ICOHESPE (2026): 361–369 QRCBN 62-6861-1753-250
International Conference on Health Science, Practice, and Education https://proceeding.unnes.ac.id/icohespe

Development Of A Stunting Risk Prediction Model Using Binary Logistic Regression In The Working Area Of Public Health Center Marawola, Sigi Biromaru Regency

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Abstract. Stunting remains a major health problem in Indonesia, with a national prevalence of 19.8% (SSGI, 2024) and Central Sulawesi Province reaching 26.1%. Sigi Regency has the second-highest prevalence of stunting, reaching 33.0% (SSGI, 2024). This condition affects long-term child growth and development. To identify risk factors, an appropriate prediction model is needed, one of which is binary logistic regression, which is able to map the relationship between various determinants and the incidence of stunting. This study aimed to predict early risk factors for stunting using binary logistic regression in the working area of Public Health Center Marawola, Sigi Biromaru Regency. The method used was a quantitative study with a cross-sectional design. The sample consisted of 40 mothers with toddlers. Data analysis was performed using the Binary Logistic Regression Test. The results of the study showed that the determinants proven to be significant and could be used as early prediction indicators for stunting risk were cigarette smoke exposure (smoking behavior of the toddler's parents) ($p = 0.010$; Exp(B) = 24.8) and family income ($p = 0.012$; Exp(B) = 0.024). Meanwhile, maternal height was not a risk factor for stunting ($p = 0.329$; Exp(B) = 1.9). Thus, stunting prevention efforts should focus on controlling exposure to cigarette smoke in the household environment and improving household economic welfare through community empowerment programs.
Keywords: Stunting, *Binary Logistic Regression*

1 Introduction

Stunting is a condition in which a child's growth and development are impaired due to malnutrition, repeated infections, and inadequate psychosocial stimulation. A child is categorized as stunted if their height-for-age is less than two standard deviations below the median growth standard (WHO, 2015). The prevalence of stunting in Southeast Asia, Afghanistan, India, and Pakistan is 32–34%. Indonesia, the Philippines, and Timor-Leste have the highest stunting prevalence in Southeast Asia. The prevalence of stunting in Indonesia is approximately 45.1% (FAO, 2023).

Stunting remains a major health problem in Indonesia, with a national prevalence of 19.8% (SSGI, 2024) and Central Sulawesi Province reaching 26.1%. Sigi Regency has the second-highest prevalence of stunting, reaching 33.0% (SSGI, 2024)(Ministry of Health of the Republic of Indonesia, 2022) (Nur et al., 2025)

Several determinants of stunting include exposure to cigarette smoke, maternal height, and family income. Maternal and toddler exposure to cigarette smoke is very high in Asia, and this exposure affects children's nutritional status. Muchlis et al. (2023) found that children living with smoking fathers are 1.8 times more likely to experience stunting than children living with non-

smoking fathers. Furthermore, exposure to cigarette smoke for more than three hours per day increases the risk of stunting by 2.05 times (Muchlis et al., 2023).

Short maternal stature is also a risk factor for stunting. This is supported by Aguayo et al. (2016), who found that maternal height has an effect on the incidence of stunting (Aguayo et al., 2016). Li et al. (2020) stated that family socioeconomic status and family nutrition affect the incidence of stunting. Children born to poor families are 1.2 times more likely to experience stunting (Li et al., 2020).

Based on the results of a preliminary study conducted by the authors in the working area of Public Health Center Marawola, Sigi Regency, in 2024 there were 182 stunted toddlers, with a prevalence of 24.6% (Nur et al., 2025)(Rosmala-Nur et al., 2020). Interviews with Public Health Center staff who handle stunted toddlers revealed that many residents still smoke, resulting in toddlers being exposed to cigarette smoke. In addition, parental income remains an obstacle in fulfilling nutritional needs for stunted toddlers, and maternal height is genetically passed down to the next generation (Nur et al., 2020).

The binary logistic regression approach allows the authors to determine the effect of an independent variable on a dependent variable. The Binary Logistic Regression Model is used to predict the probability of an event (outcome) based on the independent variable, analyze the relationship between the independent and dependent variables, and identify factors that have an effect on the event (outcome). Based on this background, the authors conducted a study entitled "Development of a Stunting Risk Prediction Model Using Binary Logistic Regression in the Working Area of Public Health Center Marawola, Sigi Biromaru Regency."

