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Ecological study on child nutrition in Indonesia: National urban–rural patterns and local-level variation

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Abstract

Indonesia continues to face a double burden of malnutrition, characterized by persistent undernutrition and a growing prevalence of overweight among children. Although urban children typically show lower rates of stunting and underweight, emerging evidence indicates rising obesity due to unhealthy behavior. At the same time, national indicators may mask substantial heterogeneity at the provincial and district levels. This study aimed to compare urban–rural disparities in child nutrition and maternal care at the national level and examines intra-provincial variation that may be obscured by aggregated statistics. An ecological analysis was conducted using data from the 2024 Indonesian Nutritional Status Survey. Urban–rural differences were evaluated using odds ratios (OR) and Chi-square tests. Sub-provincial analyses were undertaken in selected districts of Central Java and South Sulawesi to assess patterns of variation across smaller administrative units. At the national level, urban children exhibited lower odds of severe underweight (OR: 0.78; 95%CI: 0.75–0.81), underweight (OR: 0.82; 95%CI: 0.80–0.84), and stunting (OR: 0.77; 95%CI: 0.75–0.78). In contrast, they had higher odds of being at risk of overweight (OR: 1.35; 95%CI: 1.31–1.40) and of consuming unhealthy foods (OR: 1.22; 95%CI: 1.19–1.25). Rural areas showed poorer dietary diversity and lower coverage of antenatal care. District-level analyses revealed marked contrasts, where in Central Java, Magelang Municipality had lower odds of severe underweight than Surakarta and Tegal Municipalities. Meanwhile, in South Sulawesi, Makassar Municipality performed better than Pare-pare Municipality but still lagged behind Tana Toraja. These intra-provincial patterns suggest that urban residence does not uniformly confer nutritional advantage. Significant inequities persist not only between urban and rural populations but also across districts within the same province. Smaller cities with stronger health service access, such as Magelang Municipality, tend to show better child nutrition outcomes.

Keywords: Child malnutrition, dietary diversity, antenatal care, health inequity, Indonesia

Introduction

Child undernutrition remains a critical public health challenge in Indonesia, contributing to increased morbidity, impaired cognitive development, and long-term productivity losses. On the

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other hand, nutrition transitions where lower activities with increased consumption of sweet drinks and food containing too much fat causes obesity and increase the risk of non-communicable disease [1]. Globally, evidence syntheses indicate that child malnutrition is consistently associated with structural and household-level determinants, including maternal education, household income, maternal nutritional status, sanitation, family size, birth order, and low birth weight [2]. National responses have increasingly emphasised life-course prevention through the First 1,000 Days (1000 HPK) program, targeting pregnancy to age two with nutrition-specific and nutrition-sensitive interventions [3].

However, national averages can conceal substantial local heterogeneity; therefore, examining urban–rural contrasts and district-level variation is essential to identify where undernutrition persists and where nutrition-transition risks are emerging. Recent regional work in South Asia also highlights that progress toward ending hunger and child malnutrition remains uneven, with persistent policy and implementation challenges in achieving Sustainable Development Goals 2 [4]. In Indonesia, where stunting and wasting remain prevalent, the public health implications extend beyond childhood and into adult economic productivity and health system burden. Despite decades of national efforts to improve child nutrition, disparities persist across geographic, socioeconomic, and service-access dimensions [5]. While rural areas are often the focus of nutritional interventions due to historically lower service availability and food security, these challenges are not exclusive to rural settings [5].

Urban environments are traditionally associated with better access to health services, improved dietary diversity, and higher socioeconomic status. These assumptions are grounded in the urban advantage hypothesis, which posits that urban children benefit from proximity to healthcare facilities, higher parental education, and greater availability of diverse foods through market integration [6]. However, emerging evidence from low- and middle-income countries (LMICs) suggests that this advantage is neither uniform nor guaranteed [7]. The urban penalty hypothesis offers a countervailing perspective, emphasizing that rapid, unregulated urbanization can lead to overcrowded living conditions, inadequate sanitation, environmental degradation, and fragmented health systems that disproportionately affect the urban poor [7]. In such contexts, urban living may expose children to nutritional risk through food insecurity, sedentary behavior, and poor dietary choices driven by the proliferation of ultra-processed foods and limited access to nutritious options, especially in informal or peri-urban settlements [8,9].

