Mal J Nutr 32 (3): 316- 326, 2026

Stunting among children under five years and its associated factors in four provinces in Sumatra Island, Indonesia: A district-level analysis

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ABSTRACT

Introduction: Stunting remains a major public health concern on Sumatra Island, Indonesia.This study aimed to examine prevalence of stunting and its associated factors among children under five years of age across four provinces. **Methods:** This ecological study utilised secondary data from the 2018 Indonesia Basic Health Research (Riskesdas) conducted by Ministry of Health. District and city-level data from 78 regencies/cities with complete information across four provinces on Sumatra Island were analysed, including North Sumatra (*n*=33), West Sumatra (*n*=19), Lampung (*n*=15), and Jambi (*n*=11). Descriptive, comparative, and correlation analyses were performed to assess prevalence of stunting and its associated factors. Results: Median prevalence of stunting across districts was 28.6%. Overall, 24.0% of pregnant women and 10.0% of children lacked a Maternal and Child Health Handbook (Buku KIA). Stunting prevalence differed significantly between regencies and cities ($p<0.001$) but not between geographical areas. Child weight monitoring was strongly and negatively correlated with stunting ($r=-0.639$; $p<0.001$), while moderate correlations were observed for Buku KIA ownership ($r=0.337$), child height monitoring ($r=-0.491$), supplementary feeding ($r=-0.301$), and basic immunisation coverage ($r=-0.407$). **Conclusion:** Stunting prevalence on Sumatra Island remained high at 28.6%. Significant factors associated with stunting included absence of routine child growth monitoring, inadequate ownership, and utilisation of Buku KIA, insufficient supplementary feeding, and incomplete immunisation. Strengthening these interventions is crucial for preventing and reducing stunting among the population.

Keywords: associated factors, stunting, Sumatra Island, Indonesia, under 5 children

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doi: https://doi.org/10.31246/mjn-2025-0158

INTRODUCTION

Stunting is a growth and developmental disorder characterised by impaired linear growth. It reflects chronic undernutrition during critical periods of growth and development, particularly from pregnancy through early childhood. As a consequence, children with stunting are shorter than their peers of the same age and may experience long-term adverse effects on health, cognitive development, and productivity. Although undernutrition often begins during the prenatal period, the effects of stunting typically become evident after the age of two years. Stunting is assessed using length-for-age *z*-score (LAZ) for children under two years of age and height-for-age *z*-score (HAZ) for children aged two years and older. According to WHO criteria, children are classified as stunted when their z-score is below -2 standard deviations (*SD*) and severely stunted when it is below -3 *SD* from the median of the WHO Child Growth Standards (WHO, 2023).

Stunting is also a key indicator in achieving the Sustainable Development Goals (SDGs), particularly Goal 2, which aims to end hunger, improve nutrition, and ensure food security by 2030. According to WHO, a stunting prevalence exceeding 20.0% constitutes a public health concern. In Indonesia, the prevalence of stunting was 24.4% in 2021, with the government setting a reduction target of 14.0% by 2024 based on findings from the Indonesia Nutrition Status Survey (SSGI). Although the prevalence declined to 21.5% in 2023, it remained substantially above the national target. Consequently, stunting reduction remains a major government priority and an essential component of achieving the "Golden Indonesia 2045" vision. However, the modest decline in prevalence over recent years indicates that considerable efforts are still required to accelerate progress towards the national target (Ministry of Health of the Republic of Indonesia, 2023).

Child growth is a complex process influenced by multiple interrelated factors. According to WHO, the primary determinants of stunting include inadequate dietary intake and recurrent infectious diseases (Lizamona, Fikawati & Silva, 2025). Maternal factors, such as poor nutritional status during pregnancy and adolescent pregnancy, also contribute to the risk of stunting. Nadiyah & Martianto (2014) reported significant associations between low birth weight, maternal stature, and stunting among children. In addition, other studies have identified inadequate energy intake and limited access to safe water and sanitation facilities as important risk factors for stunting (Santosa, Arif & Ghoni, 2022).