2 Methods

This study is an analytical research. Analytical research is conducted to examine the relationship between independent variables exposure to cigarette smoke, family income, and maternal height with the incidence of stunting, and to predict risk factors for stunting in the future using the Binary Logistic Regression test. Sigi Regency has the second-highest prevalence of stunting, reaching 33.0% (SSGI, 2024). Because Sigi Regency consists of several sub-districts and covers a large geographical area of 5,196 km² (Sigi Biromaru Regency, 2022), the authors determined the study sample area using a purposive sampling technique, selecting the working area of Public Health Center Marawola as the study location. The population was all mothers with toddlers. Sampling used total sampling.

To make data collection in the field more effective, in the first stage direct interview techniques were conducted with mothers who had toddlers, along with Focus Group Discussions (FGDs). FGD participants included mothers with toddlers, cadres, and paramedics. Observation was also carried out. The data analysis techniques used were descriptive analysis to provide an overview of the subjects, objects, and related variables; and Binary Logistic Regression analysis to examine the effect of cigarette smoke exposure, family income, and maternal height on stunting and to predict the factors contributing to stunting in the future. The measuring instrument used was a questionnaire.

3 Results and Discussion

The data obtained in the field were processed using SPSS software and analyzed with univariate, bivariate, and multivariate methods.

3.1 Univariate Analysis

Table 1. Frequency Distribution Based on Maternal Education in the Working Area of Public Health Center Marawola

Maternal Education	N	%
Elementary School	10	25.0
Junior High School	7	17.5
High School/Vocational School	20	50.0
D3	3	7.5

Total	40	100

Source: Primary Data, 2025

Based on Table 1, of the 40 respondents, the largest proportion of mothers (20, or 50%) had high school/vocational school education, while the smallest proportion (3, or 7.5%) had a diploma (D3).

Table 2. Frequency Distribution Based on Cigarette Smoke Exposure in the Working Area of *Public Health Center* Marawola

Cigarette Smoke Exposure	N	%
Exposed	23	57.5
Not Exposed	17	42.5
Total	40	100

Source: Primary Data, 2025

Based on Table 2, of the 40 respondents, the largest proportion of toddlers (23, or 57.5%) were exposed to cigarette smoke, while the smallest proportion (17, or 42.5%) were not exposed to cigarette smoke.

Table 3. Frequency Distribution Based on Maternal Height in the Working Area of *Public Health Center* Marawola

Maternal Height	N	%
At risk (≤ 150 cm)	30	75.0
Not at Risk (> 150 cm)	10	25.0
Total	40	100

Source: Primary Data, 2025

Based on Table 3, of the 40 respondents, the largest proportion of mothers (30, or 75%) had a height at risk for having stunted children (≤150 cm), while the smallest proportion (10, or 25%) had a height not at risk (>150 cm).

Table 4. Frequency Distribution Based on Family Income in the Working Area of *Public Health Center* Marawola

Family Income	N	%
Low (UMK < Rp. 2,900,000)	32	80
High (UMK ≥ Rp. 2,900,000)	8	20
Total	40	100

Source: Primary Data, 2025

Based on Table 4, of the 40 respondents, the largest proportion of families (32, or 80%) had low income (below the district minimum wage [UMK], ≤Rp. 2,900,000), while the smallest proportion (8, or 20%) had high income (in line with the district minimum wage [UMK], >Rp. 2,900,000)

Table 5. Frequency Distribution Based on the Incidence of Stunting in the Working Area of *Public Health Center* Marawola

Stunting	N	%
Yes	24	60
No	16	40
Total	40	100

Source: Primary Data, 2025

Based on Table 5, of the 40 toddlers, the largest proportion (24, or 60%) experienced stunting, while the smallest proportion (16, or 40%) were in normal condition.

3.2 Bivariate Analysis

Bivariate analysis aimed to examine the relationship or effect of each independent variable on the dependent variable separately. Bivariate analysis in multiple logistic regression used a p-value <0.25 as a selection criterion for multivariate analysis (although not yet significant at that stage) to avoid missing potentially confounding variables.

Table 6. Candidate Test Selection Results

Variables	P-value	Multivariate Candidate
Cigarette Smoke Exposure	0.000	Yes
Maternal Height	0.033	Yes
Family Income	0.011	Yes

Source: Primary Data, 2025

Based on Table 6, the independent variables included in the multivariate candidates with a p-value <0.25 were cigarette smoke exposure, maternal height, and family income.

