TROPICAL PUBLIC HEALTH JOURNAL
Journal homepage: https://talenta.usu.ac.id/trophico

Analysis of Distribution and Determining Factors for Identifying Patterns and Predicting the Risk of Stunting

Rini Anggraeny[1], Andi Wafiah[2], Henni Kumaladewi Hengky[1*], Fivit Febriani Malik[1]

[1]*Public Health Study Programme, Faculty of Health Sciences, Muhammadiyah University of Parepare*
[2]*Information Technology Study Programme, Muhammadiyah University of Parepare*

Corresponding Author: hennikaysa14@gmail.com

ARTICLE INFO

Article history:
Received Desember 9, 2025
Revised Desember 15, 2025
Accepted January 29, 2026
Available online
https://talenta.usu.ac.id/trophico

E-ISSN: 2797-751X
P-ISSN: 2774-7662

How to cite:
Anggraeny, R., Wafiah, A., Hengky, H.K., & Malik, F. (2026). Analysis of Distribution and Determining Factors for Identifying Patterns and Predicting the Risk of Stunting. *Tropical Public Health Journal*, *5*(2), 111-116.

http://doi.org/10.32734/trophico.v5i2.23835

ABSTRACT

Stunting remains a major public health problem in many low and middle income countries, including Indonesia. According to the 2022 National Nutrition Status Survey (SSGI), the national prevalence of stunting reached 21.6%, exceeding the World Health Organization threshold of 20% and remaining far from far the 2024 National Medium Term Development Plan (RPJMN) target of 14%. In South Sulawesi, the prevalence was even higher at 35.7%. Stunting not only impairs physical growth but also affects cognitive development, health status, and long-term productivity. This study aimed to anylize the spatial distribution and determinants of stunting by integrating Geographic Information System (GIS)-based spatial analysis with a case-control study design. A total 0f 200 respondents were included, consisting of 100 stunted children (case group) and 100 non stunted children (control group). Primary data were collected and analyzed using bivariate statistical tests, followed by GIS based mapping to identify high risk areas. The results showed that maternal and child health was significantly associated with stunting, (OR = 0.190; 95% CI: 0.053–0.684; p = 0.011), indicating a protective effect. In contrast, maternal parenting practices and education were not significantly associated with stunting (OR = 2.111; 95% CI: 0.928–4.805; p = 0.108), although a tendency toward increased risk was observed among mothers with poorer parenting practices and lower education levels. In conclusion, the integration of spatial analysis and epidemiological approaches provides a comprehensive understanding of stunting distribution and its determinants. Strengthening maternal and child health remains a key strategy in reducing stunting, particulary in identified high risk area.

Keywords: *Stunting, maternal and child health, spatial analysis, GIS, case control study*

1. Introduction

Stunting is a chronic form of malnutrition that advesley afects children's physical growth and growth and cognitive development, undermines future productivity, and increases the risk of Non-communicable diseases in adulthood (Black et al., 2013). Globally, the prevalence of stunting in children under five years decreased to 20% in 2020; however, this reduction has been uneven across regions, particularly in low and middle income countries (Development Initiatives, 2018). In Southeast Asia, stunting prevalence remains higher than the global average, reaching 24.7% in 2020. Indonesia ranks among the countries with the highest burden of stunting, placing fourth globally and second in Southeast Asia. Based on the 2022 National Nutrition Status Survey (SSGI), the national prevalence of stunting was recorded at 21.6%, exceeding the WHO threshold of 20% and failing to meet the RPJMN target of 14% by 2024 (Ministry of Health of the Republic of Indonesia, 2021), at the provincial level, South Sulawesi reported a prevalence of 35,7%, indicating a critical public health challenge that requires targeted interventions.

Although various national programs have been implemented to accelerate stunting reduction, substantial disparities persist across regions, districts, and communities. These disparities suggest that stunting is

influenced by complex and context specific factors, including socioeconomic conditions, maternal and child health, access to health services, environmental sanitation, and behavioral practices (Titaley et al., 2013). Numerous studies have examined individual determinants of stunting, such as parenting practices, maternal education, and household socioeconomic status; however, most of these studies have addressed these factors separately.

