Childhood stunting disparities in Temanggung District, Indonesia: Evidence from routine electronic surveillance

Herlina Mayangsari*[1], Hadi Ashar[2]

[1] Public Health Unit, Health Office of Temanggung District, Central Java, Indonesia
[2] National Research and Innovation Agency Republic of Indonesia, Jakarta, Indonesia

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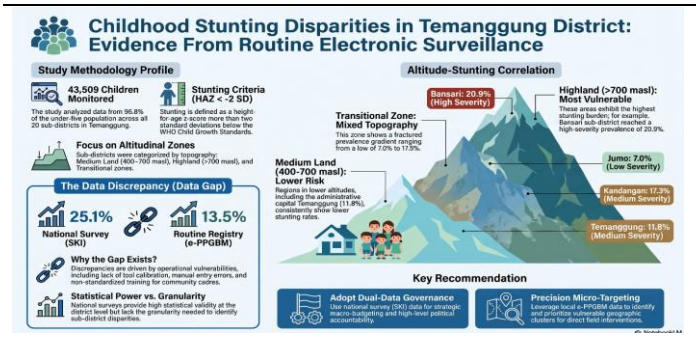
ABSTRACT

Childhood stunting remains a critical global challenge, including in Indonesia where regional variation is substantial, yet studies utilizing national survey data to identify geographical disparities and vulnerable highland areas in high-burden districts such as Temanggung remain limited. This study aimed to map the distribution of childhood stunting across sub-districts in Temanggung District, Indonesia, using routine electronic nutrition surveillance data from E-PPGBM and to compare district-level estimates with the 2023 Indonesian Health Survey. A descriptive cross-sectional study was conducted using 2023 E-PPGBM data covering 43,509 children under five, representing 96.8% population coverage. Stunting prevalence was calculated across 20 sub-districts, geographically mapped, and examined according to altitude characteristics. The E-PPGBM data showed a district-wide stunting prevalence of 13.5%, which met the national target of below 14%. However, this estimate differed substantially from the 2023 Indonesian Health Survey estimate of 25.1%, indicating a notable discrepancy between routine surveillance and sample-based survey data. Sub-district prevalence varied widely, ranging from 7.0% in Jumo to 20.9% in Bansari. The highest stunting burden was concentrated in rural highland sub-districts, suggesting that altitude-related and geographically patterned vulnerabilities may contribute to local disparities. These findings indicate that near-census routine surveillance can complement national survey data by revealing localized stunting patterns that are not visible in district-level estimates. Strengthening the use of E-PPGBM for micro-planning may support geographically targeted interventions, improve resource allocation, and prioritise high-risk highland communities in local stunting reduction strategies.

ABSTRAK

Stunting pada anak tetap menjadi tantangan global yang kritis, termasuk di Indonesia yang menunjukkan variasi regional yang cukup besar. Namun, studi yang memanfaatkan data survei nasional untuk mengidentifikasi ketimpangan geografis dan wilayah dataran tinggi yang rentan di daerah dengan beban stunting tinggi, seperti Kabupaten Temanggung, masih terbatas. Penelitian ini bertujuan untuk memetakan distribusi stunting anak di tingkat kecamatan di Kabupaten Temanggung, Indonesia, dengan menggunakan data pemantauan gizi elektronik rutin dari E-PPGBM, serta membandingkan estimasi tingkat kabupaten dengan Survei Kesehatan Indonesia tahun 2023. Penelitian deskriptif potong lintang dilakukan dengan menggunakan data E-PPGBM tahun 2023 yang mencakup 43.509 anak balita, mewakili cakupan populasi sebesar 96,8%. Prevalensi stunting dihitung pada 20 kecamatan, dipetakan secara geografis, dan dianalisis berdasarkan karakteristik ketinggian wilayah. Data E-PPGBM menunjukkan prevalensi stunting tingkat kabupaten sebesar 13,5%, yang telah memenuhi target nasional di bawah 14%. Namun, estimasi ini berbeda cukup besar dengan estimasi Survei Kesehatan Indonesia tahun 2023 sebesar 25,1%, yang menunjukkan adanya kesenjangan nyata antara data surveilans rutin dan data survei berbasis sampel. Prevalensi di tingkat kecamatan bervariasi luas, mulai dari 7,0% di Jumo hingga 20,9% di Bansari. Beban stunting tertinggi terkonsentrasi di kecamatan pedesaan dataran tinggi, yang menunjukkan bahwa kerentanan terkait ketinggian wilayah dan pola geografis dapat berkontribusi terhadap ketimpangan lokal. Temuan ini menunjukkan bahwa surveilans rutin dengan cakupan mendekati sensus dapat melengkapi data survei nasional dengan mengungkap pola stunting lokal yang tidak terlihat dalam estimasi tingkat kabupaten. Penguatan pemanfaatan E-PPGBM untuk perencanaan mikro dapat mendukung intervensi yang lebih tepat sasaran secara geografis, meningkatkan alokasi sumber daya, dan memprioritaskan komunitas dataran tinggi berisiko tinggi dalam strategi penurunan stunting di tingkat lokal.

