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Original Article

Spatial Analysis of Stunting Cases and Accessibility to Supplementary Feeding Programs in Godong, Central of Java, Indonesia

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ABSTRACT
Stunting is a chronic nutritional problem with long-term impacts on human capital. Godong Subdistrict, Grobogan Regency, had a stunting prevalence of 20.78% in 2023, exceeding the WHO threshold. This study aims to analyze the distribution patterns of stunting cases, identify regional clusters, and evaluate community accessibility to Supplementary Feeding Program (PMT) posts using a spatial approach based on Geographic Information Systems (GIS). The data used includes the number of stunting cases per village, the locations of PMT posts, as well as spatial data on administrative boundaries and road networks. Analyses were conducted using Moran's I for global spatial autocorrelation, Getis-Ord Gi* for hotspot clustering, and buffer analysis to measure accessibility. The results indicate that the distribution pattern of stunting in Godong Subdistrict is random, although certain villages were identified as hotspots. Accessibility analysis showed that most villages are within a 1–2 km radius of a PMT post; however, there are still villages on the periphery of the area with limited access. These findings underscore the importance of spatial mapping to identify priority areas for intervention, ensuring that stunting reduction programs can be more effective and equitable.

KEYWORDS
Stunting, Accessibility, Regional Clusters, Spatial Analysis

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INTRODUCTION

Stunting is a chronic nutritional problem characterized by growth failure in young children, particularly during the first 1,000 days of life. Stunted children have below-average height and are at risk of cognitive, motor, and immune system impairments into adulthood (Devi et al., 2024). The causes of stunting are not only related to insufficient postnatal nutritional intake but are also influenced by the nutritional status of pregnant women, parenting practices, and environmental sanitation (Mufida & Fahmi, 2024a). The long-term impacts of stunting include reduced learning ability, decreased work productivity, and increased vulnerability to degenerative diseases in adulthood (Nugroho et al., 2025a). Thus, stunting is not merely a public health issue

but also a long-term human resource development challenge.

According to the results of the 2022 Indonesia Nutrition Status Survey (SSGI), the prevalence of stunting in Indonesia stood at 21.6%, down from 24.4% in 2021; however, this figure remains above the WHO's maximum threshold of 20% (Ministry of Health of the Republic of Indonesia, 2022). The government aims to reduce this to 14% by 2024 through specific interventions (PMT for pregnant women and infants) and sensitive interventions (clean water, sanitation, nutrition education) (Puspitasari et al., 2023). The success of the program is highly dependent on the availability of village health services and community participation (Nugroho et al., 2025a). Previous research has largely highlighted nutritional factors, child-rearing practices, and socio-economic conditions as the primary causes of stunting; however, few studies have emphasized the spatial aspects in measuring access to nutrition services in rural areas (Mufida & Fahmi, 2024; Nugroho et al., 2025). Therefore, strengthening interventions in remote areas is a critical priority to ensure sustainable and equitable reduction in stunting.

Central Java Province is a priority for intervention due to its stunting prevalence of 20.8% (Central Java Provincial Health Office, 2024). Grobogan Regency is among the areas with a significant stunting prevalence rate, influenced by the community's socioeconomic conditions, limited access to health facilities, and geographical variations across regions (Khotimah, 2022). Research by Saputri & Tumangger (2019) indicates that villages located far from health service centers are at higher risk of having a high stunting prevalence. Similar studies also emphasize the importance of access to basic services, but few have integrated spatial analysis with detailed measurements of distances to PMT management posts (Kartini & Ummah, 2022; Sakti et al., 2023). This underscores that there remains a research gap in examining the relationship between the spatial distribution of nutrition services and stunting prevalence at the village level.

Godong Subdistrict is one of the areas in Grobogan Regency with a high prevalence of stunting, at 20.78% in 2023 (Grobogan Regency Health Office, 2024). The subdistrict consists of 28 villages, with the majority of the population consisting of farmers. Some villages are located in remote areas with uneven distribution of health services, which poses a challenge for the supplementary feeding program (PMT) (Devi et al., 2025). Previous research has largely focused on socioeconomic factors and health conditions as determinants of stunting prevalence (Ghazali et al., 2022; Rahma et al., 2023; Salsabila et al., 2024). However, few have integrated a geospatial approach to examine the relationship between case distribution, regional clusters, and accessibility to PMT management posts. The novelty of this study lies in the use of spatial analysis that combines prevalence mapping, cluster identification using statistical methods, and buffer analysis to measure the reach of nutrition services at the village level. With this approach, this study is expected to provide a more comprehensive picture of spatial disparities in stunting in Godong Subdistrict

METHOD

Research Location

The study was conducted in Godong Subdistrict, Grobogan Regency, Central Java, which comprises 28 villages and had a total percentage of toddlers suffering from stunting of 20.78% in 2023.

