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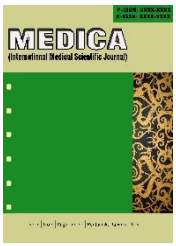

Maternal Health Interventions and Other Determinants of Childhood Stunting: A Cross-Sectional Study

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Abstract

Stunting remains a major public health problem in developing countries and is associated with impaired cognitive development, poor educational attainment, reduced productivity, and an increased risk of chronic diseases later in life. Maternal health during pregnancy is considered a key determinant of child growth and development. This study aimed to identify factors associated with stunting among children under five years of age, with a particular focus on maternal health interventions during pregnancy, including antenatal care, nutritional monitoring, and micronutrient supplementation. A cross-sectional study was conducted among 140 mothers of children under five years of age attending four community health centers in Surabaya, East Java, Indonesia. Participants were selected using proportionate stratified random sampling. Data were collected using a structured questionnaire and analyzed using descriptive statistics, Chi-square tests, and binary logistic regression, with a significance level of $p < 0.05$. The results of the study show that the prevalence of stunting was 21.4%. Bivariate analysis showed that maternal health interventions were significantly associated with stunting ($p = 0.040$), while breastfeeding and complementary feeding practices demonstrated a marginal association ($p = 0.074$). Child nutritional intake ($p = 0.271$), immunization and growth monitoring ($p = 1.000$), and environmental sanitation ($p = 0.526$) were not significantly associated with stunting. Multivariable logistic regression analysis identified maternal health intervention as the most influential factor associated with stunting (OR = 0.46; 95% CI: 0.23–0.94; $p = 0.032$), indicating a protective effect against stunting among children under five years of age. In conclusion, maternal health interventions during pregnancy play a significant role in reducing the risk of childhood stunting. Strengthening antenatal care services, maternal nutrition support, and health education for pregnant women should therefore be prioritized as part of integrated stunting prevention strategies at the primary healthcare level.

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1. INTRODUCTION

Stunting remains one of the most critical public health problems affecting children worldwide, particularly in low- and middle-income countries. Stunting is defined as impaired linear growth resulting from chronic undernutrition and repeated infections during early childhood. Children who experience stunting often suffer long-term consequences, including impaired cognitive development, reduced educational achievement, and increased risk of chronic diseases in adulthood (Victora et al., 2023). According to the World Health Organization, stunting affects millions of children globally and represents a major barrier to human capital development and economic productivity.

Stunting remains a significant public health problem in Indonesia despite recent improvements. Data from the Indonesian Nutrition Status Survey (INSS) show that the national prevalence of stunting declined from 24.4% in 2021 to 21.6% in 2022, 21.5% in 2023, and 19.8% in 2024, although it remains above the national target (Kementerian Kesehatan Republik Indonesia, 2025). At the provincial level, East Java reported a prevalence of 19.2% in 2022 and decreased to 17.7% in 2023, indicating progress but still contributing substantially to the national burden due to its large population (Trimono et al, 2025). In contrast, Surabaya City has achieved a remarkable reduction, with stunting prevalence decreasing from 28.9% in 2021 to 4.8% in 2022 and 1.6% in 2023, making it one of the lowest in Indonesia (Suyanto et al., 2024). These variations across national, provincial, and city levels highlight the importance of strengthening targeted interventions, particularly at the primary health care level, to further accelerate stunting reduction.

Among these determinants, maternal health conditions during pregnancy play a crucial role in influencing child growth outcomes (Abdul Rahim et al, 2025). Adequate maternal health interventions, such as antenatal care services, maternal nutrition monitoring, and micronutrient supplementation, contribute to optimal fetal development and reduce the risk of low birth weight, which is a major predictor of stunting (Black et al., 2013; Oktaria et al., 2025). Previous studies have shown that poor maternal health status and inadequate prenatal care significantly increase the likelihood of stunting among children (Gaiser et al., 2023; Aloys et al, 2025).

