



## NON COMMUNICABLE DISEASE

# Personal Hygiene Behaviors and Socioeconomic Determinants of Child Undernutrition: A National Cross-Sectional Study in Indonesia

YOYOK BEKTI PRASETYO<sup>1</sup>, RENDY KAVALERA HAKIM<sup>2</sup>, WAN MARINA WAN ISMAIL<sup>3</sup>, HALIZA HASAN<sup>4</sup>,  
NUR MELLIZA<sup>5</sup>, HENNY DWI SUSANTI<sup>6</sup>, IKA RIZKI ANGGRAINI<sup>7</sup>

<sup>1</sup> Department of Community Health Nursing, Magister of Nursing, University Muhammadiyah of Malang, Indonesia;

<sup>2</sup> Bachelor student of nursing, Faculty of Health Sciences, University of Muhammadiyah Malang, Indonesia; <sup>3</sup> Center for Nursing Studies, Faculty of Health Sciences, Universiti Teknologi MARA Puncak Alam Campus, Malaysia; <sup>4</sup> Department of Master of Nursing, Kuliyah of Nursing, International Islamic University Malaysia, Malaysia; <sup>5</sup> Department of Community Nursing, Faculty of Health Sciences, University of Muhammadiyah Malang, Indonesia; <sup>6</sup> Department of Women's Health Magister of Nursing, University Muhammadiyah of Malang, Indonesia; <sup>7</sup> Department of Nursing, Child Health, Faculty of Health Sciences, University of Muhammadiyah Malang, Indonesia

## Keywords

Child undernutrition • Stunting • Wasting • Underweight • Sanitation • Socioeconomic factors • Survey-weighted analysis • Indonesia

## Summary

**Background.** Child undernutrition remains a major public health concern in Indonesia. Evidence on the roles of household environmental and socioeconomic factors, based on nationally representative data analyzed using appropriate complex survey methods, remains limited. This study examined the associations between these factors and stunting, wasting, and underweight among Indonesian children under five years.

**Methods.** A cross-sectional analysis was conducted using data from the 2022 Indonesian Nutrition Status Survey (SSGI), which represents approximately 17.1 million children under 5. Survey-weighted descriptive statistics, Rao-Scott adjusted  $\chi^2$  tests, and multivariable logistic regression accounting for the complex sampling design were performed to estimate adjusted odds ratios (AORs) and 95% confidence intervals (CIs).

**Results.** Regional disparities and parental socioeconomic characteristics were consistently associated with all three forms of

undernutrition. Compared with Eastern Indonesia, children living in Western Indonesia had lower odds of stunting (AOR=0.63, 95% CI: 0.57-0.69), wasting (AOR=0.56, 95% CI: 0.50-0.62), and underweight (AOR=0.58, 95% CI: 0.51-0.66). Low parental education and parental unemployment were independently associated with higher odds of all three outcomes (all  $p<0.01$ ). Unimproved sanitation and inadequate solid waste management were associated with stunting, whereas unimproved sanitation was also associated with wasting.

**Conclusion.** Child undernutrition in Indonesia is independently associated with regional inequalities, parental socioeconomic disadvantage, and selected household environmental conditions. Multisectoral interventions that target disadvantaged regions, improve parental socioeconomic conditions, and strengthen sanitation infrastructure are needed to reduce child undernutrition.

## Introduction

Child undernutrition remains a major challenge for nursing science and practice. It reflects not only inadequate dietary intake but also caregiving behaviors, household environmental conditions, and interactions with health systems within families [1-3]. From a nursing perspective, stunting, wasting, and underweight represent nursing-sensitive outcomes because daily caregiving practices shape them. Nurses assess, guide, and strengthen these practices through family-centered and community-based interventions [4, 5].

Globally, stunting affected approximately 22% of children under five in 2020, representing 149.2 million children [6]. Indonesia continues to face a substantial burden. Although national prevalence declined from 24.4% in 2021 to 21.5% in 2023 [7], the rate remains above the World Health Organization target of below 20% and far from the national target of 14% [8]. These figures

indicate that structural and behavioral determinants continue to limit progress beyond improvements in food access alone.

Household hygiene practices play a critical role in child growth. Caregivers influence exposure to infection through water use, sanitation, waste management, and daily cleanliness [9]. Poor hygiene increases the risk of enteric infections, disrupts nutrient absorption, and contributes to growth faltering [10]. Nurses routinely address these modifiable behaviors during home visits, growth monitoring, and community outreach. Effective nutrition strategies, therefore, must extend beyond food provision and incorporate environmental and behavioral care [11].