Research Approach

The approach used was a quantitative descriptive method with spatial analysis based on Geographic Information Systems (GIS) using ArcGIS software. The focus was on mapping the distribution patterns of stunting cases, analyzing community access to PMT posts, and identifying clusters of cases.

Data Collection Tools

The research instruments and materials used consisted of hardware and software supporting spatial analysis, as well as secondary data from official sources. A laptop was used as the primary device, supported by Google Earth Pro software to obtain the coordinates of PMT management posts, Microsoft Excel for numerical data processing, and ArcGIS for spatial analysis, including the calculation of the Moran's I index, hotspot analysis (Getis-Ord Gi*), and buffer analysis.

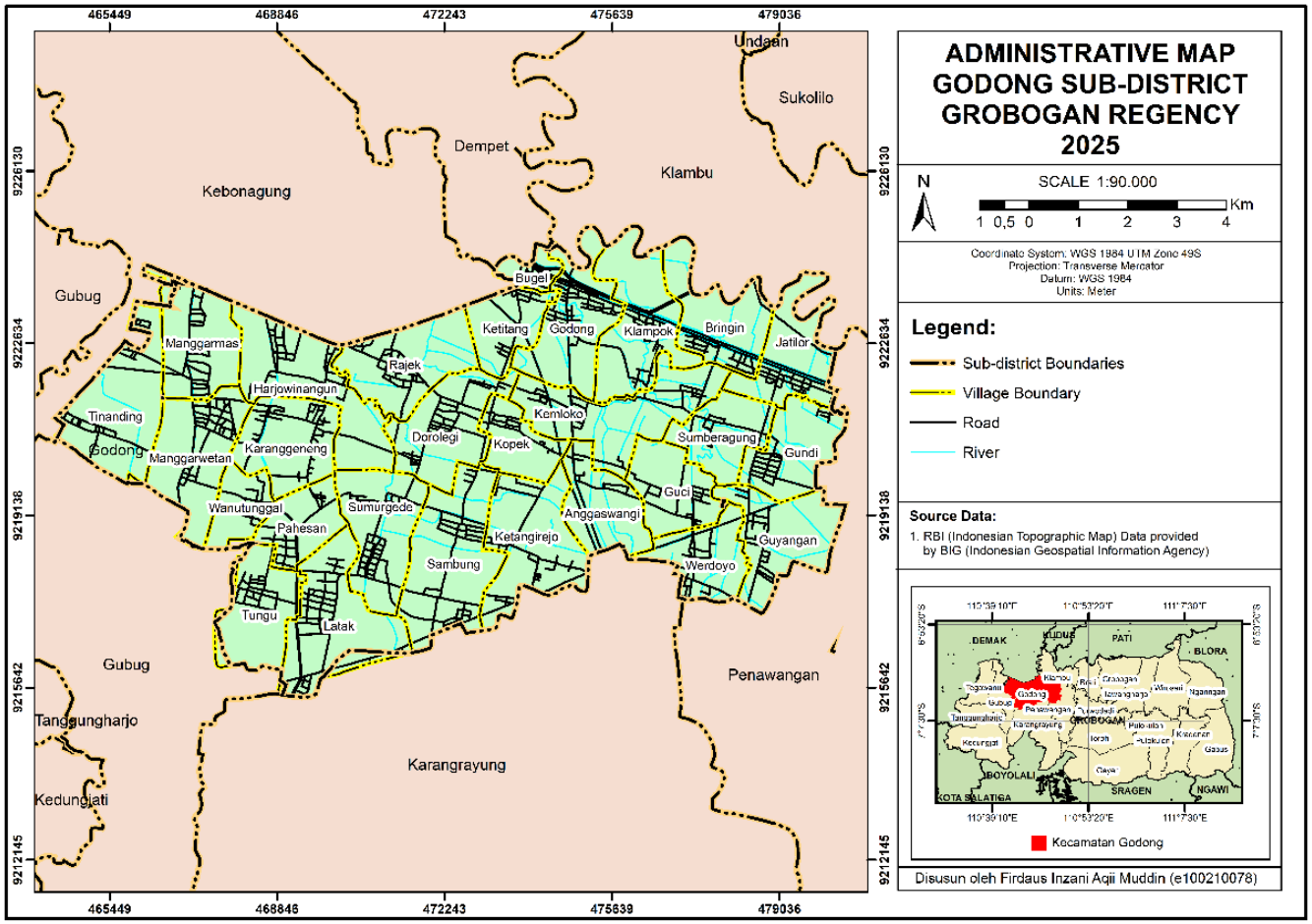

Figure 3. Godong District Administration

The research data consisted of stunting rates per village in Godong Subdistrict obtained from the Central Statistics Agency (BPS) of Grobogan Regency; data on the location and accessibility of PMT posts sourced from PMT managers' reports and coordinate mapping; and spatial data in the form of village administrative boundary maps and road networks from the National Geospatial Information Agency (BIG) and relevant local agencies.

