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Spatial Autocorrelation Analysis to Identify Hotspots of Stunting Cases in Kerinci Regency

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ABSTRACT

There has been a reduction in the prevalence of stunting nationally, the prevalence is still high in several regions, including Kerinci Regency. This study used spatial autocorrelation analysis to identify hotspots for stunting cases in Kerinci Regency, Jambi Province. The research aimed to pinpoint specific regions with high prevalence of stunting in 2019, 2020, and 2021, highlighting the importance of tailored interventions at the village level to combat stunting effectively. This research utilized data on stunting cases sourced from the community-based nutrition recording and reporting system (e-PPGBM) from 2019 to 2021. Spatial autocorrelation analysis was conducted using the global and local indicator for spatial autocorrelation (LISA) with the village as the analysis unit. This study found the Moran Index values in 2019, 2020, and 2021 were 0.148, 0177, and 0.238, respectively. Hotspots were found in specific regions of the regency in each year, with shifts in distribution patterns observed. In 2019, hotspots were in the southwest region, in 2020, in the central part. And in 2021 in the southwest region. These findings highlight the importance of targeted interventions at the village level to address issues effectively. Continued monitoring and targeted efforts are crucial to address the shifting patterns and improve the overall nutritional status of the population.

INTRODUCTION

Stunting remains a significant public health challenge globally. Unicef, WHO, and the World Bank in their joint report in 2022 found 22.3 percent of the total under-five in the world with more than half of stunted children live in Asia (UNICEF et al., 2023). WHO also reported that 27.4 percent of stunted children under-five children live in the Southeast Asia Region. Indonesia as the largest economy in Asean ranks second with the highest stunting cases after Timor Leste with a stunting prevalence of 31.8 percent (UNICEF, 2021; World Bank, 2022). At the global level, it is estimated that there will be 128.5 million stunted children if the current trend of reducing stunting prevalence is not accelerated until 2030 (UNICEF et al., 2023).

Stunting is simply defined as a child with a height that is not appropriate for their age (UNICEF et al., 2023). Stunting is a major nutrition problem facing Indonesia (Kementerian Kesehatan RI, 2018). Indonesia, including Kerici Regency, is experiencing high prevalence despite some reduction over time. Data reported by national health survey of Indonesian government (Riskesdas) indicates a 6.4 percent decrease in stunting prevalence over a 5-year period from 37.2 percent in 2013 to 30.8

percent in 2018 (Kemenkes RI, 2019; Tim Riskesdas, 2019). In 2022, based on the report from the Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting was 21.6 percent (Kemenkes RI, 2022). The number of stunting cases in Indonesia has decreased, but the decrease has not met the national target of 14 percent (Kemenko PMK, 2023).

Jambi Province is one of the provinces in Indonesia with a moderate prevalence of stunting. The prevalence of stunting in Jambi Province according to Riskesdas report in 2018 was 30 percent. Indonesian Nutrition Status Survey report in 2022 placed Jambi Province at the 7th lowest with a prevalence of 18 percent. The district with the highest prevalence of stunting in Jambi Province is Batanghari District (Kemenkes RI, 2022). The 2018 Riskesdas results placed Kerinci Regency as the district with the highest stunting prevalence of 57.64 percent, but in 2022 based on the SSGI results Kerinci Regency's position is now in 4th position with a stunting prevalence of 24.2 percent. (Badan Penelitian dan Pengembangan Kesehatan Provinsi Jambi, 2018; Kemenkes RI, 2022). When referring to the national target, this figure is still categorized as high.

Spatial analysis of stunting is crucial as it provides a better understanding of the issue at local level, allowing for more targeted interventions in specific areas with high prevalence of stunting (Sipahutar et al., 2022). Factors such as genetic predisposition, environmental conditions, sociodemographic, and access to healthcare services may contribute to the formation of hotspots in certain regions (Kusumajaya et al., 2023; Suratri et al., 2023; Vilcins et al., 2018). The identification of hotspots through spatial analysis allows for the allocation of resources and interventions to areas with the highest concentration of stunting cases (Bharti et al., 2019). By focusing on these hotspots, public health authorities can implement targeted programs that address the specific needs of the affected communities, leading to more efficient and impactful interventions. Additionally, the dynamic nature of hotspots, as observed in the shifting patterns over the years, underscores the importance of continuous monitoring and adaptation of intervention strategies to effectively combat stunting in Kerinci Regency.

