



An Analysis of Stunting Determinants in North Tapanuli Regency

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<p>Track Record Article</p> <p>Revised: 7 January 2026 Accepted: 26 February 2026 Published: 31 March 2026</p> <p>How to cite : Sitompul, E. S., Simbolon, J. L., & Siregar, M. (2026). An Analysis of Stunting Determinants in North Tapanuli Regency. <i>Contagion : Scientific Periodical of Public Health and Coastal Health</i>, 8(1), 246–258.</p>	<p style="text-align: center;">Abstract</p> <p><i>There has been a decline in stunting prevalence nationally in the last two years, requiring a more specific analysis of local determinants to optimize interventions at the regional level, especially in areas with geographical characteristics such as North Tapanuli Regency. This study aims to analyze the effect of nutritional intake, environmental sanitation, immunization status, and medical history on the incidence of stunting in toddlers. This quantitative study with a cross-sectional design involved 71 stunted toddler respondents in four working areas of the Community Health Center in North Tapanuli Regency. The data were analyzed using the Chi-Square test for bivariate analysis and Path Analysis to see the direct and indirect effects. The path analysis results showed that nutritional intake (0.365), sanitation (0.146), and immunization status (0.141) had a significant direct effect on stunting. Nutritional intake was the most dominant determining factor ($p=0.010$). Conversely, medical history ($p=0.485$) did not show a significant relationship and did not play a strong mediating role in this model. Nutritional intake is a key factor in determining the severity of stunting. Intervention strategies should focus on meeting the specific nutritional needs of toddlers in addition to improving sanitation and basic immunization coverage.</i></p> <p>Keywords: <i>Stunting, Nutritional Intake, Infectious Diseases, Sanitation, Immunization .</i></p>
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INTRODUCTION

Stunting is a condition where a child's growth and development are impaired due to chronic undernutrition, repeated infections, and inadequate psychosocial stimulation, resulting in low height-for-age. Stunting has been a crucial global public health challenge in that 148.1 million children under five worldwide are suffering from this condition, caused by long-term malnutrition (Saavedra & Prentice, 2022; UNICEF et al., 2020; WHO, 2020). The Indonesian government is paying special attention to this issue because the prevalence of stunting, according to the Indonesian Nutrition Status Survey (SSGI), was still 21.5% in 2022, requiring accelerated intervention to achieve the national target of 14% by 2024 (Kemenkes RI, 2022). This condition is also reflected in North Sumatra Province, which recorded a stunting prevalence of 21.1%, where the distribution of cases still shows significant inequality between districts (H et al., 2025). Stunting is understood as a condition of growth failure in children under five years old due to chronic malnutrition and repeated infections, especially during the first 1,000 days of life (HPK), which harms cognitive development and future productivity (Syukur & Harismayanti, 2020). The determinants of stunting are multifactorial, ranging from low intake of certain nutrients such as animal protein, inadequate parenting practices, to poor access to sanitation and clean water at the household level (Harahap et al., 2024). Therefore,

an in-depth analysis of the factors determining stunting in North Tapanuli Regency is very important, given that regional characteristics and local sociocultural factors are strongly suspected to influence the nutritional status of toddlers in particular (Pakpahan et al., 2025).

Factors affecting stunting are not limited to macronutrient deficiencies, but are also greatly influenced by low-quality animal protein intake during the critical growth phase of toddlers (Angelica et al., 2020). Empirical evidence shows that children who do not consume sufficient sources of animal protein every day have a higher risk of linear growth failure compared to those who get a varied protein intake (Ludwig et al., 2020). Beyond specific nutritional aspects, socioeconomic variables such as low household income and limited maternal nutrition literacy are major predictors that hinder access to quality food in rural areas (P. Silva et al., 2025). This condition is often exacerbated by sensitive environmental factors, where poor access to adequate sanitation and unprotected drinking water contributes to recurrent enteric infections that trigger chronic malnutrition (Regassa et al., 2023). Therefore, a synthesis of nutritional, economic, and environmental factors is an essential analytical framework for comprehensively examining the root causes of stunting at the local level (Wijaya, 2024).