Research Procedures

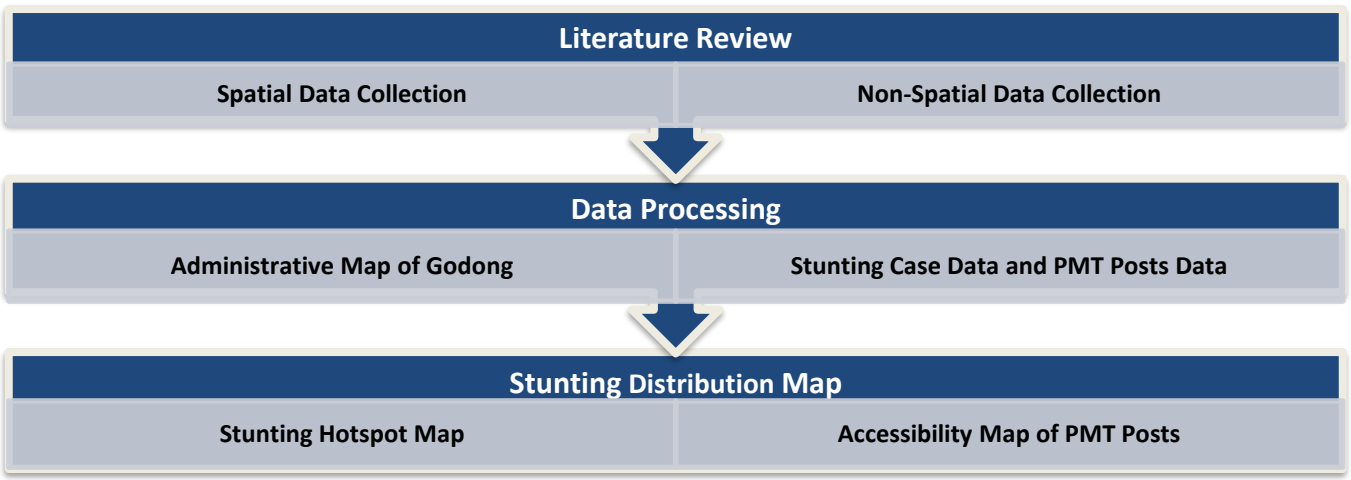

Figure 2. Research Flowchart

Data Analysis

Analysis of the Distribution Patterns and Regional Clusters of Stunting Cases

Spatial analysis was conducted using Moran's I to measure global spatial autocorrelation. Positive values indicate clustering, negative values indicate dispersion, and values close to zero indicate randomness. The formula for calculating Moran's I is:

$$I = \frac{n}{W} \cdot \frac{\sum_i \sum_i \omega ij\,(xi - x)(xj - x)}{\sum_i (xi - x)^2}$$

Where n = the number of spatial units (villages), xi, xj = prevalence values at locations i and j, x = the average prevalence value, wij = the spatial weight between villages, and W = the total weight.

The Moran's I value is interpreted as follows:

- I > 0: shows a pattern (*clustered*),
- I < 0: shows a pattern (*dispersed*),
- I ≈ 0: shows a pattern (*random*).

As a follow-up analysis, the Hotspot Analysis method (Getis-Ord Gi*) was used to identify areas with high concentrations of stunting cases. The formula for calculating Gi* is:

$$Gi* = \frac{\sum_j wijxj - \bar{X} \sum_j wij}{S\sqrt{\frac{n \sum_j \omega_{ij}^2 - (\sum_j \omega_{ij})^2}{n-1}}}$$

where xj = the prevalence of stunting

vilage j, wij = spatial weight, $\bar{X}$ = average prevalence,

S = standard deviation of all values, n = number of villages.

The interpretation is as follows:Z-score tinggi signifikan (p < 0,05) = hotspot,

- Z- significantly low score (p < 0,05) = coldspot,
- Z- The score is not significant = excluding clusters.

Analysis of Accessibility at the PMT Post

Community accessibility was analyzed using a buffer analysis with specific radii (500 m, 1 km, 2 km) from the PMT post locations. The buffer was overlaid with village data to identify areas within or outside the coverage area. The results of the analysis identified served and unserved villages, and served as the basis for determining priority areas for nutrition interventions.