Spatial analysis plays a crucial role in identifying hotspots of stunting cases in Kerinci Regency, providing valuable insights for public health decision-making and intervention planning. By understanding the spatial distribution, policymakers and healthcare providers can tailor interventions to address the specific needs of high-risk areas, ultimately working towards reducing the burden of stunting and improving the health outcomes of children in Kerinci Regency. Therefore, it is hoped that this research can help in planning and making better decisions for stunting cases which are emphasized in efforts to prevent and control stunting. This background made us interested in conducting a study with the aim of finding out the hotspots for stunting cases in Kerinci Regency 2019-2021.

METHODS

Research design and study area

This research analyzed 285 villages and 2 urban villages under 16 sub-districts in Kerinci Regency. The research was conducted in Kerinci Regency, which is located in the western part of Jambi Province. Kerinci District borders West Sumatra Province. Kerinci Regency is located at 01 41' to 02 26' south latitude and 101 08' to 101 40' east longitude. The total area is 3328.14 km^2 (BPS Kab. Kerinci, 2021).

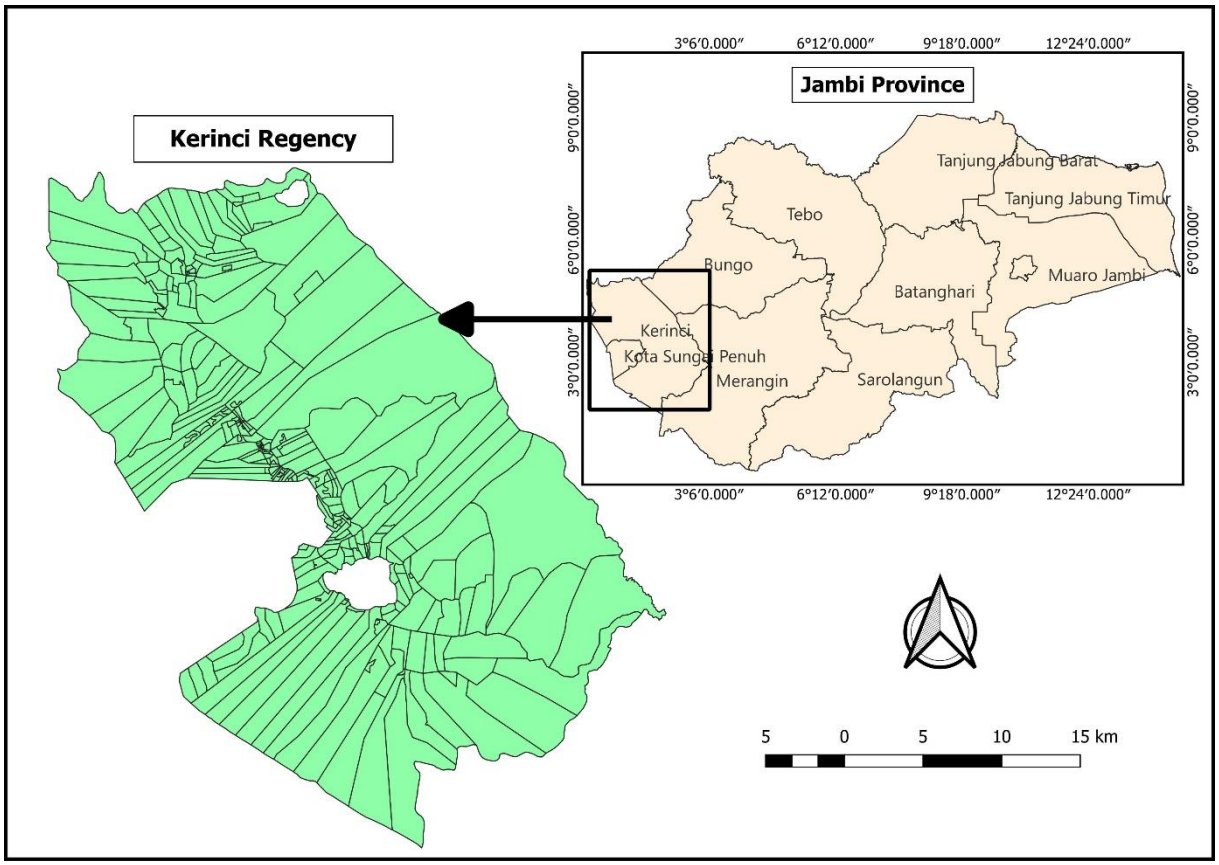


Figure 1: Map of the Study Area

Data Source

The data analyzed in this research was data sourced from the Kerinci Regency Community-Based Nutrition Recording and Reporting (e-PPGBM) system. E-PPGBM contains monthly records of nutritional measurement and reporting data that can be accessed at the community health center or health service. This research analyzes data from 2019 to 2021.

Data Analysis

This section describes the type of research, location and time of the research, Data analysis begins by entering aggregate data on stunting cases by village/kelurahan in the Microsoft Excel application. Stunting data at the village/kelurahan level was then joined with map data in the form of Shapefiles of the Kerinci Regency area at the village/kelurahan level. Data analysis began by creating a thematic map of the distribution of stunting by village/kelurahan made with the help of the open-source application Quantum GIS 3.30.2.

The autocorrelation analysis was conducted with prior weighting. Weighting is the first effort before conducting spatial autocorrelation analysis with the aim of defining the neighboring relationship between regions. In this research, the weighting is done using the queen contiquity method. The queen contiquity method is done by determining the neighborliness based on the intersecting sides and angles (Anselin et al., 2020).

Data in this study were analyzed using the global and local Moran's Index. This analysis aimed to determine the presence or absence of spatial autocorrelation to find hotspots and lowspots of stunting cases in Kerinci Regency. Hotspots can be defined as areas that have a higher concentration of stunting incidence than expected with a random distribution of incidence (Gimond, 2019).

Global Moran's Index

Autocorrelation analysis uses the Moran index test, which is useful for determining the presence of autocorrelation between villages/sub-districts globally with an acceptance criterion of 0.05. The Moran index value ranges from -1 and +1. A value of -1 indicates the presence of negative autocorrelation, which means that the data is perfectly dispersed and +1 indicates perfect clustering. A value of 0 indicates that the distribution pattern is random or indicates no clustering (Anselin et al., 2020) The autocorrelation analysis in this study used the open-source application GeoDa 10.2.

Local Indicator for Spatial Autocorrelation (LISA)

The Local Indicator for Spatial Autocorrelation (LISA) test serves to see the pattern of case distribution to determine hotspots and lowspots by displaying cluster maps and scatterplots. The scatterplot consists of four quadrants that display the spatial relationship pattern of an area with its neighbors. Quadrant I (High-High) is a quadrant that shows areas with high stunting cases that are also surrounded by areas with high cases. In this study, quadrant I is hereafter referred to as hotspots. Quadrant III (Low-Low) is an area with low stunting cases that is also surrounded by areas with low cases, commonly referred to as Lowspots.

Ethical Clearance

This research has passed ethical approval by the Health Research Ethics Committee The Health Polytechnic of Jambi with reference number LB.02.06/2/04/2022