3.3 Multivariate Analysis

Concurrent Test

A simultaneous test, or omnibus test, was used to determine whether the overall model was statistically significant in predicting the dependent variable based on the included independent variables. The results of the simultaneous test are shown in Table 7.

Table 7. Simultaneous Test Results

	Chi-Square	**Df**	**P-value**
Step	27.650	3	0.000
Block	27.650	3	0.000
Model	27.650	3	0.000

Source: Primary Data, 2025

Based on Table 7, the omnibus test results showed a p-value of 0.000 (<0.05). This meant that the independent variables simultaneously had a significant effect on the dependent variable.

Model Fit Test

Table 8. Results of the Hosmer and Lemeshow Tests

Chi-Square	**Df**	**P- Value**
0.543	4	0.909

Source: Primary Data, 2025

The Hosmer and Lemeshow test results yielded a p-value of 0.909 (>0.05). This indicated there was no significant difference between the model predictions and the observed results. Thus, the model fit the data and was considered to adequately describe the relationship between the independent and dependent variables, making the results valid for further analysis.

Partial Test

Table 9. Partial Test Results

Variables	**B**	**Df**	**P-Value**	**Exp(B)**
Cigarette Smoke Exposure	3.215	1	0.010	24.891
Maternal Height	1.074	1	0.329	1.926
Family Income	-3.718	1	0.012	0.024

Source: Primary Data, 2025

Based on Table 9, the partial test results for each independent variable indicated that the cigarette smoke exposure and family income variables had a p-value <0.05, which meant that these variables had a significant effect on the incidence of stunting in toddlers in the Working Area of *Public Health Center* Marawola. Meanwhile, the maternal height variable had a p-value >0.05, which meant that this variable had no significant effect on the incidence of stunting in toddlers in the Working Area of *Public Health Center* Marawola.

Cigarette smoke exposure (smoking behavior of the toddler's parents) had a significant effect on stunting in toddlers, with a p-value of 0.010 and an Exp(B) value of 24.891 (OR >1), indicating that this variable was a strong risk factor for stunting. This meant that toddlers exposed to cigarette smoke were 24.8 times more likely to experience stunting than toddlers not exposed to cigarette smoke.

Furthermore, family income also had a significant effect on the incidence of stunting in toddlers, with a p-value of 0.012 and an Exp(B) value of 0.024 (OR <1), making it a protective factor against stunting. This meant that respondents with high income (in line with the district minimum wage [UMK]) ≥Rp. 2,900,000 had a 97.5% lower chance of having toddlers with stunting compared to respondents with low income (below the district minimum wage [UMK]) <Rp. 2,900,000.

However, maternal height did not have a significant effect on the incidence of stunting in toddlers, with a p-value of 0.329 and an Exp(B) value of 2.926. This indicated that respondents with a height <150 cm were 2.9 times more likely to have children with stunting. However, this relationship was not statistically significant. Thus, maternal height did not have a significant effect on the incidence of stunting, although it did indicate an increased risk.

3.4 Discussion

Cigarette Smoke Exposure on the Incidence of Stunting

The results of this study show that cigarette smoke exposure (smoking behavior of the toddler's parents) had a significant effect on the incidence of stunting in toddlers, with a p-value of 0.010. The proportion of stunted toddlers whose fathers smoked was higher than that of those whose fathers did not smoke. Another possible factor is that the majority of toddlers' parents had low education levels and therefore lacked knowledge about the dangers of smoking. Smoking is a health behavior that is detrimental not only to the smoker but also to others. It is considered normal in society, and in Indonesia, the majority of smokers are men. Family members affected by cigarette smoke exposure become passive smokers. Children may be exposed to cigarette smoke as early as the prenatal stage, which puts them at risk of being born with low birth weight (LBW). Fathers therefore play a key role in creating a smoke-free environment. A smoke-free environment can help prevent various diseases in both adults and children (Weiha et al., 2023)

The effect of cigarette smoke exposure on stunting is related to two main mechanisms: the direct effect of nicotine and other toxic substances on the health of pregnant women and children, and the indirect effect through the diversion of family funds from child nutrition to cigarette purchases. Exposure to cigarette smoke can impair nutrient absorption, hinder growth and development, and increase the risk of stunting. Studies have shown that children living in households with smokers have a higher risk of stunting than those not exposed to cigarette smoke. In addition, parental smoking can reduce the allocation of family income for nutritious food, worsening nutritional status and contributing to stunting (Mashar et al., 2025).