Although various nutritional intervention policies have been implemented, their effectiveness is often hampered by an incomplete understanding of the specific determining factors in this mountainous region (Sabir & Bernet, 2022). The fundamental problem identified is the mismatch between generic nutrition assistance programs and the real needs of communities affected by economic constraints and local food consumption patterns (Gado et al., 2020). Without proper identification of the main driving factors, both sensitive aspects, such as sanitation and specific aspects such as parenting patterns, this cycle of chronic malnutrition will continue and burden the regional development system (Wells, 2022). Therefore, this study emphasizes that addressing stunting in North Tapanuli Regency requires an evidence-based approach driven by accurate analysis of local determinants, so that interventions can be more targeted and sustainable.

Current literature often generalizes the causes of stunting without considering the unique sociocultural influences and local food-based diets that play an important role in determining the nutritional status of toddlers in these areas (Mulyani et al., 2025). This research gap has resulted in existing intervention strategies often not meeting the real needs of local communities facing economic and geographical accessibility challenges that differ from those in other regions in North Sumatra. Therefore, this study aims to fill this gap by conducting a

comprehensive analysis of specific local determinants to produce a more precise and targeted intervention model for the North Tapanuli Regency Government.

METHODS

This study follows a quantitative approach with an observational analytical design through a cross-sectional study. This design was chosen to observe and measure variables simultaneously at a specific point in time in order to analyze the relationship between determining factors and the incidence of stunting in children under five years of age. This study was carried out in North Tapanuli Regency, which consists of four Community Health Centers (Puskesmas), namely Siatas Barita Puskesmas, Hutabaginda Puskesmas, Situmeang Puskesmas, and Pahae Jae Puskesmas. This research was conducted from April to October 2025.

The study population comprised all stunted children across four Community Health Centers (Puskesmas) in North Tapanuli Regency, totaling 248 individuals. From this population, a sample of 71 children was selected using purposive sampling combined with simple random sampling techniques. Primary data were obtained directly from respondents to ensure validity, while secondary data were obtained from literature reviews and relevant institutional records. Stunting among toddlers was classified according to height-for-age (TB/U) using the WHO standard deviation (Z-score) criteria. Two categories were identified: Stunted (Short), children with a Z-score between -3 SD and -2 SD, indicating below-normal growth but not severely impaired; and Severely stunted (very short), children with a Z-score below -3 SD, reflecting more serious growth retardation. Independent variables in this study included nutritional intake, medical history, environmental sanitation, and immunization status.

Data collection techniques were conducted through field observations, documentation, and in-depth interviews, as well as environmental sanitation surveys of respondents. Height measurements were processed to obtain children's nutritional status, namely TB/U. The tools used in this study included weight and height measuring devices, maternal and child health books (BKIA), and questionnaires that had undergone validity and reliability tests.

Meanwhile, other data on environmental sanitation and the history of infectious diseases were obtained through interviews, questionnaires, and direct observation. The tools used in this study included weight and height measuring devices, maternal and child health (MCH) books, and questionnaires that had undergone validity and reliability testing. In this study, univariate analysis was performed by calculating the frequency of research data results

based on variables that produced descriptive distributions and percentages. Bivariate analysis used the chi-square test, while multivariate analysis used path analysis.