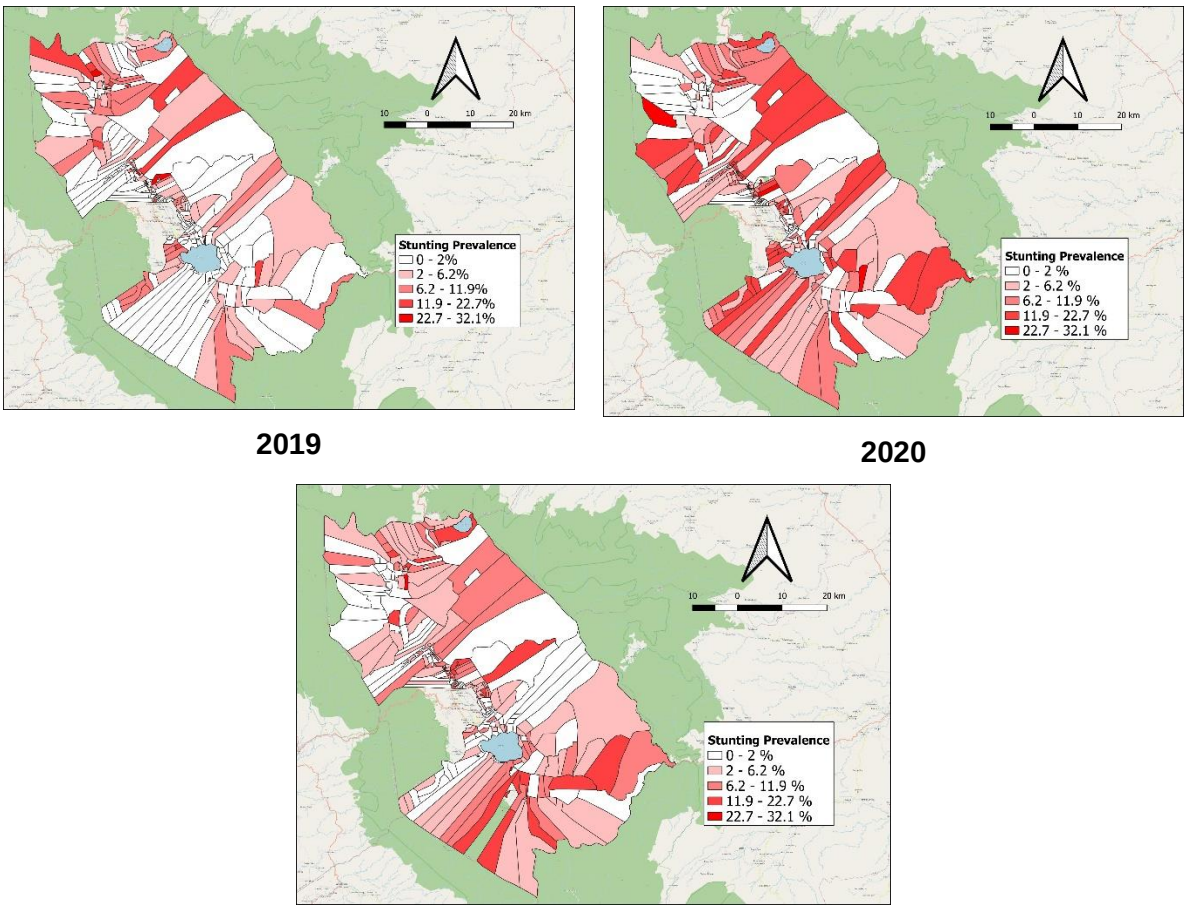
RESULTS

The results of this study are explained in two stages, namely displaying thematic maps of case distribution and maps of case distribution patterns. The thematic map of case distribution aims to determine changes in case distribution from 2019 to 2021, while the distribution pattern map aims to determine autocorrelation or distribution patterns and determine hotspot and lowspot areas of stunting cases in Kerinci Regency from 2019 to 2021. The thematic map of the distribution of stunting in Kerinci Regency by village was created using the natural breaks classification method, which optimizes natural grouping in the data.

A thematic map of stunting distribution

A map of the distribution of stunting cases in Kerinci Regency by village was created using the natural breaks classification method. Natural breaks optimize natural clustering in data.

Figure 2 above shows the distribution of the prevalence of high-category stunting cases in 2019 in the northwestern part of Kerinci Regency, indicated by the dark color of the image in the area. The darker the color of the map, the higher the stunting cases. In 2020, the distribution changed, with high prevalence spread evenly across the northwest, southwest, south and southeast of Kerinci district. In 2021, the distribution did not show significant changes, with high stunting cases spread across the southwest, south and southeast regions. In the northwest region, there was a decrease in cases but the decrease was still in the low category.