RESULTS AND DISCUSSION

Results

Distribution and Regional Clusters of Stunting Prevalence

The map of stunting prevalence in Godong Subdistrict in 2025 shows variations in prevalence rates among villages. The categories used are low (<10%), moderate (10–15%), and high (>15%). Villages with high prevalence include Rajek, Bringin, Anggaswangi, Ketangirejo, Guci, and Wanutunggul, most of which are located in the central and eastern parts of the subdistrict. Conversely, villages with low prevalence, such as Latak and Tungu, are more commonly found in the southern part. This variation illustrates that the distribution of stunting cases in Godong Subdistrict is not uniform across regions but forms a pattern indicating concentrations at specific points. A clearer picture of the distribution of stunting prevalence can be seen in Figure 3. Map of Stunting Prevalence Distribution below

The Moran's I analysis, used to measure global spatial autocorrelation, yielded a value of -0.112. This value indicates that the distribution of stunting cases in Godong Subdistrict tends to be random or does not form significant clusters among villages. Thus, villages with high prevalence are not always located near other villages with high prevalence, and vice versa. These results show that, in general, there is no strong spatial relationship between regions in terms of the distribution of stunting cases, so the distribution pattern is more diffuse and does not follow geographical proximity. A visualization of these analysis results can be seen in Figure 4. Moran Scatterplot below .