Socioeconomic conditions further shape caregiving capacity. Education, employment, and access to health services determine whether families can maintain hygienic environments and respond to their child's health needs [12, 13]. Community and primary care

nurses frequently encounter these structural constraints, which influence the effectiveness of health education and early intervention [14].

Despite extensive research on child undernutrition, few studies integrate hygiene behaviors and socioeconomic conditions within a unified nursing framework at the national level. Most studies examine dietary intake or poverty in isolation. This study addresses that gap by examining how personal hygiene behaviors and socioeconomic factors jointly influence stunting, wasting, and underweight among Indonesian children under five. By framing these determinants as nursing-sensitive, this research strengthens the evidence base for nurse-led, family-centered strategies to reduce child undernutrition.

## Methods

### STUDY DESIGN AND DATA SOURCE

This study analyzed nationally representative data collected through the 2022 Indonesian Nutrition Status Survey (SSGI). The SSGI is a nationally representative survey conducted by the Ministry of Health of the Republic of Indonesia through the Center for Data and Information Technology, in collaboration with Statistics Indonesia. The survey was designed to provide comprehensive national and subnational estimates of children's nutritional status under 5 years of age.

### STUDY POPULATION AND SAMPLING

The study population comprised all children aged 0-59 months included in the SSGI 2022 database. The survey applied a multistage stratified cluster sampling Design based on the 2020 Population Census sampling frame to ensure representativeness across provinces, districts, and urban-rural settings. For the present analysis, children were included if they had complete anthropometric measurements and complete data on household hygiene conditions and socioeconomic characteristics. After data cleaning and eligibility screening, approximately 59,577 children were included in the final analytical sample.

### VARIABLES AND MEASUREMENTS

#### *Outcome Variables*

##### Child Nutritional Status

Child nutritional status was the primary outcome variable and was assessed using three standardized anthropometric indicators recommended by the World Health Organization (WHO): stunting, wasting, and underweight.

Stunting was defined as a height-for-age z-score (HAZ) < -2 standard deviations (SD), wasting as a weight-for-height z-score (WHZ) < -2 SD, and underweight as a weight-for-age z-score (WAZ) < -2 SD. Anthropometric z-scores were calculated by the SSGI using WHO growth standards and were obtained directly from the secondary dataset.

Each nutritional outcome was dichotomized into undernourished (< -2 SD) and normal nutritional status ( $\geq -2$  SD) and treated as a nominal variable in the statistical analysis.

#### *Exposure Variables*

##### Personal hygiene behaviours

Personal hygiene behaviors were defined as nursing-sensitive household-level caregiving practices that influence children's exposure to enteric pathogens and subsequent nutritional outcomes. These behaviors primarily reflect routine actions undertaken by mothers or primary caregivers and represent modifiable targets of nurse-led family and community health interventions. Personal hygiene behaviors were measured using four indicators derived from the Clean and Healthy Living Behavior framework incorporated in the Survei Status Gizi Indonesia (SSGI) 2022 questionnaire: (1) household drinking water source, (2) drinking water treatment practices, (3) ownership and use of an improved sanitary latrine, and (4) household solid waste management. All indicators were obtained through structured household interviews and recoded in accordance with national hygiene and sanitation standards.

Household drinking water sources were initially classified into thirteen categories and subsequently dichotomized into good sources (bottled water, refill water, piped water, bore wells, protected dug wells, protected springs, public hydrants, and water terminals) and poor sources (unprotected wells, unprotected springs, rainwater storage, surface water, and informal water vendors). Drinking water treatment practices were coded as good when water was boiled before consumption and as poor when it was untreated. Ownership of an improved sanitary latrine was coded as yes when households had access to and used a private or shared latrine, and as no when no latrine was available or utilized. Solid waste management was classified as adequate when waste was managed through formal collection services, designated disposal sites, recycling, composting, or waste banks, and inadequate when waste was burned, buried, disposed of in rivers, or discarded indiscriminately.