2019 **2020**

2021

Figure 2. Thematic Map of Stunting Case Distribution at Village Level in Kerinci Regency

Distribution Pattern of Stunting Cases

Global Moran's Index

Autocorrelation analysis using the Moran Global Index test was used to look globally at the pattern of case distribution. Table 1 below is the result of the analysis.

Table 1. Distribution Pattern of Stunting Cases in Kerinci Regency 2019-2021

Year	Moran's Index	P value	Spatial pattern
2019	0.148	0.003	Clustered
2020	0.177	0.001	Clustered
2021	0.238	0.001	Clustered

Table 1 above shows the results of autocorrelation analysis using the Moran index, which shows that successively from 2019 to 2021 there is autocorrelation with a cluster distribution of cases.

Local Indicator for Spatial Autocorrelation

The local spatial autocorrelation map (LISA) provides information on the specific location of hotspot and lowspot areas. The results of the LISA analysis are divided into four: first, areas with high cases are surrounded by areas with high cases (High-High). Second, low-case areas are surrounded by low-case areas (Low-Low). Third, areas with high cases are surrounded by low cases (High-Low), and areas with low cases are surrounded by areas with high cases (Low-High). The last two quadrants in spatial analysis are referred to as spatial outliers. In this study, only areas with High-High

(hotspots) and Low-Low (Lowspots) are shown.