The UNICEF conceptual framework of child undernutrition identifies the interplay of immediate (dietary intake, illness), underlying (household food security, maternal care, health services), and basic causes (sociopolitical context and resources) in shaping nutritional outcomes [10]. Urban or rural geographical setting modulates these determinants through its influence on infrastructure, service delivery, and exposure to socioeconomic inequality. Additionally, the social determinants of health model underscores that structural inequities, including housing, income, and education, can differentially impact child nutrition in urban versus rural contexts [11]. Collectively, these frameworks justify the inclusion of urban–rural stratification in nutritional analysis and highlight the need to examine intra-urban heterogeneity to avoid masking disparities with aggregate classifications.

Understanding the determinants of child undernutrition requires a multi-level framework that accounts for both structural and behavioral drivers. From a life-course and ecological perspective, child nutritional status is influenced not only by food intake but also by maternal health, healthcare access, sanitation, and social determinants such as poverty and education [12]. This study includes anthropometric indicators—weight-for-age, height-for-age, and weight-for-height—as they are internationally recognized proxies for acute and chronic malnutrition. We also assess dietary practices, such as Minimum Dietary Diversity, Minimum Meal Frequency, Minimum Acceptable Diet, representing both availability and caregiver behavior. Lastly, we incorporate maternal care variables, particularly antenatal care (ANC) coverage, given its well-established role in improving birth outcomes, early growth, and feeding practices.

Central Java and South Sulawesi were selected for case studies due to their contrasting geography, urbanization patterns, and health system structures. Central Java includes mature urban centers with proximity to referral hospitals and education hubs [13,14], while South Sulawesi offers a mix of highland and coastal districts with variable infrastructure [15]. By comparing nutritional indicators across selected districts within these provinces, this study aimed to investigate whether urban status alone ensures nutritional advantage. At the national level, we examine urban–rural disparities in dietary and maternal health variables using the *Survei Status Gizi Indonesia* 2024 (SSGI; Indonesian Nutritional Status Survey).

Methods

Study design

This ecological, cross-sectional study examined nutritional disparities among children under five in Indonesia, using data from the 2024 SSGI. We focused on urban–rural patterns because this stratification is a policy-relevant proxy for differences in food environments, health-service access, infrastructure, and socioeconomic opportunity, while recognizing that "urban" settings are heterogeneous. To avoid masking local inequities by national averages, the national-level analysis was complemented with district-level case studies in Central Java and South Sulawesi to illustrate sub-provincial variations.

Data source

The 2024 SSGI was a nationally representative survey conducted by the Indonesian Ministry of Health in collaboration with Statistics Indonesia (BPS). The target population included all households with children under five years of age across the country. A total of 345,000 under-five households were selected from 34,500 census blocks covering all 514 districts/cities, with each block contributing 10 households. Sampling followed a two-stage, one-phase stratified design. In the first stage, census blocks were selected using probability proportional to size with replacement. In the second stage, under-five households were selected systematically from updated household listings conducted prior to sampling. Response rates were 92.5% for households, 97.1% for children visited, and 98.7% for completed interviews, yielding 42,893 under-five children in the final dataset.

Urban–rural classification

The 2024 SSGI used urban–rural classification criteria established by Statistics Indonesia (BPS), which are applied at the level of census blocks, not at the level of individual households or respondents. Each census block was categorized as either urban or rural based on a composite scoring system. This classification system considers the following indicators: (1) Population density; (2) percentage of households working in the agricultural sector; (3) access to urban-type facilities (such as schools or universities, health services, roads, markets, electricity, and telecommunication); and (4) percentage of households working in agriculture. Census blocks meeting the urban threshold across these criteria were labeled as urban; all others were considered rural. This classification was applied uniformly in both national-level comparisons and sub-provincial case studies.

National-level urban–rural comparison

Firstly, all indicators were originally reported in percentages and were converted to absolute counts by multiplying each proportion by the number of under-five children with available data for each respective item. Nutritional status was assessed using three anthropometric indices—weight-for-age (severely underweight, underweight, normal, at-risk overweight), height-for-age (stunting, severely stunting, normal), and weight-for-height (wasting, severely wasting, normal, overweight/obese)—which were derived from direct measurements of children's body weight and length/height performed by trained enumerators using standardized equipment. Dietary indicators such as Minimum Dietary Diversity (MDD), Minimum Meal Frequency (MMFF), and Minimum Acceptable Diet (MAD) were estimated based on caregiver-reported 24-hour recall of food intake. Additional dietary variables captured whether the child consumed specific food types (protein-rich foods, sweet beverages, unhealthy foods such as fried snacks or instant noodles, and vegetables or fruits) in the preceding 24 hours. Service-related variables reflected health service coverage and utilization, also collected through caregiver interviews. These included whether the child received routine growth monitoring and whether the mother accessed antenatal care (ANC) during pregnancy. ANC utilization was categorized into four levels: basic coverage (at least one visit with a skilled provider), first-trimester ANC, adequate ANC (four or more visits with appropriate spacing), and comprehensive ANC (six or more visits across trimesters, including consultations with a medical doctor and ultrasound examination).