According to the Ministry of Health of the Republic of Indonesia (2017), the prevalence of stunting in Asia is estimated at 56.0%. India, one of the region's developing countries, reduced its stunting prevalence from 44.0% in 2010 to 22.8% in 2025, demonstrating substantial progress in child nutrition. According to UNICEF (2013), Indonesia ranks fifth among countries with the highest number of children affected by stunting, following India, Nigeria, Pakistan, and China. Data from Riskesdas 2010 showed that the prevalence of stunting among children aged 0 – 59 months reached 35.6%, consisting of 37.3% of boys and 33.9% of girls. The Indonesian government subsequently set a target to reduce the prevalence of stunting among children under two years of age to 28.0% by 2019. However, data from Riskesdas 2018 indicated that stunting prevalence remained high at 30.8%. Aceh Province recorded the highest prevalence (37.9%), while East Java ranked seventh nationally (Ministry of Health of the Republic of Indonesia, 2018). In addition, the 2018 Nutrition Status Monitoring Survey reported a stunting

prevalence of 26.7% in East Java, including both stunted and severely stunted children. Despite the well-recognised determinants of stunting (WHO, 2023), evidence regarding factors associated with stunting at the aggregate district level remains limited. Therefore, further investigation is needed to ascertain contextual determinants and support targeted interventions.

Sumatra is the second most populous island in Indonesia after Java, accounting for approximately 22% of the country's population. It comprises ten provinces: Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, the Bangka Belitung Islands, and the Riau Islands. Despite its economic and demographic importance, the region continues to face significant challenges in several sectors, particularly health. The prevalence of stunting on Sumatra Island remains high, with two provinces reporting rates above the national average. North Sumatra has been reported to have the highest prevalence of stunting, at 32.4% (Ministry of Health of the Republic of Indonesia, 2020). In addition, inadequate health programme implementation and coverage have been identified as contributing factors to the high burden of stunting in the region. Stunting remains a major public health concern because of its adverse effects on physical growth, cognitive development, productivity, and human capital. Although several studies have examined the determinants of stunting, findings vary across regions due to differences in demographic and environmental characteristics (Anzarkusuma *et al.*, 2025). Furthermore, research on factors associated with stunting using aggregate district-level data remains limited. Therefore, this study aimed to describe the prevalence of stunting among children under five years of age on Sumatra Island and analyse factors associated with its occurrence.

METHODOLOGY

This study employed an ecological design to examine the prevalence of stunting and its associated factors. The analysis was based on data from Riskesdas 2018, a nationally representative survey conducted by the Ministry of Health of the Republic of Indonesia. Riskesdas is routinely implemented to assess disease prevalence, identify health risk factors, and monitor the overall health status of the Indonesian population. The survey utilises a multistage cluster sampling design with probability proportional to size, ensuring that samples are representative of regional population distributions and geographical variations. Based on data collected in 2018, Riskesdas provides comprehensive district-level coverage and consistent maternal and child health indicators, making it particularly suitable for analysing factors associated with stunting across districts on Sumatra Island.

The study population comprised all children aged 12-59 months recorded in Riskesdas 2018 across 154 regencies and cities on Sumatra Island. The study sample was selected based on the availability of complete data for all study variables. Consequently, 78 regencies/cities from four provinces were included in the analysis: North Sumatra (n=33), West Sumatra (n=19), Jambi (n=11), and Lampung (n=15). Although more recent national survey data are available, including the 2023 survey, the Riskesdas 2018 dataset was utilised because it provided substantially broader district- and city-level coverage of Sumatra Island. For instance, the 2023 survey included only 30 regencies/cities from the study area, whereas the 2018 dataset covered 78 regencies/cities, allowing for a more comprehensive ecological analysis. A total of 15,060 children aged 12 – 59

months with complete age and height measurements were included. The highest prevalence of stunting was observed in North Sumatra (32.4%), followed by Jambi (30.2%), West Sumatra (29.9%), and Lampung (27.3%). Across all provinces, the majority of children had a normal height-for-age status, with proportions ranging from 67.6% to 72.7%.