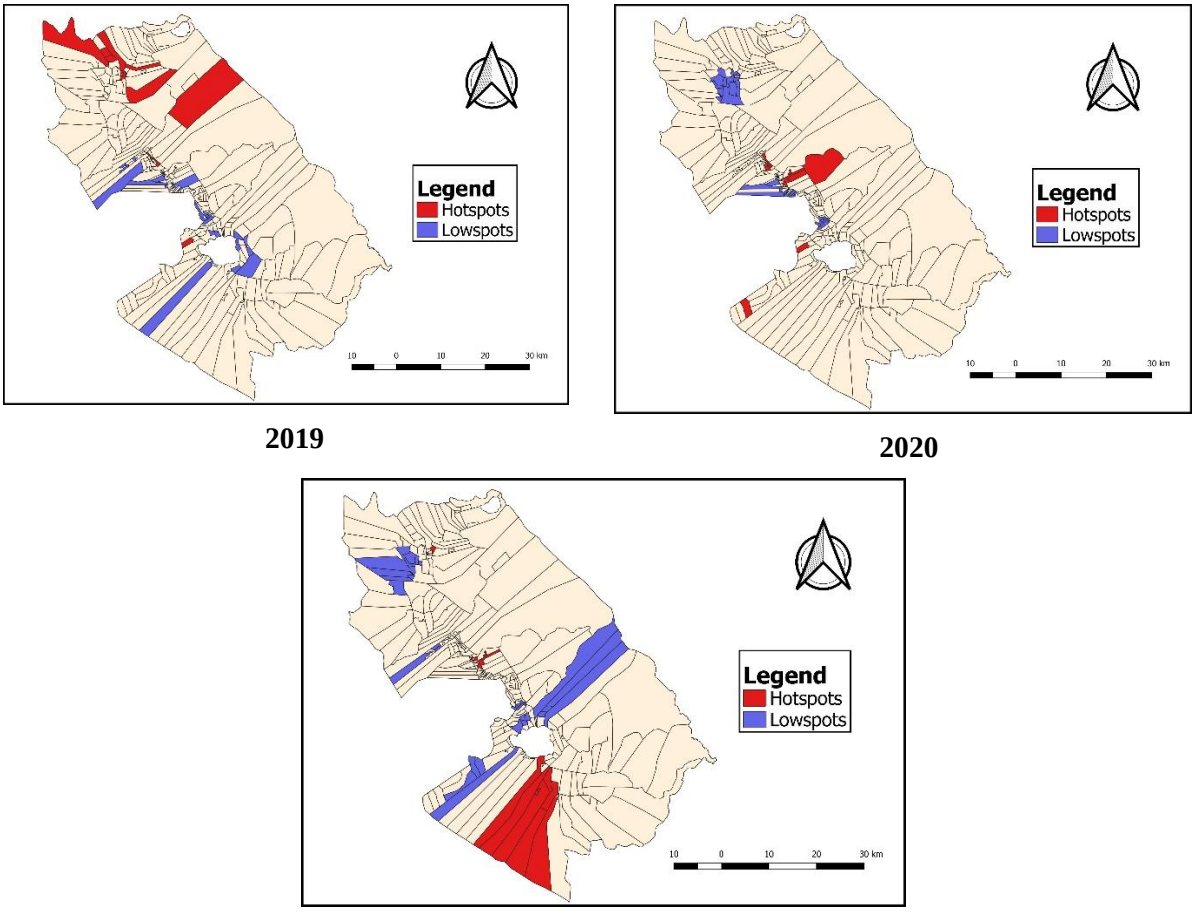


Figure 3. Hotspots of Stunting Cases in Kerinci Regency 2019-2021

The results of the analysis using the LISA method showed that in 2019 hotspots were found in the southwestern region including the sub-districts of Kayu Aro Barat, Kayu Aro, and Siulak Mukai. In 2020, there was a change in the pattern of hotspot distribution found in the central region in Air Hangat Subdistrict, in 2021 there was another change in pattern from previously hotspots found in the central region, shifting to the southwestern region in Gunung Raya Subdistrict.

Table 2. Hotspot and lowspot areas for stunting cases at the village level in Kerinci Regency from 2019 to 2021.

Year	Hotspots Areas	Low spots Areas
2019	Permata baru; Koto Tengah; Sungai Dalam; Koto Periang; Pasar Sungai Tanduk; Mukai Hilir; Sungai Tanduk; Batang Sangir; Tanjung Bungo; Bendung Air Timur; Mukai Mudik; Senimpik; Pasir Jaya; Mukai Seberang; Koto Lua; Giri Mulyo.	Tanjung Mudo; Tanjung Tanah; Baru Semurup; Pulau Tengah; Air Terjun; Padang Jantung; Lubuk Suli; Koto Simpai Kubang; Pengasi Lama; Sebukar; Pendung Tengah; Koto Salak; Sanggaran Agung; Koto Baru Hiang; Hiang Lestari; Pasar Semurup; Talang Lindung; Sungai Medang; Pasar Senen; Sekungkung; Simpang Belui; Muak.

Year	Hotspots Areas	Low spots Areas