GRAPHICAL ABSTRACT



Keyword
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*** Correspondence**
Health Office of Temanggung District, Temanggung, Central Java, 56217, Indonesia
herlinamayangsari@gmail.com

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INTRODUCTION

Stunting remains a critical global public health concern, currently affecting approximately 148.1 million children under five years old worldwide (WHO et al., 2023). Epidemiologically defined as a height-for-age z-score (HAZ) falling more than two standard deviations below the WHO Child Growth Standards. Inadequate nutritional intake and recurrent infectious episodes during the critical first 1,000 days of life result in irreversible consequences, including impaired cognitive development, reduced future economic productivity, diminished baseline health status, and an elevated predisposition to adult-onset degenerative conditions (WHO, 2014). Growth deficits occuring before two years of age are strongly associated with poorer school trajectories and academic performance later in childhood and adolescence (Gansaonré et al., 2022). Chronic malnutrition also contributes to micronutrient deficiencies and anemia, perpetuating adverse health outcomes and intergenerational cycles of malnutrition (Mizawati et al., 2023; UNICEF, 2024; World Health Organization, 2024). Consequently, reducing childhood stunting is a global priority under Sustainable Development Goal (SDG) 2, particularly Target 2.2, which aims to end all forms of malnutrition by 2030. Generating reliable local evidence on the geographical distribution of stunting is essential for guiding targeted interventions and advancing SDG 3 (Good Health and Well-being) by improving child health and reducing health inequalities (United Nations, 2025).

Despite global declines from 32.6% in 2000 to 22.2% in 2017, the absolute burden remains high, particularly in developing nations. Over half of the global stunted under-five population resides in Asia (55%), with South Asia bearing the highest concentration (WHO et al., 2023). Within Southeast Asia, Indonesia historically records some of the highest burdens, with stunting affecting roughly 30.8% (7.3 million) of its under-five demographic in 2018 (Kementerian Kesehatan RI, 2019). During the 2018-2019 surveillance period, while Southeast Asia as a whole retained the second-highest regional stunting rate in Asia at 27.4% (Global Nutrition Report, 2023), Indonesia consistently exhibited the highest individual burden among major Southeast Asian counterparts (UNICEF, 2021).

In response, national health surveillance in Indonesia has documented a steady downward trend from 37.2% in 2013 to 21.6% in 2022 (Kementerian Kesehatan RI, 2019). To accelerate this momentum, Presidential Regulation No. 72/2021 institutionalized an aggressive target of 14% by the end of 2024. Although the 2023 Indonesian Health Survey (SKI) revealed that the nation fell short of this goal, national prevalence continued a downward trajectory to 21.5% (Arief et al., 2025; Kementerian Kesehatan RI, 2023b).

However, this macro-level decline masks profound geographic disparities across provincial and regency borders. Within Central Java Province, which maintains a regional average of 20.7%, Temanggung District ranks as the sixth-highest burdened regency, presenting a stunting prevalence of 25.1%. While this represents a significant reduction from its previous second-place regional ranking of 28.9% the year prior, the burden in Temanggung remains substantially elevated above both national parameters and global target averages (Kementerian Kesehatan RI, 2023b).

Several studies have used nationally representative surveys, particularly the Demographic and Health Surveys (DHS), to examine geographical variation in childhood stunting. Spatial analyses from Ethiopia and a global mapping study have consistently demonstrated marked subnational disparities and identified geographical hotspots that provide important evidence for national policy and resource allocation (Bitew et al., 2023; Kinyoki et al., 2020; Kuse & Debeko, 2023; Tamir et al., 2022). However, these analyses rely on sample-based surveys, limiting their ability to characterize disparities at smaller administrative units.