Districts and cities were included in the analysis if complete data were available for all study variables and no variable contained zero values. The unit of analysis was the district or city. The variables examined included stunting prevalence (stunted and severely stunted), geographical characteristics (regency/city status and coastal or mountainous location), ownership of the Maternal and Child Health Handbook (Buku KIA), child weight monitoring, child height monitoring, participation in supplementary feeding programmes, and coverage of basic childhood immunisations, including Hepatitis B birth dose (HB0), Bacillus Calmette–Guérin (BCG), Diphtheria, Pertussis, Tetanus, Hepatitis B, and Haemophilus Influenzae type b (DPT-Hib) 1, DPT–Hib 2, DPT-Hib 3, polio, and measles vaccines. Data were obtained from Riskesdas 2018 datasets available through the Ministry of Health of the Republic of Indonesia for each province.

Data were analysed using IBM Statistics for Windows, version 25.0 (IBM Corporation, Armonk, New York, USA). The analyses included descriptive, comparative, and correlation procedures based on district and city-level data. Descriptive statistics were used to summarise the distribution of variables and calculate median values. Comparative analyses were conducted to assess differences in stunting prevalence according to regional characteristics, including regency/city status, coastal or mountainous location, and fiscal capacity categories. Fiscal capacity was defined as an indicator of a region's ability to finance governmental functions and development activities. Data normality was assessed using the Kolmogorov-Smirnov test, which indicated that stunting prevalence data were not normally distributed (p=0.037). Consequently, non-parametric statistical tests were applied. The Mann-Whitney U test was used to compare stunting prevalence between two groups, while the Kruskal–Wallis test was used to compare stunting prevalence between three or more groups. Spearman's rank correlation coefficient was employed to examine associations between variables. Statistical significance was set at p<0.05.

This study received ethical approval from the Esa Unggul University Code of Ethics Enforcement Board (Reference number: 0925-10.005/DPKE-KEP/FINAL-EA/UEU/XI/2025). All study procedures were conducted in accordance with the ethical principles governing research involving human participants. Informed consent was obtained to ensure voluntary participation and the protection of participant confidentiality. Participants were informed that their involvement in the study was entirely voluntary and that they could withdraw from the study at any time without penalty or adverse consequences.

RESULTS

Median prevalence of stunting was 28.6%, ranging from 12.5% to 61.3% across districts. Median proportions of pregnant women and children without a Buku KIA were 24.0% and 10.0%, respectively. The median coverage of child weight monitoring was 73.5%, while child height monitoring coverage was 35.5%. The median proportion of children who acquired supplementary feeding was 29.0%,

and the proportion of children who acquired supplementary feeding programmes was 70.6%. The median coverage of basic childhood immunisations was 77.7% for hepatitis B birth dose (HB0), 82.3% for BCG, 52.2% for DPT-Hib 1, 51.2% for DPT-Hib2, 45.5% for DPT-Hib3, 54.3% for polio, and 70.4% for measles vaccination (Table 1).

By geographical classification, the majority of study areas were regencies (75.6%), with 61.5% located in mountainous areas and 69.5% classified as having low fiscal capacity (Table 2). Comparative analysis revealed significant differences in stunting prevalence between district and city areas (Table 3).

Correlation analysis presented in Table 4 demonstrated significant associations between stunting prevalence and most of the variables examined. Buku KIA ownership, child growth monitoring, supplementary feeding, and immunisation

Table 1. Prevalence of stunting and associated factors on Sumatra Island

Prevalence	*Mean*	*Median*	*SD*	*Min*	*Max*
Stunting	30.2	28.6	9.8	12.5	61.3
Not having a Buku KIA for pregnant women	30.9	24.0	22.4	0.0	86.8
Not having a Buku KIA for children under five	16.4	10.0	15.4	0.9	71.7
Child weight monitoring	68.9	73.5	17.4	14.6	98.8
Child height monitoring	41.4	35.5	22.5	9.0	93.3
Acquire supplementary feeding	30.6	29.0	16.0	1.7	75.7
Acquire supplementary feeding programme	68.9	70.7	25.7	6.3	100.0
HB0 vaccination	72.1	77.7	18.2	27.3	100.0
BCG vaccination	78.9	82.3	16.3	21.0	100.0
DPT-HIB1 vaccination	51.5	52.2	20.4	2.4	100.0
DPT HIB2 vaccination	50.1	51.2	20.4	2.4	100.0
DPT-HIB vaccination 3	47.9	45.5	20.5	0.0	100.0
Polio vaccination	54.3	54.3	22.9	2.4	100.0
Measles vaccination	67.9	70.4	18.4	18.7	100.0