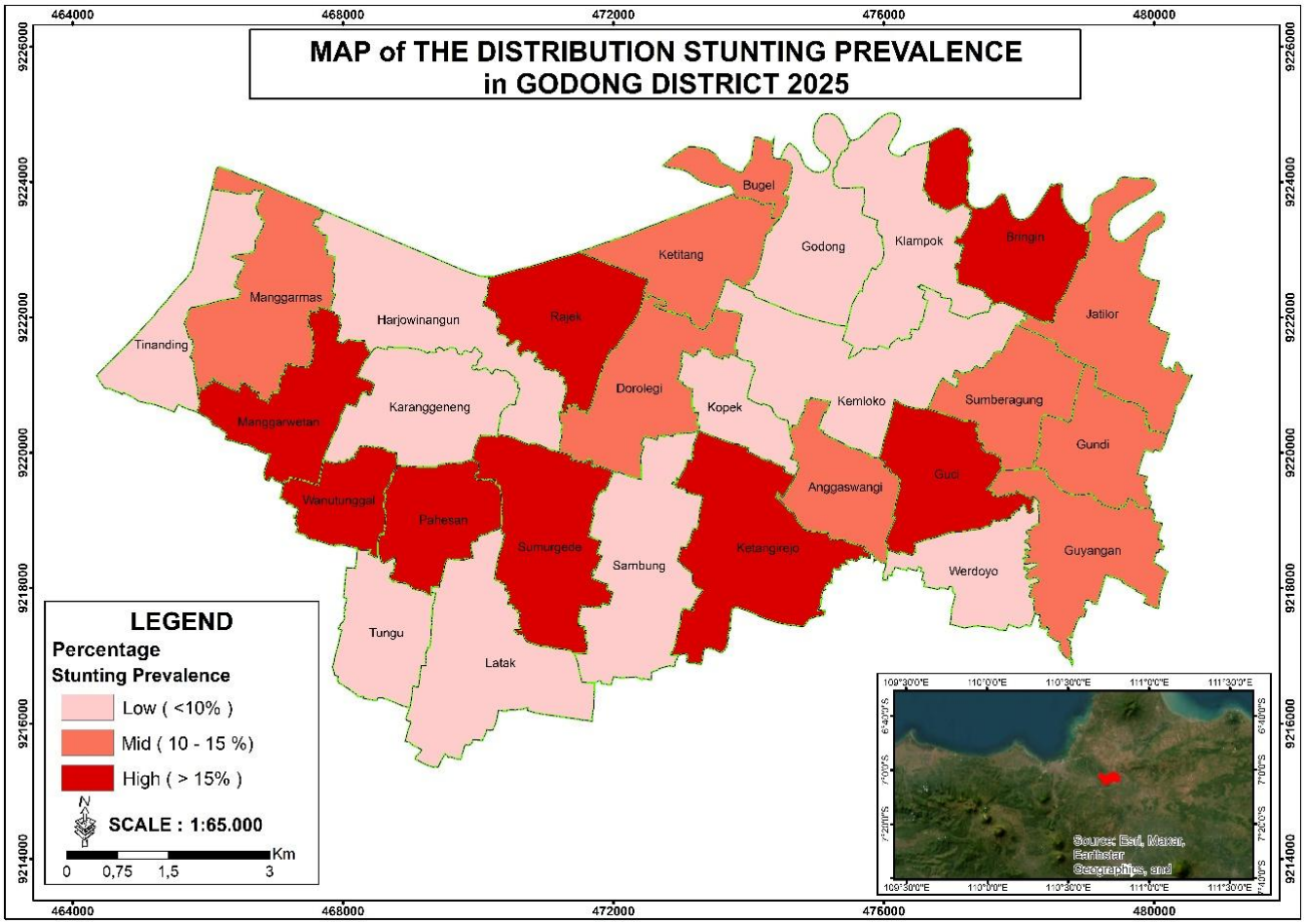

Figure 3. Map of Stunting Prevalence
Sumber: Analisis Peneliti, 2025

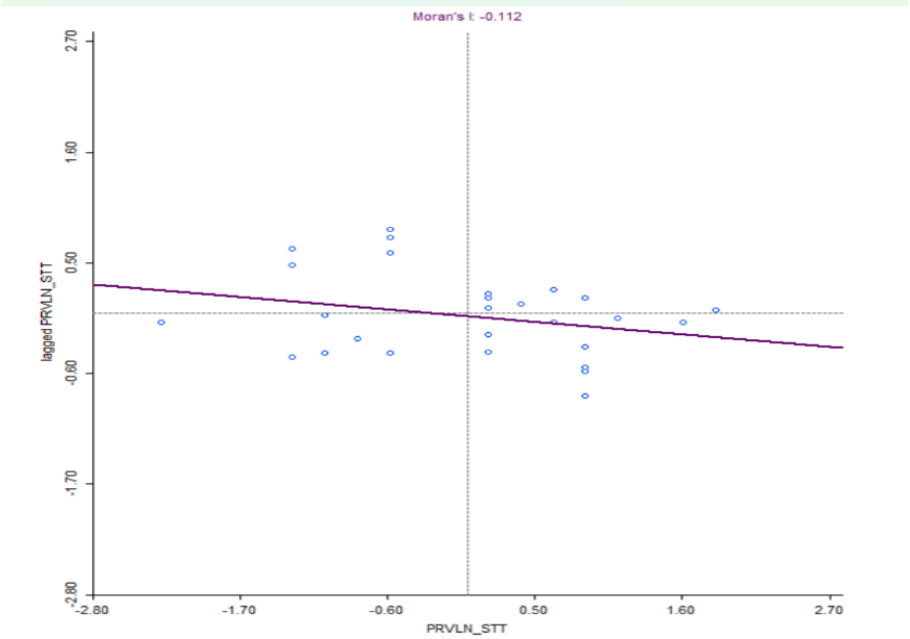

figure 4. Moran Scatterplot
Source: Researcher's Analysis, 2025

The 2025 stunting prevalence hotspot map shows the results of an analysis using the Getis-Ord Gi* method. Based on these results, one village was identified as a stunting hotspot: Wanutunggul Village, with a significance level of 90%. Additionally, Latak Village was identified as a coldspot, while the other villages fell into the non-significant category. This situation indicates that although the distribution of stunting is generally random, certain villages exhibit higher or lower concentrations of cases compared to neighboring villages. This makes Wanutunggul and Latak stand out on the stunting distribution map for Godong Subdistrict. These analysis results are clearly illustrated in Figure 5: Stunting Prevalence Cluster Map.