RESULTS

Table 1. Frequency Distribution Based on Respondent Characteristics

Variable	f	%
Incidence of Stunting		
Short	51	71.8
Vary Short	20	28.2
Nutritional Intake		
Very poor	16	22.5
Inadequate	35	49.3
Adequate	20	28.2
History of Illness		
Frequent	17	23.9
Rare	33	46.5
Never	21	29.6
Environmental Sanitation		
Poor	39	54.9
Moderate	29	40.8
Good	3	4.2
Immunization History Status		
Complete	30	42.3
Incomplete	41	57.7
Total	71	100.0

Based on Table 1, the results of univariate analysis show that all toddlers in this study (100%) experienced stunting, with 71.8% (51 children) categorized as stunted and 28.2% (20 children) as severely stunted. This nutritional status aligns with findings on dietary intake, where the majority of toddlers had inadequate nutrition: 49.3% were categorized as “deficient” and 22.5% as “severely deficient”. Only 28.2% of toddlers were recorded as having adequate nutritional intake. Preventive health indicators also warrant attention, as most toddlers (57.7%) were found to have incomplete immunization status.

In terms of environmental factors and medical history, it was found that more than half of the respondents (54.9%) lived in environments with poor sanitation, and only a small proportion (4.2%) had good sanitation. Regarding medical history, although 29.6% of toddlers had never been sick, 23.9% of toddlers were often sick, and 46.5% were rarely sick. Overall, these data indicate that the high incidence of stunting in the study location is accompanied by a prevalence of low nutritional intake, incomplete immunization coverage, and environmental sanitation conditions that are mostly below health standards.

Table 2. Frequency Distribution of Factors Associated with Stunting

Variable	Incidence of Stunting				Total		<i>p-value</i>
	Short		Very Short		n	%	
	n	%	n	%			
Nutritional Intake							
Very poor	15	88.2	2	11.8	17	23.9	0.010
Inadequate	18	54.5	15	45.5	33	46.5	
Adequate	18	85.7	3	14.3	21	29.6	
Total	51	71.8	20	28.2	71	100	
Medical History							
Frequent	13	81.2	3	18.8	16	22.5	0.485
Rarely	23	65.7	12	34.3	35	49.3	
Never (Ref)	15	75	5	25	20	28.2	
Total	51	71.8	20	28.2	71	100	
Sanitation							
Insufficient	32	82.1	7	17.9	39	54.9	0.028
Moderate	16	55.2	13	44.8	29	40.8	
Good	3	100	0	0	3	4.2	
Total	51	71.8	20	28.2	71	100	
Immunization Status							
Complete	19	63.3	11	36.7	30	42.3	0.037
Incomplete	32	78	9	22	41	57.7	
Total	51	71.8	20	28.2	71	100	

The bivariate analysis results indicate that nutritional intake, sanitation conditions, and immunization status are significant determinants of stunting severity among toddlers at the study site. Nutritional intake showed a particularly strong relationship ($p=0.010$) with 45,5% of toddlers in the “poor” intake group classified as severely stunted. Environmental sanitation also demonstrated a significant relationship ($p=0.028$), with 44,8% of severe stunting cases occurring in households with moderate sanitation conditions. In addition, basic immunization was found to be significantly associated with nutritional status ($p=0.037$), further underscoring its role in stunting outcomes.

On the other hand, the variable of disease history did not show a statistically significant relationship with the severity of stunting ($p=0.485$). This indicates that in the study population, inadequate nutritional intake, unhealthy environmental conditions, and incomplete immunization are the main factors that are more dominant in exacerbating stunting than the frequency of disease in children. These findings provide a strong basis for the need for integrated interventions that focus on improving specific nutrition and strengthening environmental health in North Tapanuli Regency.