Evidence integrating spatial analysis with determinant factor analysis remains limited. *Geographic Information System* (GIS) based approaches can identify spatial patterns and high risk clusters stunting, thereby supporting more effective, location specific interventions. However, prior GIS studies have largely focused on mapping prevalance, with limited integration of comprehensive determinant analyses and insufficient discussion of implications for targeted interventions (Purwadi et al., 2022) (Mohammad et al., 2023).

Therefore, this study aims to integrate GIS based spatial analysis with a case control epidemiological design to analyze the distribution and determinants of stunting in Parepare City. By combining spatial mapping with maternal, child, and household level determinants, this study seeks to fill the existing research gap and provide evidence based insights for stunting prevention strategies tailored to local contexts.

2. Methods

This study employed a quantitative analytical observational design using a case–control approach integrated with Geographic Information Systems (GIS)-based spatial analysis. The study was conducted in Parepare City, Indonesia, a designated stunting locus area, from August to October 2025 across four subdistricts: Soreang, Bacukiki, Bacukiki Barat, and Ujung. The study population comprised children aged 0–59 months and their households residing in the study area. Cases were defined as stunted children (height-for-age z-score [HAZ] < −2 SD), while controls were non-stunted children (HAZ ≥ −2 SD) based on the WHO Child Growth Standards. A total of 200 participants were included (100 cases and 100 controls), with sample size determined using a case–control formula to ensure adequate statistical power.

Primary data were collected through structured interviews with mothers/caregivers using a standardized questionnaire covering maternal and child health (including antenatal care history and maternal health conditions), parenting and feeding practices, maternal education, and household socioeconomic characteristics. Anthropometric measurements were conducted using standardized procedures to obtain child length/height according to age. Household geographic coordinates were recorded using smartphone GPS (WGS84 datum).

Data analysis included descriptive statistics for respondent characteristics and bivariate analysis to examine associations between independent variables and stunting status, reported as odds ratio (OR) with 95% confidence interval. Spatial analysis was performed using QGIS (version 3.40.x LTR) by plotting household coordinate to map the distribution of stunting cases and to identify high risk areas.

This study involved direct contact with participants. Administrative permission was obtained from the Parepare City One-Stop Integrated Investment and Licensing Service (DPMPTSP) (Permit No. 698/IP/DPM-PTSP/7/2025; 14 July 2025). Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. The confidentiality and anonymity of participants were ensured throughout the study; no personal identifiers were recorded, and the data were stored securely and used solely for research purposes.

3. Results

The results are presented descriptively and analytically to illustrate respondent characteristics and the association between maternal and child health, parenting practices, maternal education, and the incidence of stunting.

Respondent characteristics

Based on the Table 1, the majority of mothers were aged 31-40 years, accounting for 45% in the case group and 55% in the control group. Most children were aged 25-36 months (26% in cases and 23% in controls), followed by those aged 37-48 months (24% in cases and 26% in controls). The distribution of child sex was relatively balanced between males and females in both groups.

Regarding household socioeconomics characteristics, most families reported a monthly income between ID 1,000,000 and IDR 3,000,000, representing 70% of the case group and 85% of the control group. The majority of respondents lived in nuclear family households, while a smaller proportion resided in extended family settings.

Association between determinants and stunting

Table 2 presents the bivariate analysis of factors associated with stunting. Good maternal and child health was significantly associated with lower odds of stunting (cOR 0.19; 95% CI 0.053–0.684; p=0.011). In

contrast, parenting practices and maternal education were not statistically significant, although the crude OR suggested a tendency toward higher odds of stunting among those with poorer parenting/education (cOR 2.11; 95% CI 0.928–4.805; p=0.108).