However, evidence regarding the relative contribution of maternal health interventions compared with other behavioral and environmental determinants remains limited in many urban community settings. Understanding these relationships is important to design more targeted and effective stunting prevention programs, particularly within primary health care systems.

Therefore, this study aimed to identify factors associated with stunting among children under five years of age in selected community health centers in Surabaya, Indonesia, and to determine the most dominant factor related to stunting incidence. The findings of this study are expected to provide evidence to support the strengthening of integrated maternal and child health programs for stunting prevention.

2. METHOD

This study employed a quantitative cross-sectional design to examine factors associated with stunting among children under five years of age. The cross-sectional approach enabled the simultaneous assessment of exposure and outcome variables at a single point in time, allowing the identification of factors related to stunting within the study population. The study was conducted at four community health centers (Puskesmas) in Surabaya, East Java, Indonesia, namely Puskesmas Mojo, Puskesmas Tanah Kali Kedinding, Puskesmas Jagir, and Puskesmas Menur. These facilities provide primary

healthcare services, including maternal and child health programs, antenatal care, growth monitoring, and nutrition services.

The study population consisted of mothers with children under five years of age who were registered at the selected community health centers. Based on registration records, 140 eligible respondents were identified and included in the study. Respondents who met the inclusion criteria and agreed to participate were recruited, while those with incomplete data were excluded from the analysis. The minimum sample size was determined based on the recommendation for logistic regression analysis, which suggests 5–10 observations per independent variable. Considering the five independent variables included in this study, the minimum required sample ranged from 25 to 50 respondents. To improve statistical power and obtain more stable regression estimates, all 140 eligible respondents were included.

A proportionate stratified random sampling technique was used to ensure proportional representation from each community health center. Each health center was treated as a separate stratum, and the number of participants selected from each stratum was determined according to the proportion of eligible respondents registered at the facility. Within each stratum, respondents were selected using simple random sampling, providing every eligible mother with an equal opportunity to participate. Data collection was conducted during maternal and child health service visits.

The dependent variable was stunting status, categorized as stunted or non-stunted according to the height-for-age index based on the World Health Organization (WHO) Child Growth Standards. The independent variables were developed based on the United Nations Children's Fund (UNICEF) conceptual framework of child malnutrition and the Developmental Origins of Health and Disease (DOHaD) theory, which emphasize the influence of prenatal, nutritional, healthcare, and environmental factors on child growth. These variables included maternal health interventions during pregnancy, breastfeeding and complementary feeding practices, child nutritional intake, immunization and growth monitoring, and environmental sanitation.

Data were collected using a structured questionnaire developed from an extensive review of the literature on determinants of stunting. The instrument consisted of 22 items covering the five independent variables and the dependent variable. Maternal health interventions during pregnancy were assessed using three items, breastfeeding and complementary feeding practices using six items, child nutritional intake using seven items, immunization and growth monitoring using three items, and environmental sanitation using three items. All items employed dichotomous response options (Yes = 1, No = 0).

Prior to the main study, the questionnaire was tested among 30 mothers with children under five years of age at Puskesmas Sidotopo, Surabaya. Instrument validity was assessed using Pearson's product-moment correlation test, and all items demonstrated correlation coefficients exceeding the critical value ($r > 0.361$), indicating satisfactory validity. Reliability testing using Cronbach's alpha yielded a coefficient of 0.82, demonstrating good internal consistency.

Data were analyzed using statistical software. Descriptive statistics were used to summarize respondent characteristics and study variables through frequencies, percentages, means, and standard deviations. Bivariate associations between independent variables and stunting status were examined using the Chi-square test. Variables identified as potentially associated with stunting were subsequently entered into a binary logistic regression model to determine independent predictors of stunting. The results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). A stepwise logistic regression procedure was applied to identify the most influential determinants of stunting. Statistical significance was established at a p-value of less than 0.05.