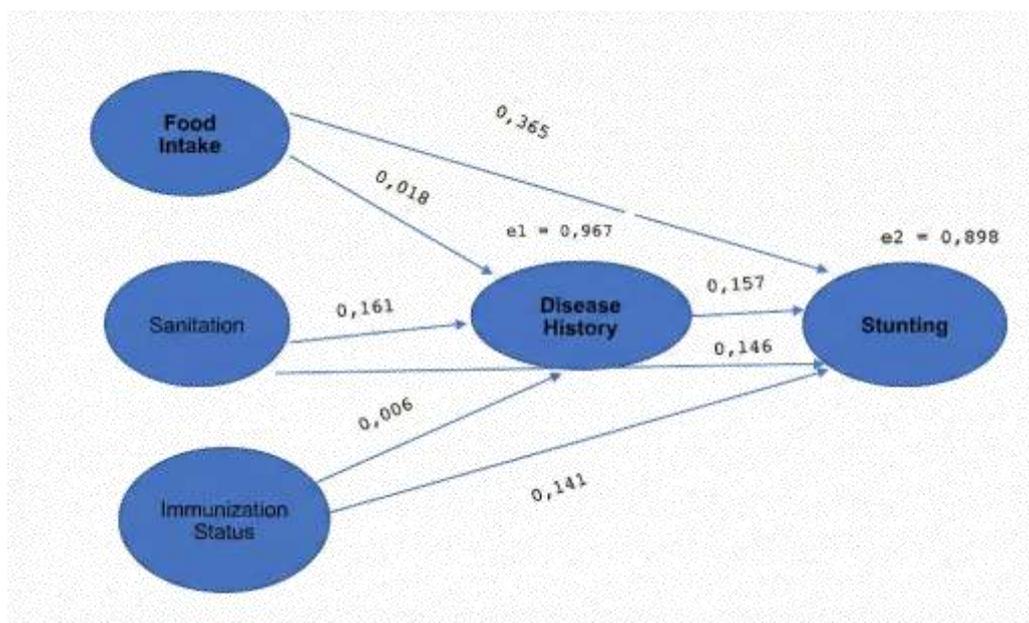


Figure 1. Factors Influencing The Incidence Of Stunting (Path Analysis)

The path analysis results show that food intake, sanitation, and immunization status have a significant direct effect on stunting rates in North Tapanuli Regency. Among these variables, food intake is the dominant determinant with a path coefficient value of 0.365, which is statistically much higher than the influence of sanitation (0.146) and immunization status (0.141). This analysis also shows that medical history does not function as a strong mediating variable in this model, given that the indirect influence of nutritional intake, sanitation, and immunization through medical history is found to be very small compared to their direct influence.

This confirms that specific nutritional interventions and improvements in environmental quality can directly improve the growth status of toddlers independently, without always having to go through the intermediary of infectious disease prevention. Therefore, strengthening nutritious eating patterns is the most crucial strategy because it has the greatest impact on overcoming stunting in the study area compared to other variables in this path analysis framework.

DISCUSSION

The findings of this study prove that nutritional intake is the most crucial determining factor in the severity of stunting in toddlers. The statistical significance of this relationship is proven by a p-value of 0.010, which reinforces the argument that daily nutritional quality is directly proportional to a child's growth status. In addition, nutritional intake has a dominant influence in this research model with a path coefficient value of 0.365. This is in line with

conditions in the field, where 46.5% of toddlers have nutritional intake in the inadequate category. This high proportion of inadequate intake is the main trigger for linear growth failure, where in the group with inadequate intake, the prevalence of the very short category reaches 45.5%. As the factor with the largest contribution, increasing nutritional intake becomes the focus of intervention because it has the highest capacity to significantly improve the physical status of toddlers compared to other variables.

Long-term nutritional deficiencies have been identified as a major risk factor directly contributing to linear growth disorders in toddlers. Situmeang et al., (2020) reported significant correlations between energy intake ($p=0.020$; $r=0.215$) and protein intake ($p=0.0001$; $r=0.354$) with stunting among children aged 24-59 months. In addition to macronutrients, specific micronutrient deficiencies also play a critical role. For example, inadequate iron intake was significantly associated with stunting ($p=0.018$), with affected toddlers facing a 1.78 fold higher risk. Dwi et al., (2020) further highlighted that low blood zinc levels were strongly associated with stunting ($p=0.023$). In addition, Ismawati et al., (2020) reported that, on average, stunted toddlers only met about 77.23% of their energy needs and 69.82% of their protein needs from the recommended nutritional adequacy level (AKG). This chronic malnutrition often begins during the first 1000 days of life due to suboptimal nutritional care and limited access to quality food.