District-level case studies

To explore local variation in child nutritional outcomes beyond broad urban–rural classifications, we conducted district-level case studies in two provinces—Central Java and South Sulawesi—selected for their contrasting geography and health system profiles. Within each province, we purposively selected a diverse set of districts representing a spectrum of settlement types, including provincial capitals, secondary cities, peri-urban areas, and rural or highland districts. In Central Java, selected districts included Magelang, Surakarta, Semarang, Pekalongan and Tegal Municipality, Grobogan, and Blora. In South Sulawesi, we included Makassar, Palopo, and Pare-pare Municipalities, Enrekang, Luwu Timur, Tana Toraja, and Toraja Utara. These districts were chosen to capture variation in urban scale (small versus large), geographic accessibility (such as coastal, inland, or mountainous), and availability of local health infrastructure.

Outcome emphasis, and data handling

Anthropometric outcomes included underweight (weight-for-age), stunting (height-for-age), and wasting (weight-for-height), reported in SSGI as categorical distributions. We emphasized stunting and underweight because they capture chronic and cumulative nutritional disadvantage and are therefore more informative for assessing structural geographic inequities; wasting was retained as a secondary indicator reflecting more acute or short-term nutritional stress and may be more episodic across settings. All indicators were analyzed at aggregated levels (national by urban/rural; and selected districts for case studies). For national analyses, percentages were converted into counts by multiplying each proportion by its indicator-specific denominator. Because denominators can vary across items, available-case denominators were used for each indicator.

Statistical analysis

All statistical analyses were conducted using RStudio (version 2024.04.2–764, running R version 4.3.3). Descriptive statistics were calculated to summarize each variable by urban–rural classification at the national level. Logistic regression models were applied to estimate odds ratios (ORs) with 95% confidence intervals (CIs) and corresponding p-values, using normal nutritional status or sufficient health service coverage as the reference group. Statistical significance was defined as a two-tailed p-value <0.05. For district-level case studies, we examined intra-urban variation through pairwise comparisons of selected districts within Central Java and South Sulawesi. For each district pair, 2×2 contingency tables were constructed for categorical nutritional outcomes, and Chi-square tests were used to estimate ORs and p-values. Only districts with complete data across all four nutritional status (W/A) categories (severely underweight, underweight, normal, at-risk overweight) were included in the pairwise analysis.

Results

National-level urban–rural disparities

Comparisons of child nutritional status, dietary practices, and maternal–child health service utilization between rural and urban populations at the national level are presented in **Table 1**. Urban residence was consistently associated with lower odds of undernutrition across most anthropometric indicators. Compared to rural children, urban children had significantly lower odds of being severely underweight (OR: 0.78; 95%CI: 0.75–0.81; p<0.001) and underweight (OR: 0.82; 95%CI: 0.80–0.84; p<0.001), but higher odds of being at risk of overweight (OR: 1.35; 95%CI: 1.31–1.40; p<0.001). Similarly, urban children had lower odds of stunting (OR: 0.77; 95%CI: 0.75–0.78; p<0.001) and severe stunting (OR: 0.63; 95%CI: 0.61–0.66; p<0.001) compared to their rural counterparts. For wasting status, urban children had slightly lower odds of wasting (OR: 0.95; 95%CI: 0.93–0.98; p=0.002) and markedly lower odds of severe wasting (OR: 0.79; 95%CI: 0.74–0.84; p<0.001). The likelihood of being overweight or obese was also significantly higher among urban children (OR: 1.20; 95%CI: 1.15–1.25; p<0.001).