coverage were all significantly associated with stunting prevalence. The absence of a Buku KIA for pregnant women was positively correlated with stunting prevalence (r=0.337; p=0.003). A stronger positive correlation was observed for the absence of a Buku KIA for children under five (r=0.466; p<0.001). Child growth monitoring was negatively associated with stunting prevalence. Child weight monitoring showed a strong negative correlation (r=–0.639; p<0.001), while child height monitoring demonstrated a moderate negative correlation (r=–0.491; p<0.001). Participation in supplementary feeding programmes was also significantly associated with lower stunting prevalence (r=–0.301; p=0.007). Furthermore, all immunisation variables examined were negatively and significantly correlated with stunting prevalence. The strongest correlations were observed for polio immunisation (r=–0.432; p<0.001) and DPT-Hib 1 immunisation (r=–0.410; p<0.001).

Table 2. Distribution of research site area

Variable	*n*	*%*
Regency/City		
Regency	59	75.6
City	19	24.4
Total	78	100.0
Coast/Mountains		
Coast	30	38.5
Mountains	48	61.5
Total	78	100
Fiscal indices		
Low	62	79.5
Medium	10	12.8
High	6	7.7
Total	78	100.0

Table 3. Analysis of differences in stunting prevalence by region and fiscal index

Variable	*n*	*Mean rank*	*p-value*
Region			
Regency	59	44.6	<0.001†***
City	19	23.6	
Coast/Mountains			
Coast	30	42.1	0.417†
Mountains	48	37.8	
Fiscal indices			
Low	62	41.5	0.243‡
Medium	10	34.0	
High	6	27.3	

†Mann-Whitney test; ‡Kruskal-Wallis test
***p<0.001

Table 4. Correlations between several independent variables and stunting prevalence

Variable	*R*	*p-value*
Not having a Buku KIA for pregnant women	0.337	0.003
Not having a Buku KIA for children under five	0.466	<0.001
Child weight monitoring	-0.639	<0.001
Child height monitoring	-0.491	<0.001
Acquire supplementary feeding	-0.301	0.007
Acquire supplementary feeding programme	0.201	0.077
HB0 vaccination	-0.362	0.001
BCG vaccination	-0.300	0.008
DPT-HIB1 vaccination	-0.410	<0.001
DPT HIB2 vaccination	-0.407	<0.001
DPT-HIB vaccination 3	-0.402	<0.001
Polio vaccination	-0.432	<0.001
Measles vaccination	-0.298	0.008

Buku KIA: Child Health Handbook; HB0: Hepatitis B birth dose; BCG: Bacillus z–Guérin; DPT-HIB: Diphtheria, Pertussis, Tetanus, Hepatitis B, and Haemophilus Influenzae type b

DISCUSSION

The prevalence of stunting across districts on Sumatra Island was 28.6%, exceeding the national prevalence of 21.5% reported in 2023. These findings indicate that stunting remains a major chronic nutritional problem in Indonesia, particularly in the Sumatra region. According to the Indonesia Nutrition Status Survey (SSGI) conducted by the Ministry of Health of the Republic of Indonesia, the prevalence of stunting varies considerably across provinces on Sumatra Island (Ministry of Health of the Republic of Indonesia, 2023). While some provinces continue to report relatively high levels of stunting, others have achieved lower prevalence rates that are closer to the national target. This variation may reflect differences in socioeconomic conditions, access to health services, nutritional practices, and the effectiveness of local public health interventions.

The proportions of pregnant women and children without a Buku KIA were 24.0% and 10.0%, respectively. The Buku KIA is an integrated health recording tool developed by the Ministry of Health of the Republic of Indonesia in collaboration with the Japan International Cooperation Agency (JICA). It serves as an important instrument for monitoring maternal and child health, including the assessment of child growth and nutritional status.