Ethical approval for this study was obtained from the Health Research Ethics Committee of the Surabaya Health Polytechnic, Ministry of Health, Indonesia (Approval No. EA/1886/KEPK-Poltekkes_Sby/V/2023). All participants received information regarding the objectives and procedures of the study prior to enrollment. Written informed consent was obtained from all respondents, and the confidentiality and anonymity of participant information were maintained throughout the research process.

3. RESULTS AND DISCUSSION

A total of 140 respondents were included in this study. The descriptive statistics of the Characteristics of Respondents.

Table 1. Characteristics of Respondents (n = 140).

Variable	Category	Frequency (n)	Percentage (%)
Maternal Age	20–25 years	34	24.3
	26–30 years	45	32.1
	31–35 years	39	27.9
	36–40 years	22	15.7
Education Level	Primary School	8	5.7
	Junior High School	14	10.0
	Senior High School / Vocational	100	71.4
	Higher Education	18	12.9
Occupation	Unemployed	94	67.1
	Employed	46	32.9
Household-Income	< IDR 4,526,000	116	82.9
	≥ IDR 4,526,000	24	17.1

Table 1 presents the demographic characteristics of the respondents (n = 140). The majority of mothers were aged between 26 and 30 years, indicating that most participants were in their early reproductive age. In terms of education, the largest proportion had completed senior high school or vocational education, reflecting a relatively moderate educational background within the study population. Most respondents were unemployed, which suggests that household income primarily depended on other family members, such as spouses. Consistent with this, the majority of households reported a monthly income below the regional minimum wage (IDR 4,526,000), indicating limited economic resources that may influence maternal and child health practices. Overall, these characteristics provide important contextual information for understanding the determinants of stunting within this population.

Table 2. Descriptive statistics of study variables.

Independent Variables	N	Mean	SD	Min	Max
Maternal health intervention	140	2.59	0.60	0	3
Breastfeeding and complementary feeding practices	140	4.87	0.85	2	6
Child nutritional intake	140	8.28	1.04	5	9
Immunization and monitoring	140	2.87	0.46	1	3
Environmental sanitation	140	2.95	0.28	1	3

Based on the descriptive analysis results in Table 2, most of the study variables showed relatively high mean values with small standard deviations, indicating that the data distribution tended to be homogeneous and categorized as good. The maternal health

intervention variable had a mean of 2.59±0.60 out of a maximum range of 3, indicating that the majority of mothers received adequate healthcare services during pregnancy. Similarly, breastfeeding practices and complementary feeding practices (4.87±0.85) and children's nutritional intake (8.28±1.04) were categorized as good, reflecting relatively adequate child feeding practices. Immunization and monitoring variables (2.87±0.46) and environmental sanitation (2.95±0.28) were also close to the maximum values, indicating that most respondents had access to basic healthcare services and a decent environment.

Table 3. Distribution of stunting status among children under five years of age (n = 140).

Stunting Status	Frequency (n)	Percentage (%)
Stunted	30	21.4
Non-stunted	110	78.6

A total of 140 respondents participated in this study. The distribution of study variables based on predefined categories is presented in Table 3. Most respondents were categorized as having good maternal health interventions, breastfeeding and complementary feeding practices, nutritional intake, immunization and growth monitoring, and environmental sanitation. Table 2 shows the distribution of stunting status among children under five years of age. Of the total respondents, 30 children (21.4%) were categorized as stunted, while 110 children (78.6%) were categorized as non-stunted.

Table 4. Bivariate analysis of factors associated with stunting status.

Independent Variables	Chi-square	p-value
Maternal health intervention	4.23	0.040
Breastfeeding and complementary feeding practices	3.18	0.074
Child nutritional intake	1.21	0.271
Immunization and monitoring	0.00	1.000
Environmental sanitation	0.40	0.526

Note: *Dependent variable: Stunting status (0 = non-stunted; 1 = stunted).*
Significant at p <0.05.