Table 1. Distribution of child nutritional status, dietary indicators, and maternal–child health service coverage by area of residence (urban versus rural)

Variable	Urban	Rural	OR (95%CI)	*p*-value
Nutritional status (W/A)				
Normal	123,333	109,290	Ref	Ref
Severely underweight	4,253	4,838	0.78 (0.75–0.81)	<0.001
Underweight	20,319	21,915	0.82 (0.80–0.84)	<0.001
Risk of overweight	9,766	6,404	1.35 (1.31–1.40)	<0.001
Stunting status (H/A)				
Normal	129,064	109,682	Ref	Ref
Stunting	22,453	24,831	0.77 (0.75–0.78)	<0.001
Severely stunting	5,495	7,378	0.63 (0.61–0.66)	<0.001
Wasting status (W/H)				
Normal	139,207	125,875	Ref	Ref
Wasting	9,530	9,031	0.95 (0.93–0.98)	0.002
Severely wasting	1,719	1,976	0.79 (0.74–0.84)	<0.001
Overweight and obese	5,624	4,233	1.20 (1.15–1.25)	<0.001
MDD				
Sufficient	23,388	17,975	Ref	Ref
Insufficient	22,382	22,693	0.76 (0.74–0.78)	<0.001
MMFF				
Sufficient	12,495	5,801	Ref	Ref
Insufficient	17,69	1,975	0.42 (0.39–0.45)	<0.001
MAD				
Sufficient	17,942	10,306	Ref	Ref
Insufficient	30,092	22,582	0.77 (0.74–0.79)	<0.001
Protein intake (24 h)				
Yes	42,025	27,251	Ref	Ref
No	9,794	84,64	0.75 (0.73–0.78)	<0.001
Sweet-beverage intake (24 h)				
Yes	5,617	4,520	0.84 (0.81–0.88)	<0.001
No	46,395	31,352	Ref	Ref
Unhealthy food intake (24 h)				
Yes	25,337	15,721	1.22 (1.19–1.25)	<0.001
No	26,689	20,172	Ref	Ref
Vegetable intake (24 h)				
Yes	12,356	9,619	Ref	Ref
No	39,561	26,141	1.18 (1.14–1.22)	<0.001
Standard growth monitoring				
Received	83,750	79,347	Ref	Ref
Not received	46,905	38,379	1.16 (1.14–1.18)	<0.001
ANC coverage (≥1 visit)				
Received	152,935	133,929	Ref	Ref
Not received	4,730	8,549	0.48 (0.47–0.50)	<0.001
First-trimester ANC visit				
Received	134,015	115,265	Ref	Ref
Not received	23,650	27,213	0.75 (0.73–0.76)	<0.001
Adequate ANC coverage				
Received	124,082	102,157	Ref	Ref
Not received	33,583	40,321	0.69 (0.67–0.70)	<0.001
Comprehensive ANC				
Received	52,187	29,635	Ref	Ref
Not received	105,478	112,843	0.53 (0.52–0.54)	<0.001

Basic ANC coverage: ≥1 visit with skilled provider; adequate ANC coverage: 4+ visits with skilled provider, appropriately spaced; comprehensive ANC: 6+ visits with trimester-based schedule and minimum 2 doctor contacts with ultrasound

Dietary indicators revealed that rural children were less likely to meet dietary adequacy. The odds of insufficient Minimum Dietary Diversity (MDD) were higher among rural children (OR: 0.76; 95%CI: 0.74–0.78; $p<0.001$), and they were also less likely to meet the Minimum Meal Frequency (MMFF) standard (OR: 0.42; 95%CI: 0.39–0.45; $p<0.001$). Similarly, the odds of receiving a Minimum Acceptable Diet (MAD) were lower for rural children (OR: 0.77; 95%CI: 0.74–0.79; $p<0.001$). In terms of 24-hour dietary recall, rural children had significantly lower odds of consuming protein-rich foods (OR: 0.75; 95%CI: 0.73–0.78; $p<0.001$). Interestingly, they were also less likely to consume sweet beverages (OR: 0.84; 95%CI: 0.81–0.88; $p<0.001$), but more likely to consume unhealthy foods (OR: 1.22; 95%CI: 1.19–1.25; p<0.001) and less likely to consume vegetables or fruits (OR: 1.18; 95%CI: 1.14–1.22; p<0.001).

Service utilization indicators showed consistent disadvantages in rural areas. The odds of not receiving standard growth monitoring were significantly higher among rural children (OR: 1.16; 95%CI: 1.14–1.18; p<0.001). Likewise, rural mothers had lower odds of receiving any antenatal care (ANC) (OR: 0.48; 95%CI: 0.47–0.50; p<0.001), initiating ANC in the first trimester (OR: 0.75; 95%CI: 0.73–0.76; p<0.001), completing adequate ANC (OR: 0.69; 95%CI: 0.67–0.70; p<0.001), and meeting the criteria for comprehensive ANC (OR: 0.53; 95%CI: 0.52–0.54; p<0.001).