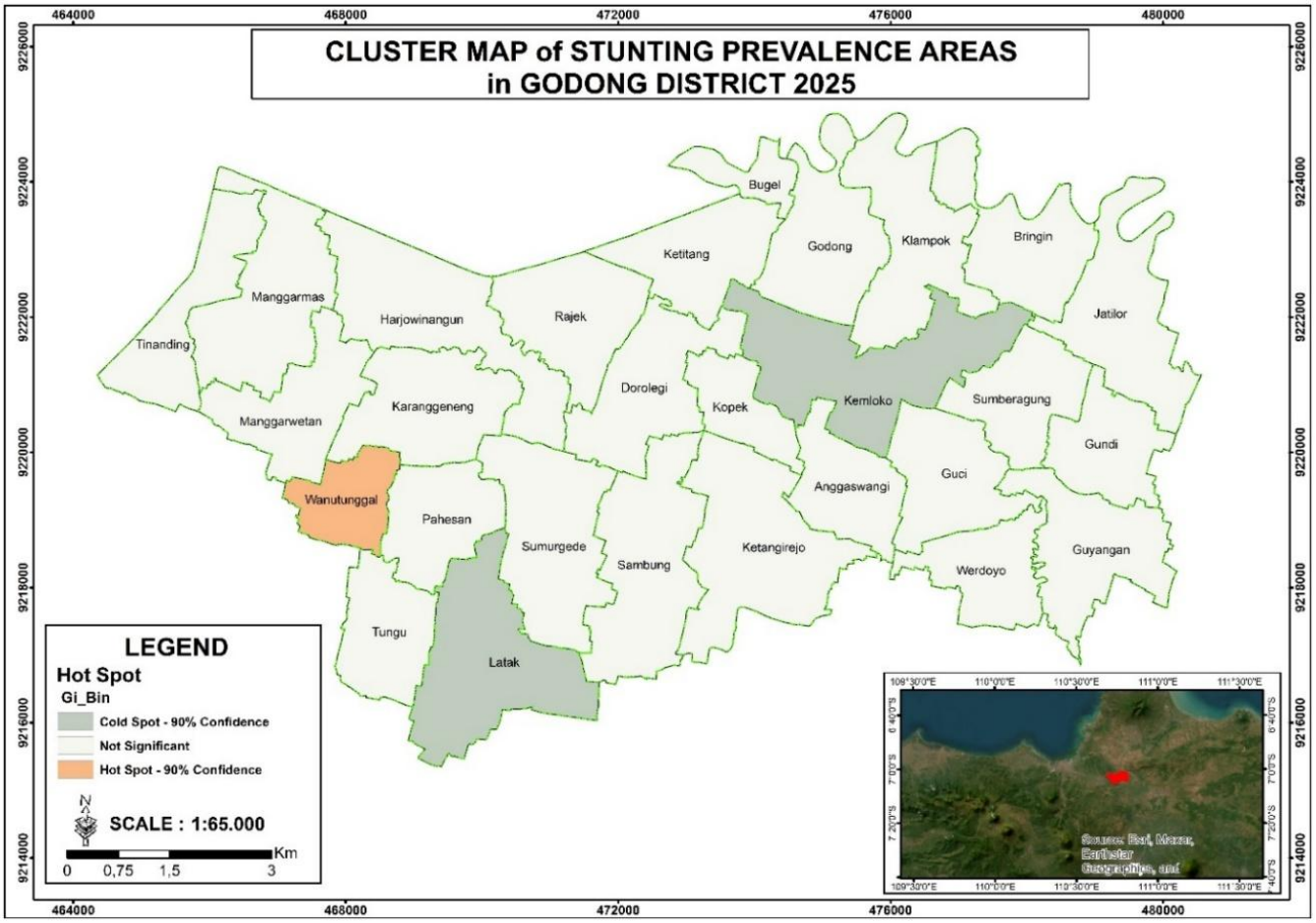

Figure 5. Map of Stunting Prevalence Clusters
Source: Researcher's Analysis, 2025

Analysis of Accessibility Buffers for PMT Management Posts

The 2025 buffer map of PMT management posts in Godong Subdistrict illustrates service coverage within radii of 500 meters, 1 kilometer, and 1–2 kilometers. The analysis results show that most villages are within a 1–2 kilometer radius, meaning that community access to PMT posts varies considerably. Villages such as Ketangirejo, Pahesan, and Latak are located within a closer distance, while villages on the sub-district's periphery, such as Bringin, Jatilor, and Tunggul, lie outside the optimal service area. This situation indicates that the distribution of PMT management posts has reached most areas, but there are still variations in the distances residents must travel between villages. A visualization of this analysis can be seen in Figure 6: Buffer Map of PMT Management Posts.