To support local interventions, the Indonesian Ministry of Health implemented the electronic community-based nutrition surveillance system known as E-PPGBM (Electronics-Community-Based Nutrition Recording and Reporting). Although discrepancies between E-PPGBM and the nationally representative SKI survey have been reported, the near-census coverage of E-PPGBM provides a unique opportunity to identify sub-district geographical disparities and vulnerable communities that national surveys cannot statistically capture.

To our knowledge, no previous study has used routine electronic nutrition surveillance (E-PPGBM) data to examine sub-district variations in childhood stunting or to explore their relationship with topographical characteristics in Temanggung District. Existing evidence is largely derived from national sample-based surveys, which cannot reliably estimate stunting prevalence at this level of geographical resolution. This study addresses this gap by using the

2023 E-PPGBM database to map sub-district stunting prevalence and examine its distribution across different elevation zones. The findings are expected to support evidence-based planning and more targeted nutrition interventions in high-risk communities.

METHODS

Study design and population

This descriptive cross-sectional study employed geographical mapping to depict the distribution of childhood stunting across the 20 sub-districts of Temanggung District. Secondary surveillance data covering the period from January to December 2023 were obtained from the integrated E-PPGBM managed by the Temanggung District Health Office, which compiles routine nutritional monitoring records from all 26 community health centers. The study analyzed aggregated sub-district data, including all children under five years with valid anthropometric measurements recorded in E-PPGBM during the study period. Individual records with missing or invalid anthropometric information were managed through the routine data validation procedures of the E-PPGBM system before aggregation. Therefore, no additional inclusion or exclusion criteria were applied by the researchers. A total of 43,509 children under five were included, representing 96.8% of the estimated target population. The remaining 3.2% were not recorded due to field-level constraints, including caregiver refusal, childhood illness, temporary absence during scheduled monitoring cycles at integrated health posts (*Posyandu*), or shortages of community health cadres to conduct active door-to-door tracking.

Data collection and anthropometric measurements

Primary anthropometric measurements, including body weight and recumbent length (0–23 months) or standing height (24–59 months), were obtained during routine monthly *Posyandu* sessions by trained community health cadres following the Indonesian Ministry of Health's standardized anthropometric measurement procedures. Measurements were performed using infantometers, stadiometers, and digital weighing scales routinely maintained and calibrated by the respective health center (*Puskesmas)*. Community health cadres received periodic training and supervision from *Puskesmas* nutrition officers to ensure standardized measurement techniques.

Anthropometric data were initially recorded in child health records and village cohort registers before being submitted to *Puskesmas* nutrition officers. Nutrition officers reviewed the completeness and consistency of the records, verified questionable or inconsistent measurements with *Posyandu* cadres when necessary, and entered validated data into the E-PPGBM system. District nutrition officers subsequently monitored data completeness, reporting timeliness, and overall data quality across all Puskesmas.