District-level nutritional disparities in Central Java

To complement the national-level urban–rural findings and explore whether nutrition-related advantages differ across local settings, we conducted district-level comparisons within Central Java, where the results are presented in **Table 2**. Magelang Municipality consistently showed more favorable nutritional outcomes compared to other urban districts. The odds of severe underweight were significantly lower in Magelang than in Surakarta (OR: 0.25; 95%CI: 0.09–0.70; p=0.008), Pekalongan (OR: 0.20; 95%CI: 0.08–0.52; p<0.001), Tegal (OR: 0.15; 95%CI: 0.06–0.39; p=0.001), and Grobogan (OR: 0.17; 95%CI: 0.06–0.43; p<0.001). A similar but statistically nonsignificant pattern was observed against Blora (OR: 0.37; 95%CI: 0.13–1.06; p=0.064). In addition, children in Magelang had significantly lower odds of being underweight compared to children in Pekalongan (OR: 0.62; 95%CI: 0.46–0.85; p=0.002), Tegal (OR: 0.73; 95%CI: 0.54–1.00; p=0.048), Grobogan (OR: 0.67; 95%CI: 0.50–0.91; p=0.009), and Blora (OR: 0.63; 95%CI: 0.46–0.85; p=0.003).

Table 2. Pairwise comparisons of child nutritional status between selected urban districts in Central Java

Nutritional status (district A vs B)	District A	District B	OR (95%CI)	p-value
Magelang vs Surakarta				
Normal	541	410	Ref	Ref
Severely underweight	5	15	0.25 (0.09–0.70)	0.008
Underweight	84	62	1.03 0.72–1.46	0.883
At-risk overweight	42	36	0.88 (0.56–1.41)	0.602
Magelang vs Surakarta				
Normal	541	392	Ref	Ref
Severely underweight	5	5	0.72 (0.21–2.52)	0.612
Underweight	84	45	1.35 (0.92–1.99)	0.124
At-risk overweight	42	44	0.69 (0.44–1.08)	0.102
Surakarta vs Semarang				
Normal	410	392	Ref	Ref
Severely underweight	15	5	2.87 (1.03–7.97)	0.043
Underweight	62	45	1.32 (0.88–1.98)	0.186
At-risk overweight	36	44	0.78 (0.49–1.24)	0.297
Magelang vs Pekalongan Municipalities				
Normal	541	549	Ref	Ref
Severely underweight	5	26	0.20 (0.08–0.52)	<0.001
Underweight	84	135	0.62 (0.46–0.85)	0.002
At-risk overweight	42	37	1.15 (0.73–1.82)	0.545
Magelang vs Tegal Municipalities				
Normal	541	499	Ref	Ref
Severely underweight	5	31	0.15 (0.06–0.39)	0.001
Underweight	84	106	0.73 (0.54–1.00)	0.048
At-risk overweight	42	31	1.25 (0.77–2.02)	0.363
Magelang Municipality vs Grobogan				
Normal	541	578	Ref	Ref
Severely underweight	5	32	0.17 (0.06–0.43)	<0.001
Underweight	84	133	0.67 (0.50–0.91)	0.009
At-risk overweight	42	28	1.60 (0.98–2.62)	0.06
Magelang Municipality vs Blora				
Normal	541	435	Ref	Ref
Severely underweight	5	11	0.37 (0.13–1.06)	0.064
Underweight	84	108	0.63 (0.46–0.85)	0.003
At-risk overweight	42	30	1.13 (0.69–1.83)	0.632

Interestingly, the difference between Magelang and Semarang—Central Java's provincial capital—was not statistically tested directly in this comparison, but Semarang outperformed Surakarta in terms of severe underweight, with children in Surakarta having higher odds (OR: 2.87; 95%CI: 1.03–7.97; *p*=0.043). Meanwhile, pairwise comparisons involving Surakarta yielded mixed results: while no difference in underweight status was detected between Surakarta and Magelang (OR: 1.03; *p*=0.883), Surakarta had significantly higher odds of severe underweight compared to Semarang. No statistically significant differences were found between districts for the risk of overweight, although children in Grobogan showed a near-significantly higher risk compared to those in Magelang (OR: 1.60; 95%CI: 0.98–2.62; *p*=0.060).