In 2022, the Ministry of Health introduced a health system transformation programme based on six strategic pillars. The first pillar, the transformation of primary healthcare services, includes stunting screening as a key intervention. As a comprehensive health recording and monitoring instrument, the Buku KIA plays a strategic role in supporting the implementation of this programme. The findings of the present study are consistent with those of Linda *et al.* (2024), who reported that the use of the Buku KIA significantly improved maternal knowledge (p=0.001). Similarly, Widyaningsih *et al.* (2022) found that child growth monitoring was significantly associated with stunting prevalence (p=0.025). These findings highlight the importance of the Buku KIA in promoting maternal awareness, facilitating growth monitoring, and supporting efforts to prevent stunting.

The coverage of child weight monitoring was 73.5%, whereas the coverage of height monitoring was substantially lower at 35.5%. Growth refers to measurable changes in body size and function, either as a whole or in specific body parts, and is commonly assessed using indicators such as weight, height, and physiological development (Bowden & Greenberg, 2010). Regular growth monitoring is essential for the early identification of nutritional and developmental problems among children. In Indonesia, community health volunteers (health cadres) play a vital role in conducting routine measurements of children's weight and height through community-based health services, thereby supporting the early detection and prevention of growth disorders, including stunting (Widiasih *et al.*, 2025).

The proportion of children receiving supplementary feeding was 29.0%, while coverage of the government supplementary feeding programme reached 70.6%. To address the persistent burden of stunting, the Government of Indonesia has implemented various policies and strategies, one of which is the supplementary feeding programme. Supplementary feeding programmes are designed to complement, rather than replace, children's regular dietary intake and are intended to improve the nutritional status of children, particularly those who are vulnerable to undernutrition and growth faltering (Ministry of Health of the Republic of Indonesia, 2022). Effective implementation of these programmes may

contribute to improving child nutritional outcomes and supporting national efforts to reduce stunting.

Coverage of basic childhood immunisation varied across vaccine types, with 77.7% for HB0, 82.3% for BCG, 52.2% for DPT-Hib1, 51.2% for DPT-Hib2, 45.5% for DPT-Hib3, 54.3% for polio, and 70.4% for measles vaccination. Immunisation has been recognised as an important nutrition-sensitive intervention that contributes to the prevention of infectious diseases associated with growth faltering and poor nutritional outcomes. Although immunisation is widely regarded as one of the most successful and cost-effective public health interventions, global vaccination coverage has remained relatively stagnant over the past decade. Consequently, strengthening immunisation programmes remains essential to improving child health and supporting efforts to reduce stunting and other forms of malnutrition.

This study showed that stunting was more common in mountainous areas compared to coastal areas. Research conducted by Phad *et al.* (2024) showed that children living in highlands had a greater risk of stunting. A meta-analysis also showed that children living in highland areas had a 2.91 times higher risk of stunting compared to those living in lowland areas (Rosyada, Sudargo & Murni, 2026). The high prevalence of stunting in mountainous areas may be partly due to limited access to health services. Difficult road access and minimal health facilities mean that communities lack access to health services, especially those related to nutritional improvement.

The prevalence of stunting in districts was also higher than in city areas, showing significant differences. Brou *et al.* (2023) found that the prevalence of moderate and severe stunting was higher in rural areas than in urban areas. Research analysing data from health surveys in India also showed that stunting was more prevalent in rural areas (Phad *et al.*, 2024). The difference in stunting prevalence between rural and urban areas is likely due to socioeconomic differences in the two regions. Rural communities have lower access to health services, education, income, adequate sanitation, and improved drinking water compared to urban areas (Hunde, 2022).

This study identified a moderate, positive correlation between the absence of Buku KIA ownership among pregnant women and children and stunting prevalence. These findings are consistent with those of Osaki *et al.* (2019), who reported that the use of the Buku KIA improved parental knowledge and enhanced the ability of families to monitor child growth and development regularly. As an integrated health recording tool, the Buku KIA plays a critical role in growth monitoring, health education, and stunting screening programmes. Nevertheless, these findings represent population-level associations derived from aggregate data and should not be interpreted as evidence of direct causal effects at the individual level.