##### SOCIOECONOMIC FACTORS

Socioeconomic factors were conceptualized as household-level structural determinants that shape caregivers' capacity to meet children's nutritional and healthcare needs and influence the implementation and sustainability of family-centered nursing interventions. Socioeconomic status was assessed using three indicators available in the SSGI 2022 dataset: (1) parental education level (mother and/or father), (2) parental employment status, and (3) ownership of health insurance. Parental education was dichotomized into lower education (no formal education or primary school) and higher education (secondary education or higher). Parental employment status was categorized as unemployed or employed, and health insurance ownership as yes or no.

## DATA COLLECTION PROCEDURES

Trained enumerators conducted data collection for SSGI 2022 through household visits. Structured interviews with mothers or primary caregivers were conducted using digital questionnaires administered via tablet applications. Anthropometric measurements were performed using calibrated digital scales and standardized length or height boards, in accordance with WHO measurement protocols. To enhance data accuracy and reliability, measurements were conducted by paired enumerators and entered directly into an electronic data capture system with real-time validation.

## STATISTICAL ANALYSIS

Descriptive statistics were generated using weighted frequencies and percentages to account for the complex sampling design of the 2022 Indonesian Nutrition Status Survey (SSGI). The survey employed a multistage stratified cluster sampling design; therefore, all analyses incorporated sampling weights, primary sampling units (PSUs), and stratification variables. Bivariate associations were examined using the Rao-Scott corrected chi-square test. Multivariable associations between personal hygiene behaviours, socioeconomic factors, and child undernutrition (stunting, wasting, and underweight) were estimated using survey-weighted multinomial logistic regression. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were reported. Statistical significance was defined as a two-sided  $p$ -value  $< 0.05$ . All analyses accounted for the complex survey design using the Complex Samples module in SPSS version 27.

## Results

### PARTICIPANT CHARACTERISTICS

Table I presents the weighted characteristics of children under five years and their households based on the complex sampling design of the 2022 Indonesian Nutrition Status Survey (SSGI). The survey represented an estimated 17.1 million children under five years in Indonesia.

Most children had mothers in early adulthood (65.1%; 95% CI: 64.5-65.8), followed by middle adulthood (34.6%; 95% CI: 33.9-35.2), whereas only 0.3% (95% CI: 0.2-0.4) had adolescent mothers. Geographically, three-quarters of the study population resided in Western Indonesia (75.3%; 95% CI: 74.9-75.6), while 16.9% (95% CI: 16.6-17.2) and 7.8% (95% CI: 7.6-8.1) lived in Central and Eastern Indonesia, respectively. Slightly more than half of the participants were from urban areas (54.5%; 95% CI: 53.7-55.3), whereas 45.5% (95% CI: 44.7-46.3) resided in rural settings.

Regarding socioeconomic characteristics, 80.3% (95% CI: 79.7-80.8) of parents had higher educational attainment, while 19.7% (95% CI: 19.2-20.3) had lower educational attainment. Approximately 7 in 10 households (69.9%; 95% CI: 69.2-70.5) had unemployed parents, whereas 30.1% (95% CI: 29.5-30.8) had employed parents.

**Tab. I.** Weighted characteristics of study participants and household environmental conditions among children under five years in Indonesia, SSGI 2022 (N=59,577).

| Variable                         | Category                       | Weighted % (95% CI) |
|----------------------------------|--------------------------------|---------------------|
| Maternal age                     | Late adolescence (14-19 years) | 0.3 (0.2-0.4)       |
|                                  | Early adulthood (20-35 years)  | 65.1 (64.5-65.8)    |
|                                  | Middle adulthood (36-54 years) | 34.6 (33.9-35.2)    |
| Region                           | Western Indonesia              | 75.3 (74.9-75.6)    |
|                                  | Central Indonesia              | 16.9 (16.6-17.2)    |
|                                  | Eastern Indonesia              | 7.8 (7.6-8.1)       |
| Residence                        | Urban                          | 54.5 (53.7-55.3)    |
|                                  | Rural                          | 45.5 (44.7-46.3)    |
| Household drinking water source  | Poor                           | 10.7 (10.2-11.1)    |
|                                  | Improved                       | 89.3 (88.9-89.8)    |
| Drinking water treatment         | Not boiled                     | 39.6 (39.0-40.3)    |
|                                  | Boiled                         | 60.4 (59.7-61.0)    |
| Improved sanitation facility     | Unimproved                     | 5.6 (5.4-5.9)       |
|                                  | Improved                       | 94.4 (94.1-94.6)    |
| Household solid waste management | Inadequate                     | 75.8 (75.2-76.4)    |
|                                  | Adequate                       | 24.2 (23.6-24.8)    |

Values are weighted percentages accounting for the multistage stratified cluster sampling design of the 2022 Indonesian Nutrition Status Survey (SSGI). Percentages were estimated using sampling weights, strata, and primary sampling units (PSUs). Confidence intervals were calculated using Taylor series linearization. Total unweighted sample size=59,577.