District-level nutritional disparities in South Sulawesi

District-level comparisons of child nutritional status across selected areas in South Sulawesi are presented in **Table 3**. These comparisons were conducted between provincial capitals, mid-tier urban centers, and highland or resource-based districts to explore local disparities beyond national trends. Makassar Municipality, the provincial capital, showed significantly better outcomes in undernutrition indicators compared to Pare-pare Municipality. Children in Makassar had lower odds of being severely underweight (OR: 0.42; 95%CI: 0.23–0.77; *p*=0.005) and underweight (OR: 0.74; 95%CI: 0.55–0.98; *p*=0.037), though the difference in at-risk overweight was not statistically significant (OR: 1.39; *p*=0.235).

Table 3. Pairwise comparisons of child nutritional status between selected urban districts in South Sulawesi

Nutritional status (district A vs B)	District A	District B	OR (95%CI)	*p*-value
Makassar vs Pare-pare Municipalities				
Normal	541	395	Ref	Ref
Severely underweight	18	31	0.42 (0.23–0.77)	0.005
Underweight	117	116	0.74 (0.55–0.98)	0.037
At-risk overweight	40	21	1.39 (0.81–2.40)	0.235
Makassar Municipality vs Tana Toraja				
Normal	541	556	Ref	Ref
Severely underweight	18	9	2.06 (0.92–4.62)	0.081
Underweight	117	67	1.79 (1.30–2.48)	<0.001
At-risk overweight	40	28	1.47 (0.89–2.41)	0.13
Makassar Municipality vs Toraja Utara				
Normal	541	528	Ref	Ref
Severely underweight	18	17	1.03 (0.53–2.03)	0.924
Underweight	117	76	1.50 (1.10–2.05)	0.011
At-risk overweight	40	21	1.86 (1.08–3.20)	0.025
Palopo Municipality vs Enrekang				
Normal	497	535	Ref	Ref
Severely underweight	22	24	0.99 (0.55–1.78)	0.965
Underweight	128	92	1.50 (1.12–2.01)	0.007
At-risk overweight	25	16	1.68 (0.89–3.19)	0.111
Palopo Municipality vs Luwu Timur				
Normal	464	464	Ref	Ref
Severely underweight	17	17	1.21 (0.63–2.30)	0.570
Underweight	105	105	1.14 (0.85–1.52)	0.380
At-risk overweight	21	44	0.53 (0.32–0.88)	0.014

However, when Makassar was compared to the highland district of Tana Toraja, the results were reversed. Makassar had higher odds of underweight (OR: 1.79; 95%CI: 1.30–2.48; *p*<0.001), and though not statistically significant, also showed a trend toward higher severe underweight (OR: 2.06; *p*=0.081) and at-risk overweight (OR: 1.47; *p*=0.13). A similar pattern was observed in the comparison between Makassar and Toraja Utara, where children in Makassar had significantly higher odds of underweight (OR: 1.50; 95%CI: 1.10–2.05; *p*=0.011) and at-risk overweight (OR: 1.86; 95%CI: 1.08–3.20; *p*=0.025), with no difference in severe underweight (OR: 1.03; *p*=0.924).

Palopo Municipality, a mid-sized city, also displayed variation in nutritional outcomes depending on the district of comparison. Compared to Enrekang, children in Palopo had significantly higher odds of underweight (OR: 1.50; 95%CI: 1.12–2.01; *p*=0.007), with no differences in severe underweight or at-risk overweight. Interestingly, Palopo and Luwu Timur had identical counts for normal weight, severely underweight, and underweight categories, resulting in non-significant differences for both severely underweight (OR: 1.21; 95%CI: 0.63–2.30; *p*=0.570) and underweight (OR: 1.14; 95%CI: 0.85–1.52; *p*=0.380). However, children in Palopo had significantly lower odds of being at risk of being overweight compared to those in Luwu Timur (OR: 0.53; 95%CI: 0.32–0.88; *p*=0.014).

Discussion

Findings from the present study reveals a persistent and multifaceted urban–rural divide in nutritional and maternal health indicators among under five children in Indonesia. Children living in rural districts had significantly higher odds of being severely underweight, underweight, stunted, and severely stunted than their urban counterparts [16]. Although wasting was only marginally higher in rural areas, the odds of severe wasting were significantly elevated. Conversely, urban children were more likely to be at risk of being overweight, confirming the early signs of a double burden of malnutrition in urban settings [17].