Based on the results of the bivariate analysis using the Chi-square test in Table 4, it was found that maternal health interventions were significantly associated with stunting (p=0.040), indicating a link between the quality of interventions during pregnancy and child growth status. Meanwhile, breastfeeding practices and the provision of complementary foods (MP-ASI) showed a trend toward a relationship but were not yet statistically significant (p=0.074). Meanwhile, the variables of child nutritional intake, immunization and monitoring, and environmental sanitation did not show a significant relationship with stunting (p>0.05).

Table 5. Multivariable logistic regression analysis of factors associated with stunting.

Independent Variables	B	OR	95% CI	p-value
Maternal health intervention	-0.767	0.46	0.23–0.94	0.032
Breastfeeding and complementary feeding practices	-0.129	0.88	0.52–1.48	0.628
Constant	1.254	–	–	0.316

Notes: *OR = Odds Ratio; CI = Confidence Interval.*
Dependent variable: *Stunting status (0 = non-stunted; 1 = stunted).*
Significant at p <0.05.

Based on the results of the multivariate logistic regression analysis in Table 3, it was found that maternal health interventions were the only factor with a significant effect on stunting (p=0.032; p<0.05). The odds ratio (OR) of 0.46 with a 95% confidence interval (CI: 0.23–0.94) indicates that maternal health interventions have a protective effect. Mothers who received adequate health interventions during pregnancy had a 54% lower risk of giving birth to stunted children compared to mothers who did not receive optimal interventions. The confidence interval, which did not cross 1, further confirms the statistical significance of the relationship and its epidemiological significance.

Table 6. Model Fit Test (Hosmer–Lemeshow Test).

Parameter	Value
Chi-square	4.45
p-value	0.727

Note: *The model is considered fit if p > 0.05*

The Hosmer–Lemeshow goodness-of-fit test was performed to evaluate the suitability of the logistic regression model. As shown in Table 6, the test produced a p-value of 0.727 (p > 0.05), indicating that the model adequately fit the observed data and was appropriate for explaining the relationship between the independent variables and stunting incidence.

The results of the study on respondent characteristics are presented in Table 1. These findings align with the theory of developmental origins of health and disease (DOHaD), which states that impaired child growth can begin in utero due to suboptimal maternal conditions (Lacagnina et al., 2019; Holme et all., 2020). Furthermore, previous research has shown that interventions during pregnancy have a stronger impact on stunting prevention than postnatal interventions (Black et al., 2013; Victora et al., 2021).

On the other hand, the high mean values and low data variation in some variables may limit the detection of statistical relationships in further analyses. This situation indicates the homogeneity of respondents, making the influence of variables such as sanitation, immunization, and nutritional intake less visible. This phenomenon has also been reported in previous studies, where the relatively uniform distribution of variables can reduce the power of the analysis in identifying the main determinants of stunting (Gaiser et al., 2023; Anvari et al., 2023). Therefore, even though descriptively the respondents' condition is classified as good, stunting prevention efforts still need to focus on more comprehensive interventions starting from pregnancy.

Based on the results of the bivariate analysis using the Chi-square test in Table 2, it was found that maternal health intervention variables had a significant association with stunting (p=0.040; p<0.05). This indicates that the quality of health interventions during pregnancy plays a crucial role in determining a child's growth status. Theoretically, interventions such as antenatal checkups, monitoring maternal nutritional status, and micronutrient supplementation contribute to optimal fetal growth and the prevention of low birth weight, a major risk factor for stunting (Lassi et al., 2021; Zavala et al., 2022). This finding aligns with previous research indicating that mothers who do not receive adequate health care during pregnancy have a higher risk of giving birth to stunted children (Laksono et al., 2022; Vikram et al., 2020).