Household environmental conditions indicated that nearly all households had improved toilet facilities (99.0%; 95% CI: 98.9-99.0). However, only 24.2% (95% CI: 23.6-24.8) of households reported adequate solid waste management, whereas the majority (75.8%; 95% CI: 75.2-76.4) had inadequate waste management practices.

### BIVARIATE ASSOCIATIONS BETWEEN PARTICIPANT CHARACTERISTICS AND CHILD UNDERNUTRITION

Table II presents the weighted bivariate associations between participant characteristics and the three forms of child undernutrition after accounting for the complex survey design. Regional distribution, place of residence, parental education, parental employment, and solid waste management were significantly associated with all three nutritional outcomes (all  $p < 0.05$ ). Children residing in Eastern Indonesia rural areas, households with lower parental education, unemployed parents, and inadequate solid waste management consistently exhibited a higher prevalence of stunting, wasting, and underweight than their respective reference groups.

Environmental sanitation factors demonstrated different patterns across nutritional outcomes. Unimproved drinking water sources, lack of household drinking water treatment, and unimproved toilet facilities were significantly associated with higher prevalences of stunting and wasting (all  $p < 0.001$ ), but these associations were not observed for underweight ( $p = 0.237$ ,  $p = 0.522$ , and  $p = 0.107$ , respectively). Similarly, toilet type was

**Tab. II.** Weighted bivariate associations between participant characteristics and child undernutrition among children under five years in Indonesia, SSGI 2022.

| Variable                 | Category          | Stunting Yes (%) | <i>p</i> -value† | Wasting Yes (%) | <i>p</i> -value† | Underweight Yes (%) | <i>p</i> -value† |
|--------------------------|-------------------|------------------|------------------|-----------------|------------------|---------------------|------------------|
| Maternal age             | Late adolescence  | 22.9             | 0.220            | 16.6            | 0.026            | 7.9                 | 0.353            |
|                          | Early adulthood   | 21.1             |                  | 15.0            |                  | 8.6                 |                  |
|                          | Middle adulthood  | 22.1             |                  | 16.3            |                  | 9.1                 |                  |
| Region                   | Western Indonesia | 20.7             | <0.001           | 14.3            | <0.001           | 8.4                 | 0.000            |
|                          | Central Indonesia | 20.3             |                  | 16.4            |                  | 8.0                 |                  |
|                          | Eastern Indonesia | 31.7             |                  | 24.2            |                  | 14.0                |                  |
| Place of residence       | Urban             | 19.6             | <0.001           | 14.3            | <0.001           | 8.1                 | <0.001           |
|                          | Rural             | 23.7             |                  | 16.7            |                  | 9.6                 |                  |
| Parental education       | Low               | 26.3             | <0.001           | 18.8            | <0.001           | 10.3                | <0.001           |
|                          | High              | 20.3             |                  | 14.6            |                  | 8.4                 |                  |
| Parental employment      | Unemployed        | 22.7             | <0.001           | 16.6            | <0.001           | 9.4                 | <0.001           |
|                          | Employed          | 18.6             |                  | 12.8            |                  | 7.3                 |                  |
| Drinking water source    | Unimproved        | 26.2             | <0.001           | 18.0            | <0.001           | 9.4                 | 0.237            |
|                          | Improved          | 20.9             |                  | 15.1            |                  | 8.7                 |                  |
| Drinking water treatment | Not boiled        | 19.5             | <0.001           | 14.4            | 0.001            | 8.6                 | 0.522            |
|                          | Boiled            | 22.7             |                  | 16.1            |                  | 8.9                 |                  |
| Toilet facility          | Unimproved        | 26.4             | <0.001           | 19.3            | <0.001           | 9.9                 | 0.107            |
|                          | Improved          | 21.2             |                  | 15.2            |                  | 8.7                 |                  |
| Toilet type              | Unimproved        | 22.1             | 0.676            | 17.9            | 0.044            | 9.1                 | 0.784            |
|                          | Improved          | 21.4             |                  | 15.4            |                  | 8.8                 |                  |
| Solid waste management   | Inadequate        | 22.7             | <0.001           | 16.7            | <0.001           | 9.1                 | 0.004            |
|                          | Adequate          | 17.5             |                  | 13.6            |                  | 7.9                 |                  |
| Healthy housing          | Inadequate        | 22.9             | 0.015            | 16.1            | 0.162            | 9.2                 | 0.352            |
|                          | Adequate          | 21.1             |                  | 15.3            |                  | 8.7                 |                  |