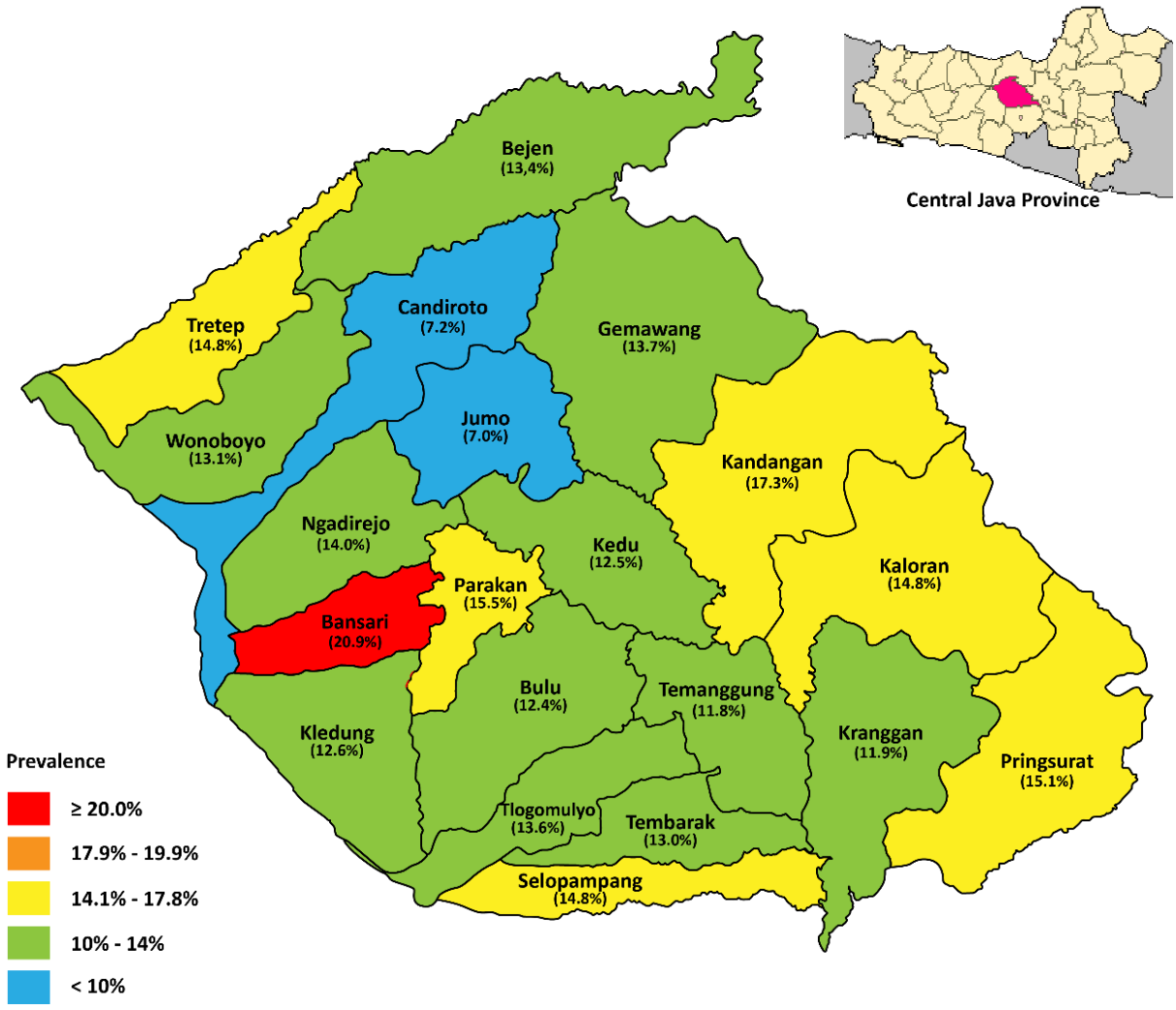
Variables and statistical analysis

The primary dependent variable was childhood stunting, automatically classified by the E-PPGBM algorithm as a height-for-age z-score (HAZ) below -2 standard deviations according to the 2006 WHO Child Growth Standards. Aggregated sub-district stunting prevalence was calculated as the proportion of stunted children among all measured children under five years of age. Sub-district administrative boundaries were obtained from the official administrative map of Temanggung District published by the Central Bureau of Statistics (BPS) (BPS Kabupaten Temanggung, 2021). A choropleth map was manually prepared using Adobe Illustrator based on aggregated prevalence data. Prevalence categories were manually classified according to WHO public health thresholds (<10.0% as the low-severity threshold and ≥20.0% as the high-severity threshold) and Indonesia's national stunting reduction targets (17.8% for 2023 and 14.0% for 2024), resulting in five categories: <10.0%, 10.0-14.0%, 14.1-17.8%, 17.9-19.9%, and ≥20.0% (De Onis et al., 2019; Kementerian Kesehatan RI, 2022, 2023a). To examine topographical patterns, sub-districts were further categorized into lowland (<400 masl), medium land (400-700 masl), and highland (>700 masl) using elevation data from the Central Bureau of Statistics (Badan Pusat Statistik, 2025).

Ethical considerations

This study utilized fully anonymized, aggregated secondary data obtained with formal administrative permission from the Temanggung District Health Office (Approval No. B/070/630/XI/2024). Because the study involved no direct interventions with human participants and contained no personal identifiable information, separate institutional review board (IRB) approval was not required under national regulations. All data

Figure 1
The geographical distribution of the stunting rates in Temanggung District, 2023



Note: WHO Severity Thresholds: Low (<10%), Medium (10-<20%), High (20-<30%) according to De Onis et al. (2019); Indonesia's national stunting reduction targets: 17.8% for 2023 and 14.0% for 2024, according to Kementerian Kesehatan RI (2022) and Kementerian Kesehatan RI (2023a).

management adhered to national health privacy laws and international research ethics principles.