Meanwhile, breastfeeding practices and complementary feeding showed a trend toward an association with stunting (p=0.074), although not yet statistically significant. This indicates that child feeding practices still play a role, but their influence may be indirect or influenced by other factors. Previous studies have shown that exclusive breastfeeding and appropriate complementary feeding contribute to child growth, but these effects are often

influenced by socioeconomic conditions and overall nutritional quality (Kutbi et al., 2025; Veiga et al., 2022).

The variables of child nutritional intake, immunization and monitoring, and environmental sanitation did not show a significant association with stunting ($p>0.05$). This lack of significance is likely due to the relatively homogeneous distribution of the data, with most respondents in the good category, thus limiting data variation. Furthermore, the relatively small sample size and the potential presence of confounding factors such as economic status, maternal education, and parenting styles may also have influenced the analysis results (Victora et al., 2021). These findings contrast with several previous studies that showed that sanitation and nutritional status significantly influence stunting. However, differences in population context and respondent characteristics may explain these differences (Alema et al., 2025; Mahmood et al., 2025).

Although postnatal factors such as breastfeeding practices, complementary feeding, nutritional intake, immunization, and environmental sanitation are widely recognized as important determinants of stunting, these variables were not statistically significant in the present study. Several explanations may account for these findings. First, most respondents demonstrated relatively good postnatal health practices and environmental conditions, resulting in limited variability across the study variables. This homogeneity may reduce the ability of statistical analysis to detect significant associations.

Second, the urban setting of Surabaya may contribute to relatively better access to healthcare services, immunization programs, sanitation facilities, and nutrition information compared with other settings where postnatal factors have shown stronger effects. Consequently, differences in child growth outcomes in this population may be more strongly influenced by prenatal conditions rather than postnatal exposures.

Third, the influence of postnatal factors on stunting is often mediated by broader socioeconomic determinants such as household income, maternal education, food security, and parenting practices, which were not fully assessed in this study. Previous studies have reported that the effects of feeding practices and sanitation on stunting may become less apparent after adjustment for maternal and socioeconomic factors (Victora et al., 2021; Weber et al., 2023).

Overall, the results of this bivariate analysis indicate that prenatal factors, particularly maternal health interventions, have a more dominant role than postnatal factors in this study, so they need to be the main focus in stunting prevention efforts.

These findings confirm that the prenatal period is a critical phase in determining a child's nutritional status and growth. From an epidemiological perspective, risk factors occurring in early life, particularly during pregnancy, have a long-term impact on child health outcomes, as explained in the Developmental Origins of Health and Disease (DOHaD) framework. Interventions such as antenatal care, meeting maternal nutritional needs, and micronutrient supplementation play a crucial role in preventing intrauterine growth retardation and low birth weight, which are key determinants of stunting (Sofiyulloh, 2025; Warssamo et al., 2025). Global studies also show that improving the quality of maternal healthcare services can significantly reduce the prevalence of stunting in child populations in developing countries (Kassie et al., 2024).

Meanwhile, breastfeeding practices and complementary feeding did not show a significant effect in the multivariate model ($p=0.628$; OR=0.88; 95% CI: 0.52–1.48). Although theoretically, these factors play an important role in meeting children's nutritional needs, these results indicate that after controlling for other variables, their effect becomes insignificant. This could be due to several factors, such as the homogeneity of respondent data, which was largely in the good category, thus limiting data variation. Furthermore, the

possibility of confounding factors such as socioeconomic status, maternal education, and household food quality not included in the model could also influence the analysis results (Gao et al., 2025).

The results of this study are partly consistent with previous studies that suggest that prenatal factors have a more dominant influence than postnatal factors in determining stunting incidence, especially in populations with relatively good access to healthcare (Muglia et al., 2022). However, several other studies continue to emphasize the importance of child feeding practices as a key determinant, so these differences in results may be influenced by population characteristics, study designs, and different socioeconomic contexts (Weber et al., 2023).