The distinction of this study lies in the strength of the direct influence of nutritional intake, which surpasses the effects of sanitation and immunization. These findings confirm that in the North Tapanuli region, targeted nutritional interventions provide the most effective leverage for reducing stunting compared to other environmental factors.

The findings of this study also indicate that environmental sanitation is a significant predictor of stunting severity among toddlers. The statistical significance ($p=0.028$) confirms that living conditions are not merely supporting factors but have a direct functional relationship with children's linear growth. An unexpected result was the high prevalence of severe stunting (44.8%) in the "moderate" sanitation group, which exceeded that of the poor sanitation group. This phenomenon suggests that the risk of growth disorders is not confined to visibly poor environments but can also arise under seemingly adequate sanitation conditions that still harbor pathogen contamination, leading to subclinical infections. Such suboptimal environments place a continuous burden on toddlers' immune systems, diverting energy that should support growth toward combating repeated exposure to germs.

Inadequate environmental sanitation conditions are consistently identified as a universal risk factor that significantly increases the probability of stunting in toddlers in various

developing countries, according to (J. R. M. Silva et al., 2023). The findings of Rah et al., (2020) explain that access to better sanitation facilities is closely related to a 28% reduction in the risk of stunting in children in Indonesia. Purba et al., (2020) found a very strong correlation between the quality of clean water sources, the availability of family toilets, and sewage systems, with the nutritional status of toddlers in the South Sumatra region. In addition, Zahtamal et al., (2024) emphasized that poor sanitation directly contributes to linear growth failure through the mechanism of increased exposure to pathogens in the household environment. The negative impact of suboptimal sanitation is often exacerbated by poor hygiene practices that trigger recurrent infectious diseases, according to (Aprihatini et al., 2020). Rizaldi et al., (2025), in their systematic review in Asia, concluded that sanitation interventions are one of the main pillars of effective strategies to accelerate stunting reduction. Batool et al., (2023) also reported that poor WASH (Water, Sanitation, and Hygiene) practices at the household level are directly associated with children's physical growth deficits. However, Das et al., (2020) provide an additional perspective that while sanitation is very important, successful recovery from stunting also depends heavily on the timing of interventions.

The results of the study in North Tapanuli Regency show similarities with the above literature in terms of the statistical significance of sanitation variables on the stunting status of toddlers. However, there is a unique difference in the findings, where the group with 'moderate' sanitation actually has a higher proportion of 'very short' toddlers (44.8%) compared to the 'poor' sanitation group (17.9%). This is an anomaly when compared to common findings, such as those in studies by Rah et al. (2020) or J. R. M. Silva et al., (2023), which tend to show a linear relationship where the worse the sanitation, the more severe the stunting. Furthermore, the direct effect value of sanitation in the path analysis model (0.146) shows that although sanitation has an effect, its contribution is still much lower than that of nutritional intake, confirming that in the study location, nutritional fulfilment remains the more dominant intervention priority.

Immunization status was also identified as a significant determinant affecting the severity of stunting in toddlers in North Tapanuli Regency. With a statistical significance value of $p=0.037$, this finding confirms that complete basic immunization is not only a routine health procedure, but also plays a crucial protective role in supporting children's linear growth. Path analysis shows that immunization status has a direct effect of 0.141 on the nutritional status of toddlers, indicating that optimal immunological protection contributes directly to the prevention of growth disorders. Clinically, these findings indicate that incomplete immunization, which occurred in the majority of respondents (57.7%), creates a biological

vulnerability gap that can hinder the maximum growth potential of toddlers. Although nutritional intake remains a dominant factor, immunization status still remains an important pillar in specific interventions to ensure that the toddler's immune system remains optimal so that the growth metabolism process is not disrupted by preventable diseases.