This finding is consistent with a study by Nurhayati (2023), which found a significant relationship between parental smoking behavior and stunting in children aged 25–59 months, with a p-value of 0.012 (Nurhayati, 2023). Similarly, Dewi et al. (2024) reported that cigarette smoke exposure increased the risk of stunting in toddlers, with a p-value of 0.000. These findings provide evidence that household cigarette smoke exposure negatively affects the nutritional status and growth of children (HM et al., 2024). Hasanah et al. (2020) further explained that children exposed to cigarette smoke may experience impaired nutrient absorption, ultimately interfering with growth and development. Nicotine and carbon monoxide in cigarette smoke can interact directly with chondrocytes through specific receptors, resulting in impaired bone growth in children (Hasanah et al., 2020).

Exposure to cigarette smoke significantly increased the risk of stunting in toddlers by up to 24.8 times. Cigarette smoke contains 2,256 hazardous chemicals, including pro-oxidants and carcinogens, many of which can penetrate the blood–gas barrier and enter the bloodstream and peripheral tissues. One of the effects of these substances is vasodilation disorders, which impair oxygen distribution in the body. Furthermore, cigarette smoke stimulates the secretion of pro-inflammatory cytokines. Children from families with smoking parents are more likely to experience stunting than those from families with non-smoking parents. Smoking behaviors are also associated with intrauterine growth retardation (IUGR), one of the main risk factors for stunting (PP Lestari et al., 2025)

These findings indicate that smoking can harm non-smoking family members, especially toddlers, who are often exposed to cigarette smoke as passive smokers within the household environment. The air inhaled by non-smoking family members becomes contaminated with cigarette

smoke, leading to health problems such as sore throat, asthma, respiratory diseases, and impaired toddler growth. This mechanism involves exposure to harmful substances, such as nicotine and carbon monoxide, which can interfere with nutrient and oxygen absorption in children. Such disruption can hinder optimal child growth and increase the risk of stunting. To prevent these negative impacts, awareness and responsibility are required from family members who smoke. They are expected to avoid smoking inside the home or near residential areas. This preventive step aims to reduce the risk of stunting caused by cigarette smoke exposure (Nur et al., 2019).

Family Income on the Incidence of Stunting

The results of this study show that family income had a significant effect on the incidence of stunting in toddlers, with a p-value of 0.012. This is because the majority of families had low income. Family income influences household purchasing power for nutritious food, as it determines the type of food purchased depending on income level. Low-income families typically provide less varied and smaller amounts of food for their children, especially foods that supply essential nutrients for growth, such as protein, vitamins, and minerals. As a result, these limitations increase the likelihood of toddlers experiencing stunting (Mariatun Mariatun et al., 2024).

This study is consistent with findings by Nurmalasari (2020), who revealed a relationship between family income and stunting, with an OR of 5.132 (CI: 2.602–10.121) and a p-value of 0.000 <0.05. Low-income families were five times more likely to have stunted children compared to high-income families. Income is the most important determinant of food quantity and quality (Nurmalasari et al., 2020). Families with poor economic status (low income) have difficulty obtaining nutritious food. This economic limitation results in toddlers not receiving the nutritional intake they need, due to a lack of purchasing power for a variety of foods (Nurhayani, 2023).

This study is also consistent with findings by Lestari et al. (2022), who reported that the calculated R value of 0.696 was greater than the R table value of 0.098 with n = 390 and a 5% significance level (W. Lestari et al., 2022). This study is also consistent with findings by Lestari et al. (2022), who reported that the calculated R value of 0.696 was greater than the R table value of 0.098 with n = 390 and a 5% significance level (W. Lestari et al., 2022). Similarly, Agustin and Rahmawati (2021) found that 67.9% of families with stunted toddlers had incomes below the minimum wage, compared with 32.1% of families without stunting. Bivariate analysis using the chi-square test on the relationship between family income and the incidence of stunting yielded a p-value of 0.004 (OR = 0.178, 95% CI: 0.52–0.607), indicating a relationship between these variables (Agustin & Rahmawati, 2021).

In addition, family income is influenced by several factors, including type of employment, number of dependents, and housing status. These factors significantly affect family income by shaping expenses and financial obligations. For example, a higher income does not necessarily translate into a higher standard of living if there are many dependents, as the associated costs will also rise (Indah et al., 2024).