The findings in this present study also suggest that rural children were less likely to meet MDD, MMFF, and MAD. Rural children also had lower reported protein intake and vegetable consumption, with higher consumption of unhealthy foods and sugar-sweetened beverages. These results indicate both dietary insufficiencies and growing exposure to energy-dense foods among rural children [18,19]. Herein, rural children were found to be more likely to miss standard growth monitoring. Mothers in rural districts were less likely to access antenatal care, whether defined as ≥1 visit, first-trimester initiation, adequate ANC, or comprehensive ANC. These disparities reflect systemic barriers in rural healthcare access, continuity, and quality, as supported in previous research [20]. Further, our findings are aligned with a published systematic review revealing that food availability and accessibility in rural environments were the most consistently associated with diet quality and nutritional status [21]. Limited availability of nutritious foods and poor access to formal or informal food vendors in rural areas of LMICs are drivers for persistent undernutrition [21].

The Central Java comparisons, in the present study, reinforce the idea that urbanicity does not automatically confer nutritional advantage, as Magelang Municipality performed better than several other urban or semi-urban districts for severe underweight and underweight. On contrary, districts like Surakarta and Pekalongan, despite being well-known urban centers, show underperformance in key indicators, warranting targeted intervention. This within-urban heterogeneity is compatible with Indonesian evidence that household structure and social stratification can produce concurrent undernutrition and overweight risks within the same broad setting, thereby weakening the “average urban advantage” narrative. A plausible interpretation is that smaller urban systems may sometimes deliver more effective outreach or more consistent primary-care follow-up, while larger cities may contain pockets of vulnerability that elevate undernutrition indicators despite better overall infrastructure [2].

In South Sulawesi, Makassar showed better outcomes than Pare-pare for severe underweight and underweight, consistent with the national pattern. However, Makassar had worse odds of underweight compared with highland districts (Tana Toraja and Toraja Utara), indicating that geography and “infrastructure advantage” alone are insufficient explanations and that local food practices, service performance, or community-level protective factors may shape outcomes. This further suggests that geographic location alone does not explain disparities, given that cultural or programmatic factors (such as community feeding practices or ANC coverage) may shape the nutritional status [11]. Moreover, findings from the present study reveal that risk of overweight was higher in Toraja Utara, highlighting the early emergence of nutrition transition even in traditionally undernourished regions [22]. Palopo presented as a middle-tier city with mixed outcomes. Compared to Enrekang, Palopo had higher underweight, yet no difference in other indicators. Against Luwu Timur—a resource-rich district—Palopo had a significantly lower risk of overweight, pointing to local dietary transitions that may not track neatly with urbanization level. These district comparisons indicate three critical insights: (1) urban–rural divides persist even within provinces; (2) urbanicity does not automatically confer nutritional protection; and

(3) districts experiencing economic growth may face accelerated nutrition transitions, sometimes outpacing preventive health services.

In rural areas, strengthening maternal services, expanding ANC coverage, and improving dietary diversity must be prioritized. However, as suggested previously, these efforts will remain limited without equitable distribution of healthcare facilities and skilled personnel, particularly in remote or geographically isolated regions [5]. In urban settings—especially in major cities like Makassar—early-onset obesity and poor dietary quality demand greater attention, as sedentary lifestyles and increased access to energy-dense, nutrient-poor foods begin to shape health outcomes [23]. Notably, smaller cities such as Magelang may serve as models of localized success, possibly due to closer proximity to provincial health hubs and more adaptable primary care systems. These findings highlight how national-level averages can obscure important sub-provincial disparities [24]. As Indonesia advances toward universal health coverage and expands initiatives such as the *Makan Bergizi Gratis program* (MBG; Free Nutritious Meals), and the establishment of a *Badan Gizi Nasional* (BGN; National Nutrition Agency), nutrition planning must be decentralized and responsive to district-level realities [25]. In addition to addressing structural determinants—like healthcare infrastructure and workforce distribution—greater attention must be paid to behavioral factors, including food preferences and lifestyle patterns [26].