2020	Koto Majidin Hilir; Permai Baru; Pasar Jujun; Kemantan Tinggi; Kemantan Darat; Pungut Mudik; Pasar Siulak Gedang; Mukai Hilir; Tebing Tinggi; Kemantan Balai; Kemantan Agung; Siulak Gedang; Koto Beringin; Mukai Tengah; Mukai Mudik.	Betung Kuning; Koto Baru; Koto Periang; Koto Panjang; Semumu; Koto Lanang; Lubuk Suli; Kubang Agung; Sungai Jambu; Kampung Baru; Pasar Minggu; Sebukar; Pendung Tengah; Koto Baru Hiang; Hiang Lestari; Angkasa Pura; Pasar Semurup; Sungai Tanduk; Bedeng Baru; Mekar Jaya; Baru Kubang; Kubang Gedang; Koto Tuo; Koto Payang; Sekungkung; Simpang Belui; Ladeh; Bedeng Delapan; Bedeng Dua; Patok Empat; Bento; Sungai Asam.
2021	Koto Majidin Hilir; Jujun; Kemantan Tinggi; Kemantan Darat; Pasar Kerman; Tanjung Syam; Bintang Marak; Manjuto Lempur; Koto Dua Lama; Koto Panjang; Mekar Sari; Kemantan Kebalai; Lolo Kecil; Talang Kemuning; Muara Lolo.	Dusun Baru Tanjung Tanah; Betung Kuning; Baru Sungai Betung Mudik; Lempur Danau; Koto Tengah; Bukit Pulai; Koto Rendah; Sako Duo; Sungai Kering; Kampung Baru; Pasar Minggu; Tanjung Harapan; Agung Koto Iman; Koto Tengah; Koto Iman; Ujung Pasir; Koto Salak; Pendung Talang Genting; Tebing Tinggi; Koto Baru Hiang; Hiang Lestari; Angkasa Pura; Serumpun Pauh; Pelak Gedang; Demong Sakti; Batu Hampar; Sungai Renah; Bedeng Delapan; Bedeng Dua; Patok Empat;; Bento.