This finding suggests that family incomes below the district minimum wage [UMK] increase the incidence of stunting. The number of family members (dependents) in a household also affects food availability, increases expenses, and reduces household food security. Families with good economic status benefit from better public services such as education, health care, and infrastructure, which positively impact children's nutritional status. They also have greater access to food, thereby improving well-being. By contrast, families with poor economic status tend to purchase carbohydrate-rich foods rather than protein-rich foods because they are cheaper and more readily available. This economic constraint affects purchasing power, limiting the ability of low-income families to meet nutritional needs, unlike sufficient or high-income families whose purchasing power is greater.

Maternal Height on the Incidence of Stunting

The results of this study show that maternal height did not have a significant effect on the incidence of stunting in toddlers, with a p-value of 0.329. Maternal height is one observable predictor of stunting. Exposure to risk in early childhood, as reflected in adult height, has the potential to negatively impact child growth through several pathways, including maternal health, biomechanical factors, and biological factors such as intrauterine growth retardation and premature birth (Perkins et al., 2016).

The majority of respondents in this study were short, with a height of ≤150 cm. This is consistent with Baidho et al. (2021), who categorized mothers as short if their height was <150 cm and tall if their height was ≥150 cm. The findings of this study indicate that maternal height did not have an effect on the incidence of stunting. Human growth is influenced by a combination of genetic, environmental, and nutritional factors (Baidho et al., 2021). Maternal height reflects genetic factors that cannot be changed because they are inherited. Although genetics play a major role, external factors such as environmental conditions and nutritional adequacy also contribute significantly to a person's height (Oktavia et al., 2023).

This study is consistent with findings by Fadilah et al. (2020), who revealed no significant relationship between parental height and stunting (p=0.518). This condition is thought to be more strongly influenced by pathological or nutritional problems in the parents rather than genetic abnormalities in the chromosomes, so the short stature trait is not necessarily inherited. Toddler growth and development are not determined solely by genetic factors but also by nutritional intake during pregnancy, parenting practices, and the child's nutritional adequacy (Nadiah et al., 2020).

A study by Setyaningrum et al. (2020) also reported similar results, showing no statistically significant relationship between parental height and the incidence of stunting (p=0.584 for fathers and p=0.075 for mothers). A child's height growth is influenced by a combination of genetic and environmental factors, one of which is adequate nutritional intake, both during pregnancy to support fetal development and during the child's growth period. However, parental short stature can still affect children if there is a genetic abnormality in the chromosomes that carries the short stature trait and is passed on to offspring (Roro Wulansari Setyoningrum et al., 2025).

Overall, maternal height does not directly affect the incidence of stunting in children. This may be because maternal height does not always reflect genetic factors alone but is also influenced by nutritional and health history since childhood. Therefore, short maternal stature is not automatically inherited by children. Child growth is largely determined by external factors such as adequate nutritional intake during pregnancy and growth, parenting practices, environmental conditions, and exposure to infectious diseases. These factors play a more dominant role than maternal height in determining a child's growth status.

4 Conclusion

1. A binary logistic regression model was able to identify factors associated with the risk of stunting in toddlers. Significant variables were determined based on a p-value <0.05, an odds ratio (OR), and a 95% confidence interval (CI).
2. There was an effect of cigarette smoke Exposure on the incidence of stunting in toddlers with a p-value of 0.010 and an Exp(b) value of 24.8, which means that toddlers exposed to cigarette smoke had a 24.8 times greater chance of experiencing stunting than those who were not exposed.
3. There was an effect of family income on the incidence of stunting in toddlers with a p-value of 0.012 and an Exp(b) value of 0.024, which means that toddlers whose family income was above the UMK had a 0.24 times greater chance of experiencing stunting than toddlers whose family income was below the UMK.
4. There was no effect of maternal height on the incidence of stunting in toddlers with a p-value of 0.329 and an Exp(b) value of 2.9. This indicates that respondents with a height <150 cm had a 2.9 times greater tendency to have children with stunting. However, statistically, this relationship was not significant. Thus, maternal height did not significantly affect the incidence of stunting, although it showed a direction of increased risk.
5. The determinant factors that were proven to be significant and can be used as early prediction indicators for the risk of stunting were cigarette smoke exposure and family income.

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