associated with wasting ( $p=0.044$ ) but showed no significant association with either stunting ( $p=0.676$ ) or underweight ( $p=0.784$ ).

Maternal age was significantly associated with wasting ( $p=0.026$ ) but not with stunting ( $p=0.220$ ) or underweight ( $p=0.353$ ). In contrast, healthy housing conditions were associated with stunting ( $p=0.015$ ) but showed no significant association with wasting ( $p=0.162$ ) or underweight ( $p=0.352$ ).

Overall, the bivariate analysis indicated that socioeconomic and geographic characteristics were consistently associated with all forms of child undernutrition, whereas the associations of household water, sanitation, and hygiene (WASH) factors varied across nutritional outcomes, with stronger relationships observed for stunting and wasting than for underweight.

### MULTIVARIABLE ANALYSIS

After adjusting for all covariates and accounting for the complex survey design, several sociodemographic and environmental factors remained independently associated with child undernutrition (Tab. III).

For stunting, children living in Western Indonesia (AOR=0.63; 95% CI: 0.57-0.69) and Central Indonesia (AOR=0.64; 95% CI: 0.58-0.71) had significantly lower odds of stunting than those residing in Eastern Indonesia (both  $p<0.001$ ). Urban residence was also associated with lower odds of stunting compared with rural residence (AOR=0.92; 95% CI: 0.85-0.99;

$p=0.022$ ). Conversely, children from households with unimproved drinking water sources (AOR=1.15; 95% CI: 1.05-1.27), unimproved sanitation facilities (AOR=1.17; 95% CI: 1.03-1.31), and inadequate solid waste management (AOR=1.19; 95% CI: 1.09-1.29) had significantly higher odds of stunting. In addition, low parental education (AOR=1.26; 95% CI: 1.16-1.36) and parental unemployment (AOR=1.25; 95% CI: 1.16-1.35) were independently associated with increased odds of stunting (all  $p<0.05$ ). Maternal age, toilet type, and healthy housing were not significantly associated with stunting after adjustment.

For wasting, regional disparities persisted after multivariable adjustment. Compared with children living in Eastern Indonesia, those residing in Western Indonesia (AOR=0.56; 95% CI: 0.50-0.62) and Central Indonesia (AOR=0.68; 95% CI: 0.61-0.75) had significantly lower odds of wasting (both  $p<0.001$ ). Children born to mothers in early adulthood exhibited slightly lower odds of wasting than those born to mothers in middle adulthood (AOR=0.92; 95% CI: 0.85-0.99;  $p=0.031$ ). Unimproved sanitation facilities (AOR=1.15; 95% CI: 1.01-1.32), low parental education (AOR=1.23; 95% CI: 1.12-1.34), and parental unemployment (AOR=1.35; 95% CI: 1.24-1.48) remained significant predictors of wasting, whereas place of residence, drinking water source, drinking water treatment, toilet type, solid waste management, and healthy housing were not independently associated with wasting.

**Tab. III.** Survey-weighted multivariable logistic regression analysis of factors associated with child undernutrition among children under five years in Indonesia, SSGI 2022.