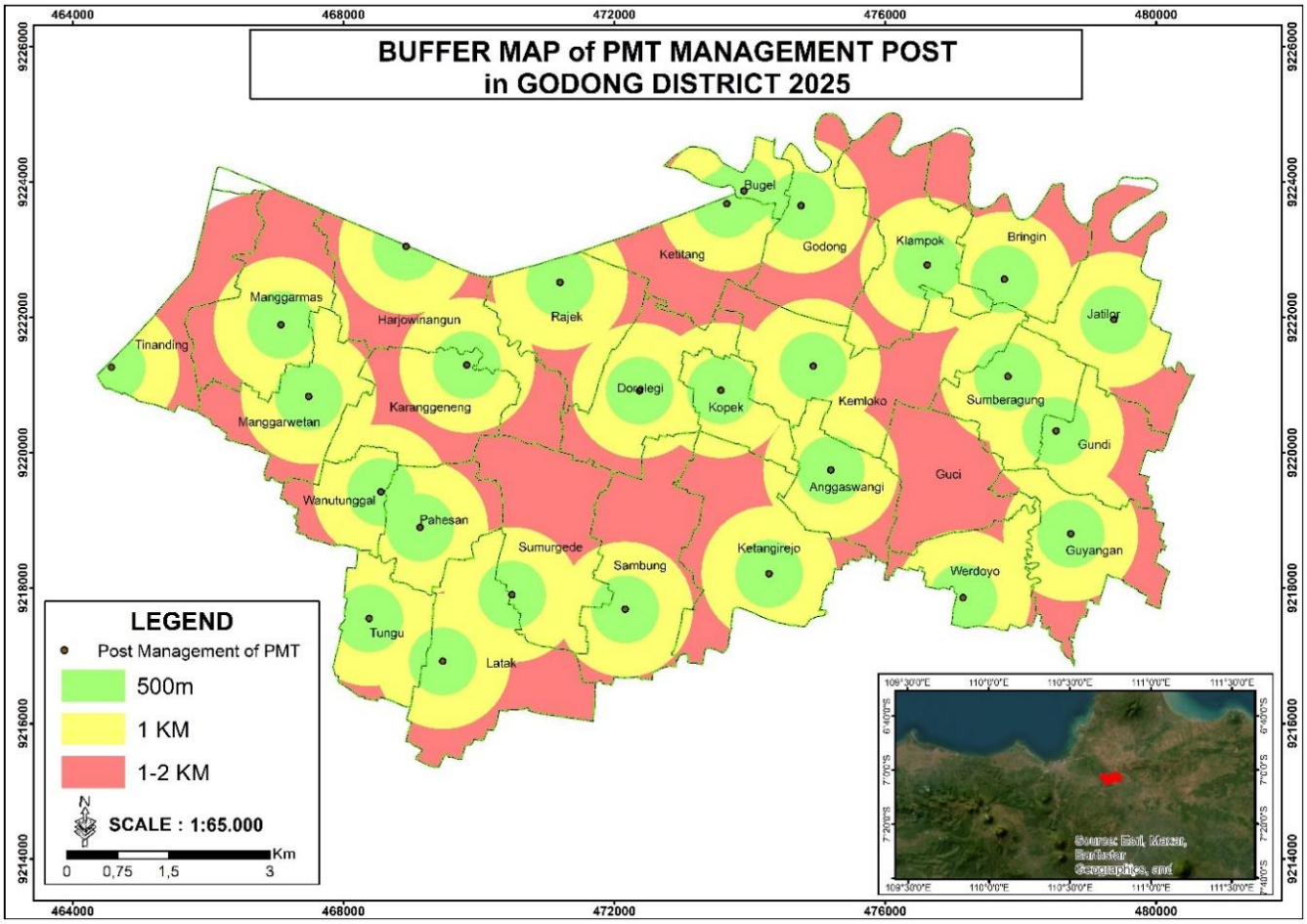

Figure 6. Map of PMT Management Post Buffers
Source: Researcher's Analysis, 2025

Discussion

Analysis of the Spatial Distribution and Regional Clusters of Stunting Prevalence

Variations in stunting prevalence across villages in Godong Subdistrict reflect differences in social, economic, and health conditions that influence incidence rates. Villages with high prevalence, such as Rajek, Bringin, Anggaswangi, Ketangirejo, Guci, and Wanutunggul, tend to have limited access to nutritional interventions, low parental education levels, and inadequate sanitation. Conversely, villages with low prevalence, such as Latak and Tungu, demonstrate relatively better conditions in terms of both health services and the environment. This disparity illustrates a fairly significant geographic disparity. Previous studies have shown that differences in socioeconomic conditions and inequities in health services are significant determinants of high stunting prevalence in rural areas. (Beal et al., 2018; Guagliardo, 2004; Salsabila et al., 2024b). Geographical factors also play a major role, as areas with less supportive environmental conditions and those located far from health service centers tend to experience higher stunting prevalence. (Ayuningtyas et al., 2022). Therefore, villages with high prevalence rates need to be the focus of attention in planning interventions based on local conditions

The results of the global spatial autocorrelation analysis using the Moran's I index showed a value of -0.112 with a weak level of significance. This figure indicates that the distribution of stunting cases in Godong Subdistrict does not form a strong cluster pattern but is rather random in nature. In other words, villages with high prevalence are not always adjacent to other villages with high stunting rates, and villages with low prevalence are not always adjacent to similar villages. This suggests that the factors playing a major role in influencing stunting rates stem more from the internal conditions of each village, such as the quality of food intake, family caregiving practices, environmental sanitation, and access to health services. These findings align with

previous research that also found no significant spatial autocorrelation in the distribution of stunting in other regions, such as Jombang Regency (Istiqlala & Fahmi, 2024). This underscores that global spatial analysis alone is not enough, and that a local approach is needed to identify villages that should be prioritized for intervention (Arbiyan et al., 2023).

Although the global analysis indicates a random distribution pattern, the local analysis using the Getis-Ord Gi* method reveals a concentration of cases in specific areas. The analysis results identify Wanutunggul Village as a stunting hotspot with a 90% significance level, while Latak Village was detected as a coldspot. Other villages did not show a significant level, so the distribution of cases remains generally random. The existence of these hotspots is important because it highlights villages with higher case counts compared to others, making them stand out on the distribution map. The concentration of cases in Wanutunggul may be caused by environmental factors, socioeconomic conditions, or limited health services (Noeris et al., 2023). Previous studies have also emphasized that access to clean water, adequate sanitation, and household income levels are closely linked to the emergence of stunting hotspots. Thus, although the distribution pattern is generally random, local analysis is very useful for identifying areas of concentration that warrant further attention (Murad et al., 2022; Sipahutar et al., 2021).