In this study, participation in the supplementary feeding programme was also significantly associated with lower stunting prevalence. Manik *et al.* (2025) found that continuous supplementary feeding was effective in improving the nutritional status of stunted children under five years of age. The consumption of supplementary feeding made from local foods was also found to improve the nutritional status of toddlers experiencing malnutrition and stunting (Rachmah, Mawaddah & Rahim, 2025). Supplementary feeding is made in accordance with the principles of balanced nutrition and is rich in animal protein, which is important for child growth (Ministry of Health of the Republic of Indonesia, 2024).

Immunisation was significantly associated with stunting prevalence. This finding is in line with previous research suggesting immunisation can improve children's overall health and may reduce the risk of stunting through the non-specific effects of certain vaccines. The underlying mechanisms may involve trained immunity, a form of innate immune memory, as well as lymphocyte cross-reactivity, which can enhance resistance to a broad range of infections (Degenais, Villalba-Guerrero & Olivier, 2023). In addition, immunisation not only prevents childhood morbidity and mortality but also serves as an indicator of access to essential healthcare services, which may indirectly protect against undernutrition and growth faltering.

The association between immunisation coverage and stunting prevalence may be explained through several mechanisms. Immunisation plays a crucial role in the development of a child's immune system. Children who receive complete immunisation are generally better protected against infectious diseases, which can adversely affect nutritional status and growth. A meta-analysis reported that incomplete immunisation was associated with an increased risk of acute respiratory infections, one of the most common infectious diseases among children under five years of age (pooled odds ratio=1.8; 95% *CI*=1.3-2.5) (Hobani & Alhalal, 2022). Furthermore, certain vaccines, particularly live vaccines such as BCG and measles, have been shown to provide non-specific protective effects that reduce overall childhood mortality beyond the prevention of the targeted disease (Ruswati *et al.*, 2021). These protective effects may contribute indirectly to improved growth and nutritional outcomes. However, the association observed in the present study reflects a population-level relationship derived from aggregate district-level data and should not be interpreted as evidence of a direct causal effect of individual immunisation status on stunting.

This study has several limitations related to its design, representativeness, and the age of the data used. Firstly, as an ecological study based on aggregate district-level data, the observed associations between the selected factors and stunting prevalence may not reflect relationships at the individual level and should not be interpreted as indicators of individual risk. Nevertheless, the variables included in the analysis were selected based on robust evidence from existing literature and are recognised determinants of stunting. Secondly, the study included 78 regencies/cities from four out of ten provinces on Sumatra Island. Consequently, the findings may not be fully representative of the entire island and may be subjected to selection bias. However, the selected provinces represent the northern, central, and southern regions of Sumatra, providing broad geographical coverage and enhancing the relevance of the findings. Finally, although the study utilised data from Riskesdas 2018, which may not fully reflect the current prevalence of stunting, this dataset remains the most comprehensive source of district- and city-level information available for Sumatra Island. Compared with more recent national surveys, Riskesdas 2018 provides a wider geographical coverage and more complete data for analysing contextual factors associated with stunting. While stunting prevalence may have changed over time, the key determinants examined in this study remain relevant and continue to be recognised as important factors influencing child nutritional status.

CONCLUSION

A significant difference was observed between regencies and cities included in this study (p<0.001). At the population level, a positive correlation was found between the absence of Buku KIA for both pregnant women and children and stunting prevalence. In contrast, negative correlations were observed between stunting prevalence and child weight and height monitoring, supplementary feeding, and basic immunisation coverage. Strengthening interventions targeting these factors is crucial for preventing and reducing stunting among the population.

Acknowledgements

The researchers would like to thank the Ministry of Health of the Republic of Indonesia for providing the 2018 data that served as the basis for this research.

Author's contribution

Febrianti R, contributed substantially to the conception and design of the study and carried out the data collection; Fikawati S, analysed and interpreted the data and drafted the manuscript; Aima S, Habibi A and Putri RA, reviewed the manuscript critically for important intellectual content; all authors read and approved the final manuscript and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of interest

The authors declare no conflict of interest related to this study.

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