| Variable                 | Category (comparison)                 | Stunting AOR (95% CI) | p-value | Wasting AOR (95% CI) | p-value | Underweight AOR (95% CI) | p-value |
|--------------------------|---------------------------------------|-----------------------|---------|----------------------|---------|--------------------------|---------|
| Maternal age             | Late adolescence vs. Middle adulthood | 0.92 (0.56-1.52)      | 0.751   | 0.88 (0.50-1.53)     | 0.640   | 0.78 (0.37-1.63)         | 0.505   |
|                          | Early adulthood vs. Middle adulthood  | 0.96 (0.90-1.03)      | 0.242   | 0.92 (0.85-0.99)     | 0.031   | 0.95 (0.86-1.04)         | 0.264   |
| Region                   | Western vs. Eastern Indonesia         | 0.63 (0.57-0.69)      | <0.001  | 0.56 (0.50-0.62)     | <0.001  | 0.58 (0.51-0.66)         | <0.001  |
|                          | Central vs. Eastern Indonesia         | 0.64 (0.58-0.71)      | <0.001  | 0.68 (0.61-0.75)     | <0.001  | 0.55 (0.49-0.63)         | <0.001  |
| Place of residence       | Urban vs. Rural                       | 0.92 (0.85-0.99)      | 0.022   | 0.95 (0.87-1.03)     | 0.191   | 0.88 (0.80-0.98)         | 0.019   |
| Drinking water source    | Unimproved vs. Improved               | 1.15 (1.05-1.27)      | 0.005   | 1.06 (0.96-1.18)     | 0.269   | 0.95 (0.83-1.08)         | 0.405   |
| Drinking water treatment | Not boiled vs. Boiled                 | 0.91 (0.85-0.98)      | 0.008   | 0.94 (0.87-1.01)     | 0.100   | 1.06 (0.96-1.16)         | 0.246   |
| Sanitation facility      | Unimproved vs. Improved               | 1.17 (1.03-1.31)      | 0.012   | 1.15 (1.01-1.32)     | 0.039   | 1.02 (0.86-1.21)         | 0.816   |
| Toilet type              | Unimproved vs. Improved               | 1.00 (0.84-1.19)      | 0.967   | 1.12 (0.94-1.33)     | 0.225   | 1.00 (0.79-1.27)         | 0.994   |
| Solid waste management   | Inadequate vs. Adequate               | 1.19 (1.09-1.29)      | <0.001  | 1.07 (0.98-1.18)     | 0.145   | 1.04 (0.92-1.17)         | 0.538   |
| Parental education       | Low vs. High                          | 1.26 (1.16-1.36)      | <0.001  | 1.23 (1.12-1.34)     | <0.001  | 1.17 (1.04-1.31)         | 0.008   |
| Parental employment      | Unemployed vs. Employed               | 1.25 (1.16-1.35)      | <0.001  | 1.35 (1.24-1.48)     | <0.001  | 1.31 (1.17-1.46)         | <0.001  |
| Healthy housing          | Inadequate vs. Adequate               | 1.03 (0.95-1.12)      | 0.493   | 1.02 (0.93-1.12)     | 0.663   | 1.01 (0.89-1.14)         | 0.928   |

AOR: adjusted odds ratio; CI: confidence interval. Estimates were obtained using survey-weighted multivariable logistic regression accounting for the complex multistage sampling design of the 2022 Indonesian Nutrition Status Survey (SSGI). Reference categories were: middle adulthood, Eastern Indonesia, rural residence, improved drinking water source, boiled drinking water, improved sanitation improved toilet type, adequate solid waste management, high parental education, employed parents, and adequate healthy housing. Statistical significance was defined as  $p < 0.05$ .

For the underweight, significant regional differences were also observed. Children living in Western Indonesia (AOR=0.58; 95% CI: 0.51-0.66) and Central Indonesia (AOR=0.55; 95% CI: 0.49-0.63) had significantly lower odds of being underweight than those in Eastern Indonesia (both  $p < 0.001$ ). Urban residence was associated with reduced odds of underweight compared with rural residence (AOR=0.88; 95% CI: 0.80-0.98;  $p = 0.019$ ). Furthermore, low parental education (AOR=1.17; 95% CI: 1.04-1.31) and parental unemployment (AOR=1.31; 95% CI: 1.17-1.46) remained independently associated with underweight. No statistically significant associations were observed for maternal age, drinking water source, drinking water treatment, sanitation facility, toilet type, solid waste management, or healthy housing after multivariable adjustment.

Overall, regional disparities, parental socioeconomic characteristics, and selected environmental conditions emerged as the most consistent determinants of child undernutrition across the three nutritional outcomes, although the magnitude and significance of these associations varied according to the specific anthropometric indicator.