Overall, the results of this multivariate analysis indicate that maternal health interventions are the primary determinant of stunting in this study. Therefore, stunting prevention efforts need to focus on improving the quality of maternal healthcare services during pregnancy as part of a comprehensive public health strategy.

Based on the results of the Hosmer–Lemeshow model fit test in Table 4, a p-value of 0.727 ($p>0.05$) was obtained, indicating that the logistic regression model had goodness-of-fit. Statistically, a p-value greater than 0.05 indicates that there is no significant difference between the observed and predicted values, indicating that the model accurately represents the data. Therefore, the logistic regression model used in this study can be considered suitable for explaining the relationship between the independent variables and stunting incidence.

In the context of epidemiological analysis, the Hosmer–Lemeshow test is a common method for evaluating the suitability of a logistic regression model, particularly in public health research. A good model fit indicates that the estimated probability of occurrence generated by the model is sufficiently consistent with the empirical data, allowing the analysis results to be interpreted validly (Warssamo et al., 2025). Therefore, this test result strengthens the internal validity of the study, particularly in ensuring that the relationship between maternal health interventions and stunting incidence is not the result of model bias.

Furthermore, a good model fit also indicates that the variable selection in the multivariate analysis is sufficiently appropriate in explaining variations in stunting incidence. However, relatively small pseudo-R^2 values in logistic regression models are often found in epidemiological studies, as stunting is a multifactorial phenomenon influenced by various complex determinants, such as socioeconomic, environmental, and behavioral factors (Alema et al., 2024). Therefore, although the model meets the feasibility criteria, further development by adding other relevant variables is still necessary in future research.

By meeting the feasibility assumptions of this model, the results of the logistic regression analysis, particularly regarding the significant effect of maternal health interventions on stunting incidence, can be trusted and used as a basis for drawing conclusions and recommending public health policies. This is crucial to ensure that designed interventions are based on valid scientific evidence and can be effectively implemented in stunting prevention efforts.

This study identified maternal health intervention as the most significant determinant of stunting among children, with a strong protective effect demonstrated in the multivariate analysis. While other variables such as breastfeeding and complementary feeding practices, child nutritional intake, immunization, and environmental sanitation showed generally favorable conditions, they were not significantly associated with stunting in the

adjusted model. These findings highlight the critical importance of prenatal factors, particularly maternal health during pregnancy, in influencing child growth outcomes.

The implications of this study emphasize the need to strengthen maternal health services, especially antenatal care, nutritional support, and health education for pregnant women. Public health strategies aimed at reducing stunting should prioritize early-life interventions, focusing on improving maternal conditions before and during pregnancy. Integrating maternal and child health programs at the primary healthcare level may enhance the effectiveness of stunting prevention efforts.

However, this study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between variables. Second, the relatively homogeneous distribution of several independent variables may reduce the statistical power to detect significant associations. Third, potential confounding factors such as socioeconomic status, maternal education, and household food security were not included in the model. Therefore, future studies are recommended to use longitudinal designs and incorporate broader determinants to better understand the complexity of stunting.

4. CONCLUSION

This study concludes that maternal health intervention is the most significant determinant of stunting, demonstrating a protective effect in reducing the risk of stunting among children. Although most postnatal factors, including breastfeeding and complementary feeding practices, child nutritional intake, immunization, and environmental sanitation, were generally in good condition, they were not significantly associated with stunting in the final model. These findings indicate that prenatal factors, particularly maternal health during pregnancy, play a more critical role in determining child growth outcomes. Therefore, improving the quality of maternal health interventions is essential in addressing stunting effectively. It is recommended that health policymakers and primary healthcare providers strengthen maternal health services, particularly antenatal care, nutritional supplementation, and health education for pregnant women. Future research should incorporate broader determinants such as socioeconomic status and use longitudinal designs to better capture causal relationships and improve the comprehensiveness of stunting prevention strategies.

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