These findings reflect a complex interplay of behavioral, structural, and environmental determinants. In rural areas, undernutrition remains strongly linked to systemic disparities in health infrastructure, including fewer skilled personnel, longer travel distances to health facilities, and inconsistent service availability—challenges well documented in the Indonesian context [16,27]. Lower maternal education and food insecurity may further limit caregivers' ability to ensure adequate child nutrition [28]. In contrast, urban areas—though better served by health infrastructure—face a different set of challenges. Rapid urbanization has reshaped family diets and behaviors, with increased exposure to processed foods, limited time for home meal preparation, and easy access to sugar-sweetened beverages and fast-food outlets [29]. These patterns contribute to rising overweight and obesity even in children [30]. Furthermore, urban children often live in environments characterized by limited safe play spaces, screen-centered entertainment, and reduced physical activity, which contribute to more sedentary lifestyles [31]. Urban parents may also adopt permissive feeding styles or be more influenced by commercial food marketing [32,33]. In cities like Makassar, this nutritional transition may be compounded by social inequalities and household income disparities, which can influence both food quality and lifestyle behaviors.

Despite recent policy efforts such as MBG and the establishment of the BGN, the government's approach still tends to emphasize programmatic delivery—such as food provision and service expansion—without adequately addressing the behavioral determinants and systemic poverty that sustain malnutrition [25,34,35]. These top-down initiatives often treat undernutrition as a matter of food absence or service gaps, yet fail to engage with how household behaviors, cultural norms, or parental knowledge influence child-feeding practices and health service utilization. For example, even where food is available, choices may be shaped by deeply embedded habits, misinformation, or economic constraints that push families toward calorie-dense, low-nutrient foods [36,37]. Moreover, the current model insufficiently tackles structural poverty, which remains a root driver of both undernutrition and poor maternal health coverage. In many rural and semi-urban areas, families face intergenerational disadvantages—limited education, insecure employment, and fragile social safety nets—that cannot be resolved through food assistance alone. Without stronger integration of social protection, nutrition education, and behavior change interventions, such programs risk being palliative rather than transformative [5,38].

It is worth to mention that urban interventions often focus on supply-side measures—monitoring school meals, regulating food sales, or expanding health posts—while ignoring the social determinants of overweight and obesity, such as sedentary living, aggressive food marketing, and unequal access to recreational spaces [23,39]. Children growing up in poor urban neighborhoods may face the paradox of food abundance but health scarcity, where cheap, unhealthy food is ubiquitous, yet safe water, green spaces, and time for physical activity are limited [40,41].

Despite offering valuable insights, this study is not without limitations. The use of aggregate data from the 2024 SSGI precluded individual-level adjustments, limiting our ability to assess the influence of household or parental factors on nutritional outcomes. Several indicators, particularly those related to dietary intake and service utilization, relied on caregiver recall, which may introduce recall bias or overreporting. While anthropometric measurements were drawn from direct observation, inconsistencies in field procedures and equipment calibration across districts may affect data quality. Additionally, count approximations from proportion data may carry minor rounding errors, though unlikely to alter directionality of findings. Finally, the district case studies were purposively selected and may not reflect broader intra-provincial dynamics.

Conclusion

There are persistent and complex disparities in child nutrition and maternal care across Indonesia, shaped not only by rural–urban divides but also by local structural and systemic factors. At the national level, rural children consistently experience higher risks of undernutrition, limited dietary diversity, and inadequate maternal health service coverage. "Sub-provincial case studies in Central Java and South Sulawesi demonstrate that nutritional outcomes vary not only between urban and rural areas but also within urban and rural districts themselves. These intra-urban disparities suggest that factors such as local health system performance, geographic proximity to referral centers, socioeconomic conditions, and district-level governance may play a more decisive role than urbanization alone. To reduce malnutrition and promote equity in child health, Indonesia must enhance the effectiveness of its decentralized health systems and ensure interventions are tailored to specific local needs. In rural settings, this includes improving access to antenatal care and dietary diversity, while also tackling the structural poverty that underlies these gaps. In urban and transitioning districts, greater attention is needed to address the rising risk of overweight among children, driven by lifestyle-related factors such as poor diet quality and physical inactivity.

Ethics approval

This study analyzed secondary, fully anonymized data from the SSGI 2024. Ethical approval was not required as no identifiable personal information was collected, in accordance with national regulations for the use of publicly available survey datasets.

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Competing interests

The authors declare that they have no competing interests.

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Underlying data

The datasets analyzed in this study are publicly available through the Indonesian Ministry of Health's SSGI 2024 repository. Additional materials generated during the analysis are available from the corresponding author upon reasonable request.

Declaration of artificial intelligence use

Artificial intelligence tools, including ChatGPT, were used to support language refinement, structural editing, and formatting of the manuscript. All analytical decisions, interpretation of findings, and final approval of the content were made solely by the authors. The authors take full responsibility for the integrity and accuracy of the manuscript.

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