Table 1. Characteristics of study respondents

Characteristics	Case		Control	
	n	%	n	%
Mother's age (years)				
< 20	1	1,0	2	2,0
20–30	53	53,0	36	36,0
31–40	45	45,0	55	55,0
>40	1	1,0	7	7,0
Total	100	100,0	100	100,0
Child's age (months)				
0–6 months	4	4,0	5	5,0
7–12 months	6	6,0	24	24,0
13–24 months	32	32,0	30	30,0
25–36 months	25	25,0	23	23,0
37–48 months	24	24,0	13	13,0
49–59 months	9	9,0	1	1,0
Total	100	100,0	100	100,0
Sex				
Male	50	50,0	40	40,0
Female	50	50,0	60	60,0
Total	100	100,0	100	100,0
Monthly Family Income (IDR)				
< 1.000.000	5	5,0	9	9,0
1.000.000 – 3.000.000	70	70,0	86	86,0
> 3.000.000	25	25,0	5	5,0
Total	100	100,0	100	100,0
Household type				
Nuclear Family (Father, Mother, and Children)	68	68,0	62	62,0
Extended Family (Including grandparents, other relatives)	31	31,0	38	38,0
Single-Parent Family (one parent and one child)	1	1,0	0	0,0
Total	100	100,0	100	100,0

Table 2. Analysis of the Relationship Between Maternal and Child Health, Parenting Patterns, and Maternal Education with the Incidence of Stunting

Variable	Group		OR (95% CI)	P-value
	Case	Control		
	n (%)	n (%)		
Maternal and Child Health				
High	97 (97,0%)	86 (86,0%)	0,190 (0,053-0,684)	0,011
Low	3 (3,0%)	14 (14,0%)		
Parenting practices and maternal education				
Good	81 (81,0%)	90 (90,0)	2,111 (0,928-4,805)	0,108
Poor	19 (19,0)	10 (10,0)		

Spatial distribution of stunting risk

Figure 1 presents the spatial distribution of stunting cases (red) and mapped risk (green) across Parepare City. he map shows that cases are not evenly distributed and appear to concentrate in certain locations, indicating a non-random spatial pattern. This spatial distribution complements the epidemiological findings by highlighting priority areas that may benefit from targeted, location-specific interventions.

TROPHICO: Tropical Public Health Journal Vol.05, No.02 (2025) 111-116

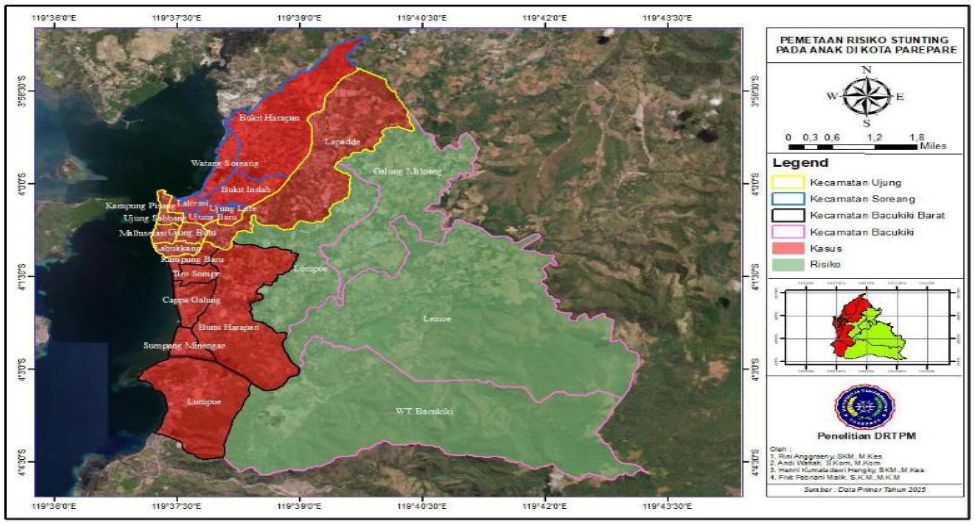

Figure 1. Spatial distribution of stunting cases (red) and risk areas (green) among children aged 0–59 months in Parepare City, 2025.

4. Discussion

This study found a significant association between maternal and child health and stunting, suggesting a protective relationship against growth failure. Children whose mothers/caregivers reported better maternal and child health conditions were less likely to be stunted than those with poorer health conditions. This finding underscores the importance of maternal health before and during pregnancy, as well as child health in early life, for achieving optimal growth outcomes.

The observed protective relationship may be explained by several mechanisms. Adequate maternal nutrition, regular antenatal care, and early detection of pregnancy-related complications contribute to improved fetal growth and birth outcomes, thereby reducing stunting risk. In addition, healthier children tend to experience fewer infectious diseases, which can impair nutrient absorption and linear growth. These findings are consistent with previous studies reporting maternal nutritional status, antenatal care utilization, and child morbidity as key determinants of stunting(Gudeta et al., 2023; Ibrahim et al., 2023; Maulina et al., 2024).