RESULTS

The E-PPGBM platform revealed that the aggregated under-five stunting prevalence in Temanggung District for the year 2023 stood at 13.5%, indicating that the district had achieved the national stunting reduction target of <14%. In contrast, the 2023 SKI estimated a substantially higher prevalence of 25.1%, representing a marked discrepancy between the routine surveillance system and the nationally representative survey. This difference constitutes one of the study's principal findings because it leads to contrasting assessments of district performance and has important implications for program monitoring and evaluation. However, the E-PPGBM district-level average masked highly diverse localized variations at the sub-district level. As shown in Figure 1, stunting prevalence ranged from 7.0% in Jumo to 20.9% in Bansari. Based on the National Medium-Term Development Plan (RPJMN) target for 2023 (<17.8%), 19 of the 20 sub-districts (95.0%) had achieved the national target, whereas Bansari remained the only sub-district exceeding this threshold.

When benchmarked against the more stringent 2024 national target of 14.0%, nearly two-

Table 1
Distribution of childhood stunting prevalence across altitudinal zones in Temanggung District, 2023

Altitudinal Zone (masl)*	Sub-district	Under-Five Population (N)	Stunted Children (n)	Stunting Prevalence (%)	WHO Severity Classification**
Medium Land (400-700 masl)	Temanggung	3937	465	11.80%	Medium
	Kranggan	2647	314	11.90%	Medium
	Bejen	1197	160	13.40%	Medium
Highland (>700 masl)	Bansari	1384	289	20.90%	High
	Parakan	2674	414	15.50%	Medium
	Kledung	1372	173	12.60%	Medium
	Tretep	1107	164	14.80%	Medium
Transitional Land (Mixed Topography)	Jumo	1693	118	7.00%	Low
	Kandangan	3054	529	17.30%	Medium
	Kaloran	2320	343	14.80%	Medium
	Pringsurat	2995	453	15.10%	Medium
	Selopampang	1278	189	14.80%	Medium
	Ngadirejo	3386	475	14.00%	Medium
	Gemawang	2028	278	13.70%	Medium
	Tlogomulyo	1363	185	13.60%	Medium
	Wonoboyo	1670	218	13.10%	Medium
	Tembarak	1845	1845	13.00%	Medium
	Kedu	3351	420	12.50%	Medium
	Bulu	2480	308	12.40%	Medium
	Candiroto	1728	125	7.20%	Low
District Total	20 Sub-districts	43.509	5.873	13.50%	Medium

Note: *Altitudinal classifications obtained from the Central Bureau of Statistics (BPS Kabupaten Temanggung, 2025) and Istiawan & Kastono, (2019).
**WHO Severity Thresholds: Low (<10%), Medium (10-<20%), High (20-<30%) according to De Onis et al. (2019).

thirds of the sub-districts (n=13, 65.0%) had already surpassed this threshold, maintaining stunting rates below 14.0%. Conversely, more than one-third of the regions (n=7, 35.0%) remained heavily burdened by elevated stunting rates. Notably, Bansari sub-district exhibited a critical public health deficit, with its 20.9% prevalence crossing the WHO epidemiological threshold designated as a "High" public health significance (20%) (De Onis et al., 2019).

As illustrated in Figure 1, the geographical distribution of stunting across Temanggung District exhibits prominent spatial heterogeneity. While localized variations are apparent, a clear geographic trend emerges: the highest concentrations of stunting are predominantly clustered along the outer, peripheral boundaries of the regency, with a pronounced clustering observed across the southern and high-altitude zones. This contiguous high-prevalence belt is anchored by the sub-districts of Bansari (20.9%), Parakan (15.5%), Pringsurat (15.1%), Kaloran (14.8%), Selopampang (14.8%), and Kandangan (17.3%). In contrast, the lowest stunting rates are concentrated within a distinct northern and central geographic corridor, which includes Jumo (7.0%) and the administrative capital of Temanggung sub-district (11.8%).