Complete basic immunization status has been identified as one of the specific nutritional interventions that are effective in reducing the risk of stunting in toddlers. Research by Purwanti et al., (2025) shows a statistically significant relationship between basic immunization status and the incidence of stunting in Indonesia after conducting a multivariate analysis. This finding is reinforced by Theresia and Sudarma, (2022), who state that immunization status plays an important role in reducing the incidence of stunting in children aged 1–5 years by reducing children's vulnerability to infections that can interfere with growth. In India, Khan and Mohanty (2025) reported that the prevalence of stunting was much lower in groups of children who received complete immunization compared to those who did not receive complete immunization. Wahyuni et al., (2021) Also confirmed in their study in the Gilingan Community Health Center working area, that there is a clear relationship between immunization status and stunting in toddlers. Similarly, research by Wanda et al., (2021) in Hegarmanah Village concluded that basic immunization history is a factor closely related to toddler nutritional status. Dadras et al., (2024) added that basic and complete immunization coverage has the potential to reduce the risk of stunting in developing countries such as Afghanistan. Overall, global literature shows that optimal immunological protection through vaccination programs is an important pillar in preventing chronic physical growth retardation in childhood.

The results of the study in North Tapanuli Regency show consistency with the above literature in terms of statistical significance ($p=0.037$) and its direct effect in the path analysis model (0.141). The high rate of incomplete immunization in the sample (57.7%) is in line with the concerns expressed by Khan and Mohanty (2025) regarding the burden of stunting in groups that did not receive complete immunization. However, there is a very contrasting and unique difference in the bivariate analysis results, where the group with complete immunization actually has a higher percentage in the 'Very Short' category (36.7%) compared to the incomplete group (22%). This is an anomaly or "false protective factor" that differs from the findings of the majority of the literature, such as the study by Theresia and Sudarma (2022), which consistently shows that immunization reduces the incidence of stunting. This difference provides an interesting point of discussion that in the study location, there are other factors that have a much stronger influence on nutritional status (such as nutritional intake, which has a

path coefficient of 0.365), so that the protective role of immunization is not seen linearly in the bivariate data.

The results of this study provide a strong basis for prioritizing specific nutritional interventions in strategies to accelerate stunting reduction in North Tapanuli Regency, particularly by improving the quality and quantity of food intake for toddlers through a Supplementary Feeding Program (PMT) based on local animal protein. Nutrition education for mothers needs to be strengthened to ensure that infants' energy and protein needs are met in accordance with nutritional adequacy levels. Local governments need to integrate environmental health (WASH) programs and strengthen basic immunization coverage simultaneously. Although nutritional intake is the strongest determining factor, the significant influence of sanitation and immunization shows that sensitive interventions are still needed to create an environment that supports optimal and sustainable linear growth in toddlers.

This study has several limitations that need to be considered. First, the use of a cross-sectional study design limits the ability of the study to draw strong temporal causal relationships between the determining variables and stunting. Second, the relatively limited sample size (N=71) may not fully represent the diversity of toddler conditions throughout the North Tapanuli region. Third, data collection on nutritional intake and medical history relied on mothers' memories (memory bias), which could potentially be subjective. Further research using a prospective (cohort) design with a larger sample size is recommended to validate this pathway model more broadly.

CONCLUSIONS

This study concludes that nutritional intake, environmental sanitation, and immunization status are determining factors that have a significant direct influence on the severity of stunting in North Tapanuli Regency. Nutritional intake was found to be the dominant factor in determining the linear growth status of toddlers (path coefficient 0.365), far exceeding the contribution of other environmental and health factors. On the other hand, medical history was not found to be a significant mediating variable in this model. These findings confirm that the main intervention that must be carried out is to improve the nutritional consumption patterns of toddlers at the household level as the main lever for reducing stunting rates.

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