Furthermore, integrating spatial analysis strengthens interpretation by illustrating that stunting cases (red) and mapped risk areas (green) are not evenly distributed across Parepare City (Figure 1). Areas with higher concentrations of cases and risk may reflect unequal access to quality health services, differences in environmental conditions, or variations in community-level health practices. This spatial perspective supports geographically targeted interventions rather than uniform, population wide strategies

In contrast, parenting practices and maternal education were not statistically significant in this study, although the estimated odds ratio indicated a tendency toward increased risk among mothers with poorer parenting practices and lower education levels. This lack of statistical significance may be influenced by the relatively high proportion of respondents classified as having good parenting practices and education, which could reduce variability and statistical power to detect meaningful differences.

Similar findings have been reported in several studies showing no significant association between maternal education or parenting practices and stunting (Rosalina Madai et al., 2024; Shodikin et al., 2023). These studies suggest that, in certain contexts, the direct influence of parenting and education on child growth may be overshadowed by more proximal determinants, such as maternal and child health conditions or access to health services.

Importantly, maternal education and parenting practices may influence child growth through indirect pathways rather than exerting immediate effects on anthropometric outcomes. A quasi experimental study by (Anggraeny et al., 2025) demonstrated that integrating maternal health literacy interventions significantly improves mother's knowledge, attitudes, and health practices related to stunting prevention, although changes in nutritional status require longer term follow up. Consistently, a predictive study by (Hengky & Rusman, 2022) identified socioeconomic status and immunization as dominant determinants of stunting, while maternal education and parenting practices contribute indirectly to stunting prevention and are strongly mediated by structural and health service related factors.

However, contrasting evidence indicates that poor parenting practices, low maternal education, and lack of exclusive breastfeeding can increase the risk of stunting certain contexts (Erda et al., 2022; Sholikha et al.,

2025; Yulika et al., 2025). These discrepancies highlight the context specific nature of stunting determinants, shaped by interaction between social, cultural, and environmental, and health system factors.

Overall, this study confirms that stunting is a multifactorial and context specific problem. Strengthening maternal and child health services across the continuum of care should remain a primary strategy, while educational and behavioral interventions should be integrated with improvements in health services access and broader structural conditions.

5. Conclusion

This study found that maternal and child health was significantly associated with stunting, with better maternal and child health conditions linked to lower odds of stunting among children aged 0–59 months in Parepare City. In contrast, the combined indicator of parenting practices and maternal education was not statistically significant, although the crude odds ratio suggested a tendency toward higher stunting risk among respondents with poorer parenting/education profiles. These findings indicate that the role of parenting and education may be context-specific and may operate indirectly through access to and quality of maternal–child health services.

The integration of a case–control approach with GIS-based spatial mapping provides additional insight by visualizing the uneven spatial distribution of stunting cases and mapped risk areas, supporting geographically targeted interventions. Overall, stunting prevention should prioritize strengthening maternal and child health services, complemented by context-appropriate behavioral/educational strategies and improvements in environmental and service access conditions. Spatially targeted actions based on risk mapping may enhance the effectiveness and equity of stunting reduction programs.

6. *Acknowledgement*

We, the research team from Muhammadiyah University Pare-pare, would like to express our deepest gratitude to the Directorate of Research and Community Service (DPPM) of the Ministry of Higher Education, Science and Technology of the Republic of Indonesia for funding this research activity through the Early Career Lecturer Research scheme with contract number 130/C3/DT.05.00/PL/2025.

Bibliography

Anggraeny, R., Thamrin, S., Hengky, H. K., Thasim, S., & Syawal, S. (2025). Optimasi Integrasi Health Literacy Ibu Dalam Pencegahan Stunting Pada Anak Balita. *Jurnal Gizi Kerja Dan Produktivitas*, *6*(1), 1. https://doi.org/10.62870/jgkp.v6i1.30119

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., Ezzati, M., Grantham-Mcgregor, S., Katz, J., Martorell, R., & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, *382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Development Initiatives, 2018. (2018). Global Nutrition Report: Shining a light to spur action on nutrition. In *Global Nutrition Report* (Issue June). http://www.segeplan.gob.gt/2.0/index.php?option=com_content&view=article&id=472&Itemid=472

Erda, R., Alisyah, N. K., Suntara, D. A., & Yunaspi, D. (2022). *Hubungan Pola Asuh Ibu , Pendidikan Ibu , dan Asi Eksklusif dengan Kejadian Stunting pada Balita The Relationship of Mothering Parenting Patterns , Mother Education , and Exclusive Breast Milk With Stunting Events in Toddlers*. *6*(2), 310–316.