This spatial clustering directly intersects with the regency's distinct topodemographic profiles. Topographical datasets indicate that Temanggung District possesses no lowland territories situated below an altitude of 400 masl (Badan Pusat Statistik, 2025; Istiawan & Kastono, 2019). A small proportion of the district (n=3, 15.0%) is situated within a strict medium-land configuration (400-700 masl), including Temanggung, Kranggan, and Bejen, where lower stunting rates consistently occur. Another distinct cluster (n=4, 20.0%) occupies the true highland terrain situated entirely above 700 masl, namely the sub-districts of Bansari, Tretep, Parakan, and Kledung, which exhibit the most severe stunting burdens. Finally, the vast majority of the regency (n=13, 65.0%) spans an intermediate, transitional landscape fluctuating between medium land and highland topographies. Within this transitional zone, stunting prevalence displays a wide, fractured gradient, ranging from the district baseline minimum of 7.0% in Jumo to an elevated 17.3% in Kandangan, encompassing the remaining sub-districts of Wonoboyo, Candiroto,

Ngadirejo, Gemawang, Kedu, Kaloran, Bulu, Tlogomulyo, Tembarak, Selopampang, and Pringsurat as shown in Table 1 (Badan Pusat Statistik, 2025; Istiawan & Kastono, 2019).

Figure 1 further shows that although the highest stunting prevalence was concentrated in several highland sub-districts, elevated prevalence was also observed in some sub-districts located relatively close to the district administrative center including Kaloran, Kandangan, Selopampang and Pringsurat, indicating that geographical proximity to urban services alone does not fully explain local variation in childhood stunting.

DISCUSSION

Data discrepancies and measurement issues

The 2023 e-PPGBM reported a lower stunting prevalence in Temanggung District (13.5%) compared to the SKI of the same year (25.1%), highlighting a significant discrepancy that warrants further investigation. Methodologically, the SKI sample in Temanggung represented only 1.8% (n=786) of the under-five population (N=43,509), limiting its statistical power to capture granular sub-district variations (Kementerian Kesehatan RI, 2023b). However, the primary driver of this disparity lies in operational vulnerabilities within the routine surveillance system. While SKI deployed trained enumerators with standardized anthropometric tools, frontline e-PPGBM data collection relies entirely on community health cadres who frequently operate without uniform measurement protocols, adequate training, or routine equipment calibration.

These field-level challenges are heavily compounded by systemic bottlenecks identified in national evaluations of the e-PPGBM platform by UNICEF and Pulse Lab Jakarta. Nationally, the system lacks digital frontline data-collection controls, forcing village *posyandus* to rely on manual, error-prone paperwork before text data is forwarded to *Puskesmas*. This operational model shifts the role of nutrition surveillance from an active early-warning signal into a passive, compliance-driven record-keeping exercise (Susilawati, 2025). Furthermore, *Puskesmas* officers face a severe double burden, overwhelmed by massive data entry backlogs while simultaneously navigating labor-intensive, cross-sectoral verification processes to correct errors introduced at the village level (Pulse Lab Jakarta & UNICEF, 2023). Locally, these factors manifest as digit preferences in height measurements (Riyanto et al., 2025), uneven tool calibration, and delayed system entries (Susilawati, 2025), ultimately resulting in underreporting and an artificially deflated routine stunting figure.

One of the principal findings of this study was the substantial discrepancy between the routine E-PPGBM estimate (13.5%) and the nationally representative SKI estimate (25.1%). This difference requires systematic validation to ensure equitable health planning and local resource allocation. Reconciling these data systems is crucial for determining whether routine reports accurately reflect field conditions or merely mask localized gaps. Addressing this, the Government of Temanggung District has initiated a proportionate response by adopting a dual-data governance framework. This architecture is specifically justified by the structural limitations of national survey designs. While the 2023 SKI provides high statistical validity, its estimates are strictly aggregated at the district level, offering no granular visibility into sub-district or village-level variances. To overcome this dilemma, the district planning authority utilizes SKI's macro-estimates exclusively to establish strategic baseline targets, define fiscal budgets, and secure high-level political accountability. Concurrently, e-PPGBM records are leveraged as operational micro-targeting tools, not for their absolute statistical values, but to proportionally direct the secured resources to high-prevalence clusters like highland sub-districts.