Identifying stunting hotspots has significant implications for intervention planning strategies. Villages identified as hotspots, such as Wanutunggul, require special attention in terms of resource allocation and the implementation of intervention programs. The results of cluster-based spatial mapping can be used to prioritize villages in need of immediate intervention, thereby ensuring that program implementation is more targeted. Previous studies have shown that spatial mapping is effective in health intervention planning because it can guide the distribution of resources more efficiently. Thus, this approach enables stunting mitigation efforts to be more focused and sustainable, given the limited resources available to local governments. (Anselin, 1995; Hidayati et al., 2023; Nurul Fajri et al., 2025). In addition, hotspot analysis can provide a solid basis for formulating more specific local policies tailored to the needs of each region (Salsabila et al., 2024b).

Analysis of Accessibility Buffers for PMT Management Posts

The buffer analysis used in this study shows that the service coverage of PMT management posts in Godong Subdistrict falls within a radius of 500 meters, 1 kilometer, and 1–2 kilometers. The analysis results indicate that most villages are within a 1–2 kilometer radius of a PMT post. Some villages are closer, but there are also villages that are relatively far from the optimal coverage area. This pattern indicates that the distribution of PMT posts in Godong Subdistrict is not yet fully equitable, as there are still areas outside the service coverage. This situation results in variations in the ease with which communities can access nutrition services. Several previous studies have confirmed that buffer analysis is an effective method for identifying spatial access gaps to health and nutrition services, and can thus serve as a basis for determining which villages require additional or adjusted services (Arbiyan et al., 2023; Nur Taufiqurrahman et al., 2024; Sipahutar et al., 2021).

The limited reach of PMT service points has a tangible impact on community participation rates. Villages located a considerable distance from service points generally face difficulties in utilizing the program on a regular basis. Distance is one of the key determinants of a nutrition program's success because it is directly linked to community attendance at activities. The greater the distance that must be traveled, the lower the level of community participation.(Nugroho et al., 2025a; Purnama, 2025). Studies in other regions have also shown similar results, namely that long distances from service centers reduce the effectiveness of PMT program implementation. Therefore, spatial accessibility to nutrition services is one of the key factors that must be considered in planning stunting reduction programs at the local level (Nur Taufiqurrahman et al., 2024).

The uneven distribution of PMT services in Godong Subdistrict highlights the need for strategies to ensure equitable access to nutrition services so that no village is left behind. One strategy that can be implemented is the establishment of additional service points in strategic locations or the provision of mobile services for villages with limited accessibility. This approach can be designed based on spatial mapping results to ensure a more equitable distribution of the program. Several studies have shown that spatially-based nutrition interventions can improve the effectiveness of outreach to previously underserved areas. (Gusti & Anggani, 2025; Nurul Fajri et al., 2025; Trimono et al., 2025). This approach is also consistent with the concept of location-based

development, which emphasizes the importance of equitable access to health services and the reduction of disparities between regions. Through the implementation of a well-planned spatial strategy, it is hoped that the stunting reduction program can operate more efficiently and reach all segments of the community in Godong Subdistrict (Devi et al., 2024; Septiyaningsih et al., 2019).

CONCLUSSION

This study shows that the prevalence of stunting in Godong Subdistrict remains relatively high and varies across villages. Moran's I analysis indicates a distribution pattern of cases that tends to be random, although there is one village that stands out as a significant hotspot: Wanutunggul Village. This confirms that internal village factors, such as food access, socioeconomic conditions, sanitation, and the availability of nutrition services, have a more dominant influence on stunting than spatial proximity between areas. The results of the buffer analysis show that most villages are within a 1–2 km radius of a PMT management post, although there are still villages on the outskirts of the subdistrict with limited access.

These findings confirm the existence of disparities in the distribution of nutrition services, which have implications for the effectiveness of stunting reduction programs. Therefore, the equitable distribution of services through the addition of PMT posts or the provision of mobile services is essential, accompanied by education on nutrition, sanitation, and community parenting practices. The limitations of this study lie in the use of secondary data covering a one-year timeframe and the lack of comprehensive inclusion of other socioeconomic variables. For future research, it is recommended to integrate primary data through field surveys, conduct longitudinal analyses, and include socioeconomic and cultural variables to provide a more comprehensive picture in support of spatially-based stunting reduction intervention strategies.

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Conflict of interest The author has no competing interests to declare that are relevant to the content of this article.

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