Gudeta, H. T., Nagari, S. L., Dadi, D. G., Abdulahi, T., & Abose, S. (2023). Predictors of Stunting among 6-35 Months Old Children in Assosa Zone, Northwest Ethiopia: Unmatched Case-Control Study. *Advances in Public Health*, *2023*. https://doi.org/10.1155/2023/3491977

Hengky, H. K., & Rusman, A. D. P. (2022). Model Prediksi Stunting di Kota Parepare. *Jurnal Ilmiah Kesehatan*, *4*(2), 309–318.

Ibrahim, N. I. F., Khomsan, A., & Riyadi, H. (2023). Stunting is influenced by toddler and maternal characteristics, history of infectious disease, IYCF practices, and protein intake: case control study in Nabire coastal areas, Indonesia. *International Journal Of Community Medicine And Public Health*, *10*(9), 3039–3046. https://doi.org/10.18203/2394-6040.ijcmph20232658

Maulina, R., Qomaruddin, M. B., Prasetyo, B., & Indawati, R. (2024). Maternal Complications during Pregnancy and Risk Factors for Stunting. *Iranian Journal of Nursing and Midwifery Research*, *29*(3), 309–313. https://doi.org/10.4103/ijnmr.ijnmr_358_22

Ministry of Health of the Republic of Indonesia. (2021). *Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tingkat Nasional, Provinsi, dan Kabupaten/Kota Tahun 2021*.

Mohammad, M. I., Hermanda, A. M., Karmanto, B., & Khasanah, L. (2023). Pemetaan Distribusi Prevalensi dan Faktor Risiko Stunting dengan Sistem Informasi Geografis Kota Cirebon: Laporan Data. *Health*

Information : Jurnal Penelitian, *15*(3), e925. https://doi.org/10.36990/hijp.v15i3.925

Purwadi, H. N., Oktaviani, D., & Latief, K. (2022). Determinan Faktor Risiko Kejadian Stunting Berdasarkan Pemetaan Kasus Stunting pada Balita dengan Geographic Information System (GIS). *Faletehan Health Journal*, *9*(3), 320–326. https://doi.org/10.33746/fhj.v9i3.221

Rosalina Madai, Nur Al-faida, & Bau Kanang. (2024). The Relationship Between Education, Knowledge and Parenting Patterns of Mothers Towards The Incidence of Wasting in Toddlers. *International Journal of Public Health*, *1*(4), 132–153. https://doi.org/10.62951/ijph.v1i4.205

Shodikin, A., Mutalazimah, Muwahhidah, & Mardiyati, N. . (2023). Tingkat Pendidikan, Tingkat pengetahuan dan Pola Asuh Ibu dengan Wasting dan Stunting pada Balita Usia 24-59 Bula. *Journal of Nutrition College*, *12*(1), 33–41.

Sholikha, S., Muthoharoh, H., Muslim, D. A., & El, H. M. (2025). *Analysis of the Relationship between Parenting Patterns and Supplementary Feeding on Stunting Incidence in Gedungboyountung Village*. *11*(2). https://doi.org/10.21070/midwiferia.v11i2.1749

Titaley, C. R., Ariawan, I., Hapsari, D., & Muasyaroh, A. (2013). Determinants of the Stunting of Children in Indonesia : A Multilevel Analysis of the 2013 Indonesia Basic Health Survey. *Nutrients*, *11*, 1160.

Yulika, M., Syah, N. A., & Yusrawati, Y. (2025). Maternal determinants of stunting: findings from a cross-sectional study in Padang, Indonesia. *BKM Public Health and Community Medicine*, *41*(3), e11556. https://doi.org/10.22146/bkm.v41i03.11556