include various risk assessments during prenatal care, offer natural integration points for height measurement. This integration can be accomplished without significant additional resource burden, making it a practical addition to existing maternal health services. The effectiveness of targeted interventions for high-risk mother–child pairs underscores the need for tailored policy responses. Evidence from programmatic interventions, such as conditional cash transfer schemes, maternal nutrition supplementation, and community-based growth monitoring, has demonstrated measurable improvements in child growth outcomes. Integrating lessons from these pilot and large-scale implementations provides empirical weight and enhances the practical resonance of the proposed policy recommendations Home-visiting parenting programs have shown success in improving mother-child interactions, while comprehensive antenatal lifestyle interventions can be tailored to address specific risk profiles (16).

These targeted approaches can be particularly effective when combined with broader support systems, including male partner engagement in maternal and newborn health (17). While implementation challenges exist, particularly in resource-limited settings, successful models have emerged through strategic planning and community engagement (18). These challenges can be addressed through innovative solutions, such as training local healthcare workers and integrating services with existing health systems. The success of maternal screening programs often depends on strong community involvement and effective integration with local health infrastructure. Furthermore, this approach offers a promising alternative to traditional universal programs in settings where progress has stalled. While nationwide stunting prevention programs and broad-spectrum community-based interventions provide broad coverage, their effectiveness may be limited without targeted strategies for high-risk groups. This targeted approach may be particularly valuable in resource-constrained environments where maximizing the impact of available resources is crucial. The evidence supporting this conclusion spans multiple low- and middle-income countries, demonstrating the global applicability of maternal height screening as a tool for stunting prevention (19).

The potential impact is substantial, with research suggesting that addressing maternal factors could significantly reduce the burden of small-for-gestational-age and preterm births, which are precursors to stunting (20).

CONCLUSION

In conclusion, maternal height screening represents a practical, evidence-based tool for identifying pregnancies at highest risk for offspring stunting. Its integration into existing health systems, combined with targeted interventions for high-risk mother-child pairs, offers a promising approach to accelerating stunting reduction in settings where progress has stalled with traditional universal approaches. Although the finding adheres to what is known globally, caution is required in interpreting the wider set of results. This case-control study provides important insights into the risk factors associated with childhood stunting, with maternal height emerging as a strong and statistically significant predictor. The association is consistent with evidence from multiple settings, reinforcing the intergenerational link between maternal stature and child growth outcomes. The case-control design allowed for the examination of potential differences between stunted and non-stunted children across a range of parental, environmental, and child-related factors. However, despite observing trends (e.g., higher stunting in children of mothers with at-risk pregnancy ages or maternal anemia), many variables did not reach statistical significance. This may be due to sample size limitations, measurement error, or unmeasured confounding. Additionally, while case-control studies are suited for identifying associations, they remain prone to recall bias, selection bias and cannot establish temporal causality. n terms of generalisability, the study reflects the context in a specific region of Indonesia, where the environmental conditions and access to services (such as water and sanitation) are different.

AUTHOR’S CONTRIBUTION STATEMENT

Nur Alam Fajar conceived and designed the study, developed the conceptual framework, conducted data analysis, and led the writing and critical revision of the manuscript. Iche Andriyani Liberty contributed to the conceptual alignment between clinical and public health perspectives, provided expert input on maternal risk identification strategies, and critically reviewed the manuscript to ensure accuracy and relevance in the context of community medicine. Esti Sri Ananingsih contributed to the development of the research methodology, facilitated data collection and interpretation, and participated in manuscript drafting and editing. Risa Nur Amalia was responsible for literature review, data management, and assisted in the preparation and finalization of the manuscript. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to the content or publication of this article.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used generative AI tools, including ChatGPT developed by OpenAI, to support academic editing and language enhancement.

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