DISCUSSIONS

The study analyzed stunting data at the village level in Kerinci Regency from 2019 to 2021, revealing a positive spatial autocorrelation of stunting cases. In 2018, Bappenas identified stunting locus in ten villages across six sub-districts in Kerinci Regency. The determination of this locus area does not pay attention to regional aspects that influence the number of stunting cases in an area. The study's findings in 2019 indicated hotspot cases in the Northwest Region of Kerinci Regency, specifically in the Sub-districts of Kayu Aro Barat, Kayu Aro, and Siulak Mukai. These results align with previous research by Halim et al. (2023), which also identified clusters of stunting cases in the same area using a spatial analysis method with the Poisson model (Halim et al., 2023). Spatial analysis of stunting cases in Kerinci Regency, Indonesia, is crucial for understanding the distribution patterns and identifying hotspots of stunting prevalence. Previous studies have highlighted the significance of geographic distribution in health issues like stunting, emphasizing the need for targeted interventions based on spatial data (Ahmed et al., 2023; Kuse & Debeko, 2023; Sipahutar et al., 2021).

The spatial distribution of stunting cases in 2021 in Kerinci District shows a similar pattern on both the choropleth map and the LISA analysis map. Identified stunting hotspots are located in rural areas with limited access, indicating a need for further research to understand specific local risk factors. This is crucial for developing targeted interventions to reduce stunting prevalence in Kerinci District. However, it is important to note that the study's reliance on data from the Community-Based Nutrition Recording and Reporting System may introduce biases due to differences with the

Indonesian Nutrition Status Survey data. The discrepancies in data could be attributed to low coverage of children measured for height and weight at integrated health posts (posyandu). Consequently, caution is advised when interpreting the results, as variations in the coverage of child visits for measurements across villages may lead to inaccuracies in identifying hotspots.

The regions of Kayu Aro Barat, Kayu Aro, and Siulak in Kerinci District are characterized by mountainous terrain and high plateaus. Studies have shown that children living in high-altitude areas are more susceptible to growth retardation due to factors like hypoxia exposure, which can impact their overall development (Baye & Hirvonen, 2020; Mohammed et al., 2020; Yang et al., 2020). Apart from physical growth impairments, children in high-altitude environments may also experience physiological challenges (Wang et al., 2023). The slowed growth rate in these areas can be attributed not only to hypoxia but also to factors such as limited access to healthcare services, sociocultural influences, and specific genetic factors of children residing at higher altitudes.

In 2020, research identified stunting hotspots in the central areas of Kerinci Regency, particularly in Air Hangat Subdistrict. This designation was reinforced by the government in 2020, recognizing Air Hangat as a focal point for addressing stunting issues (Sandari, 2023). Studies from Ethiopia have shown that children in stunting clusters often come from economically disadvantaged families, with young mothers who are typically farmers or homemakers (Belayneh et al., 2021). Children within stunting hotspots share similar characteristics influenced by lifestyle, sociocultural norms, and access to healthcare services (Almasi et al., 2019). By 2021, the hotspot cases had shifted southwestward in Kerinci Regency.

CONCLUSIONS

This study found from 2019 to 2021, a noticeable relocation of stunting hotspots has been observed, with cases shifting from the southwest to central regions. This shift underscores the critical importance of pinpointing and addressing local-level issues effectively. Stakeholders must prioritize understanding regional correlations when devising strategies to combat stunting, ensuring that interventions are tailored to the specific needs of each area. By recognizing these shifts and focusing on localized solutions, stakeholders can make significant strides in addressing stunting and improving overall health outcomes.

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