This approach directly overcomes critical vulnerabilities highlighted in recent implementation research. Nationally, Sufri et al. (2024) noted that Indonesian stunting policies often falter at local levels due to inadequate data integration and weak collaboration between health and non-health sectors. Locally, empirical evidence from neighboring Jepara District by Sujatmiko (2025) demonstrates that relying blindly on routine data can obscure programmatic bottlenecks. For instance, a 90-day supplementary feeding program tracked via local data yielded a growth recovery rate of only 4.8%, undermined by suboptimal resource allocation and fragmented inter-agency tracking. Furthermore, regional stunting elimination is hindered when budgets focus heavily on administrative coordination rather than direct, evidence-based field interventions, a misallocation frequently driven by flawed routine data reporting (Sujatmiko, 2025). By assigning complementary roles to survey and routine datasets according to their respective strengths, the dual-data governance framework adopted in Temanggung District provides a pragmatic approach for translating district-level

survey estimates into precise, sub-district multi-sectoral action as mandated by Presidential Regulation No. 72/2021, which demands cross-sectoral institutional convergence and data-driven precision.

Geographic patterns

This study shows that stunting prevalence was not evenly distributed across sub-districts, displaying prominent geographic variations influenced by topography and altitude. Beyond mapping distribution patterns, these disparities highlight a critical need to investigate the localized structural and environmental drivers of growth faltering across the district. This observation aligns with recent spatial analyses in Central Java, which demonstrate that stunting cases are rarely distributed uniformly, instead displaying significant localized variance and hotspots that require sub-district geographic targeting (Inzani et al., 2026)**.**

Existing public health literature suggests that the physical environment where communities reside is crucial for health, directly creating disparate child growth outcomes. Conventional frameworks argue that living in urban areas provides a distinct health advantage for children, as city centers typically offer superior housing, diversified food markets, and enhanced socio-economic opportunities that allow mothers to achieve higher literacy and health awareness (Hathi et al., 2017; Zhou et al., 2026). This argument aligns with the low rate of stunting observed in the Temanggung sub-district (11.8%), which serves as the administrative capital city of the district, as well as its neighboring areas including Kranggan (11.9%), Bulu (12.4%), Kedu (12.5%), Tembarak (13.0%), and Tlogomulyo (13.6%).

However, the notably high prevalence of stunting in sub-districts located relatively close to the district capital, such as Kaloran (14.8%), Selopampang (14.8%), Pringsurat (15.1%), and Kandangan (17.3%), suggests that geographical proximity to urban services alone does not guarantee better nutritional outcomes. This pattern indicates that other contextual factors may contribute to local disparities. Previous studies have shown that inadequate water, sanitation, and hygiene (WASH), persistent open defecation, household poverty, limited dietary diversity, and unequal access to or utilization of health and nutrition services can adversely affect children's linear growth regardless of rural or urban location (Fasya et al., 2026; Hathi et al., 2017; Silva et al., 2023). Furthermore, analyses of nationally representative DHS and MICS surveys from 67 low- and middle-income countries have demonstrated that socioeconomic inequalities in childhood stunting persist despite overall improvements in national prevalence, indicating that localized deprivation can remain even in relatively well-served areas (Crochemore et al., 2018). These findings underscore the importance of conducting local environmental and socioeconomic assessments to identify the specific factors driving stunting in these sub-districts and to inform targeted, context-specific interventions.

Furthermore, while standard paradigms emphasize that urban residents benefit from superior healthcare access (Hathi et al., 2017; Sarraj et al., 2020; Zhou et al., 2026), our empirical findings reveal that lower stunting prevalence paradoxically occurs in several rural settings. This indicates that less dense settlement patterns characteristic of rural Temanggung may offer protective health benefits for children. Epidemiological evidence confirms that lower population density in rural areas reduces early-life health risks, even in the presence of inadequate sanitation infrastructures (Hathi et al., 2017). The relationship between place and child growth appears to be significantly moderated by the interaction between sanitation coverage and population concentration. The plausible underlying mechanism is that reduced human-to-human interaction in sparse populations limits the transmission pathways of fecal-oral pathogens, partially neutralizing the health impact of environmental contamination caused by open defecation. This dynamic is further explained by Mustofa et al. (2026) in rural Central Java, who revealed that where infrastructure or dietary diversity is lacking, lower population density serves as an environmental buffer by mitigating rapid disease transmission (Mustofa et al., 2026). Nevertheless, these notable variations across different zones of the district call for targeted spatial epidemiology to isolate the precise confounders of this density-sanitation dynamic.

Lastly, the geographical distribution of stunting prevalence exhibits a clear correlation with altitude. The recorded prevalence of stunting is significantly lower in the medium-altitude lands than in the high-altitude lands. Almost all highland sub-districts exhibit elevated stunting rates, anchored by Bansari sub-district, which experiences the highest prevalence in the entire regency (20.9%). This upward trend of malnutrition corresponding with rising elevation implies an intersection of systemic factors, including chronic food insecurity, physical isolation from healthcare facilities, and potential physiological

constraints. Global literature has increasingly documented the links between physical geography and child linear growth, validating the negative impact of higher geographical altitude on stunting risks (Mohammed et al., 2020; Phad et al., 2024; Shively et al., 2020; Shively & Schmiess, 2021). This geographic risk factor is robustly supported by a comprehensive global systematic review and meta-analysis, which definitively concluded that higher residential altitude acts as an independent risk factor that slows children's physical growth due to environmental and physiological challenges. Remote communities living at high altitudes away from urban economic centers are frequently vulnerable to supply-chain disruptions that impair food security. This socioeconomic isolation interacts with the biological stresses inherent to highland features, where atmospheric hypoxia can exacerbate intrauterine growth restriction, impair nutrient delivery, and suppress linear growth (Debebe et al., 2026).

This study has several strengths. First, it utilized routine E-PPGBM data with near-census population coverage (96.8%), providing substantially greater geographical resolution than sample-based national surveys and enabling identification of sub-district disparities that are not captured by district-level estimates. Second, the use of routine surveillance data reflects real-world program implementation and provides practical evidence for local nutrition planning.

Nevertheless, several limitations should be acknowledged. First, this was an ecological study based on aggregated sub-district data. Therefore, the observed associations cannot be interpreted as causal relationships at the individual or household level. In particular, the finding that higher stunting prevalence was concentrated in several highland sub-districts does not imply that children living at higher altitudes are inherently at greater risk of stunting. The observed geographical patterns may instead reflect contextual differences in socioeconomic conditions, food security, water and sanitation, healthcare access, or other unmeasured environmental factors. Second, because the study relied on routinely collected surveillance data, its findings depend on the completeness and quality of anthropometric measurements recorded in the E-PPGBM system. Finally, the descriptive design did not permit adjustment for potential confounding factors. Future studies incorporating household- or individual-level data together with multilevel spatial analyses are needed to better understand the determinants of geographical variation in childhood stunting.

CONCLUSIONS

Routine E-PPGBM surveillance indicated that Temanggung District achieved the national stunting reduction target in 2023; however, a substantial discrepancy with the 2023 Indonesian Health Survey (SKI) underscores the need for harmonized interpretation of routine surveillance and national survey data in program evaluation. The study also revealed marked geographical heterogeneity in stunting prevalence across sub-districts, with the highest burden concentrated in several rural highland communities. These findings demonstrate that routine surveillance with near-census coverage complements national survey data by identifying localized disparities and supporting geographically targeted interventions.

In the short term, local health authorities should prioritize validation and quality assurance of routine E-PPGBM data through regular field audits before using the data for intervention planning and resource allocation. Strengthening Posyandu services and community nutrition surveillance in rural highland areas, together with micro-targeting of children under five in priority sub-districts, may improve the effectiveness of local stunting prevention and control programs. From a policy perspective, local governments should adopt complementary use of the two surveillance systems by using SKI as the primary reference for district-level budgeting, strategic planning, and program evaluation, while utilizing E-PPGBM to identify priority sub-districts and villages for targeted nutrition interventions. Future studies should integrate household- and individual-level data with advanced spatial analytical approaches to validate routine surveillance findings and better understand the contextual determinants of geographical disparities in childhood stunting.

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AUTHORS' CONTRIBUTIONS

Herlina Mayangsari contributed to the study design, conceptualisation of the study, manuscript writing, data collection, data acquisition, and data analysis. Hadi Ashar contributed to the study design, conceptualisation of the study, manuscript writing, manuscript review, and manuscript revision. Both authors read and approved the final version of the manuscript.

AUTHORS' INFORMATION

Herlina Mayangsari, S.ST, MPH, is a researcher and public health official affiliated with the Health Office of Temanggung District, Indonesia. Hadi Ashar, SKM, MPH, is a researcher affiliated with the National Research and Innovation Agency, Republic of Indonesia.

COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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