## Discussion

This study examined associations between household

environmental conditions, socioeconomic characteristics, and child undernutrition using nationally representative data from the 2022 Indonesian Nutrition Status Survey (SSGI), accounting for the country's complex multistage sampling design. Several important findings emerged. First, regional disparities remained the strongest and most consistent determinants of all three forms of undernutrition. Second, parental socioeconomic disadvantage, particularly low educational attainment and unemployment, independently increased the likelihood of stunting, wasting, and underweight. Third, environmental factors, especially sanitation and solid waste management, showed stronger associations with chronic undernutrition than with acute nutritional deficits, suggesting that different forms of undernutrition may be influenced by distinct causal pathways.

One of the most prominent findings was the substantial regional disparity across Indonesia. Children in Eastern Indonesia consistently had higher odds of stunting, wasting, and underweight than those in Western and Central Indonesia. These findings align with previous national reports and international evidence showing persistent geographic inequalities in child nutrition across low- and middle-income countries [15, 16]. Regional disparities likely reflect unequal access to health services, maternal and child nutrition programs, food security, infrastructure, clean water, sanitation, and socioeconomic opportunities [17-19]. Eastern Indonesia

continues to have lower human development indicators, higher multidimensional poverty, and more limited access to healthcare than Western regions, collectively contributing to poorer child nutritional outcomes [20–22]. The persistence of these regional differences after multivariable adjustment suggests that geographic inequality reflects structural determinants that extend beyond individual household characteristics.

Parental socioeconomic characteristics also emerged as robust predictors of child undernutrition. Children whose parents had lower educational attainment experienced significantly higher odds of stunting, wasting, and underweight. Likewise, parental unemployment remained independently associated with all three nutritional outcomes. These findings reinforce the well-established role of socioeconomic position in shaping child health. Parents with higher educational attainment generally possess greater health literacy, improved infant feeding knowledge, stronger healthcare-seeking behavior, and better hygiene practices [12, 23–25]. Employment further provides economic resources necessary to ensure dietary diversity, healthcare utilization, and adequate living conditions [8]. Together, education and employment influence both material resources and caregiving capacity, thereby affecting children's nutritional status throughout early childhood [26–28].

Environmental determinants demonstrated more heterogeneous relationships across nutritional outcomes. Unimproved sanitation facilities and inadequate solid waste management remained independently associated with stunting, while unimproved sanitation also increased the likelihood of wasting. In contrast, several household water variables lost statistical significance after multivariable adjustment. These findings support the growing evidence that poor sanitation contributes to chronic growth impairment through repeated exposure to enteric pathogens, environmental enteric dysfunction, recurrent diarrheal disease, and chronic intestinal inflammation, all of which reduce nutrient absorption despite adequate food intake [5, 23, 29]. The stronger association observed with stunting than with underweight further supports the hypothesis that prolonged environmental exposures primarily affect long-term linear growth rather than short-term changes in body weight [9, 11, 29, 30].

Interestingly, some variables that showed significant associations in the bivariate analysis became non-significant after adjustment. Maternal age, toilet type, healthy housing, drinking water treatment, and several other environmental indicators no longer independently predicted undernutrition after controlling for socioeconomic and geographic factors. This attenuation suggests that their crude associations were partially explained by confounding, particularly household socioeconomic status and regional context. These findings underscore the importance of multivariable analyses that appropriately adjust for correlated determinants rather than relying solely on unadjusted comparisons.

The present findings underscore the multidimensional

nature of child undernutrition. Although environmental improvements remain important, interventions focused solely on water and sanitation are unlikely to eliminate undernutrition without concurrent efforts to reduce socioeconomic inequalities. Integrated strategies that combine nutrition-specific interventions with nutrition-sensitive programs, including poverty reduction, parental education, job creation, improved sanitation infrastructure, and equitable regional development, are likely to yield greater and more sustainable reductions in child undernutrition. Given the particularly elevated burden observed in Eastern Indonesia, geographically targeted interventions may further enhance program effectiveness.

A major strength of this study is the use of nationally representative SSGI 2022 data, with appropriate survey-weighted analyses that account for stratification, clustering, and sampling weights. This analytical approach addresses an important methodological limitation identified in previous analyses of Indonesian survey data and improves the validity and generalizability of national-level estimates. Nevertheless, several limitations should be acknowledged. First, the cross-sectional design precludes causal inference, and the observed associations should not be interpreted as causal relationships. Second, information on several household characteristics was collected through caregiver reports and may therefore be subject to reporting bias. Third, although multiple socioeconomic and environmental variables were included, residual confounding from unmeasured factors such as dietary intake, infectious diseases, birth weight, maternal nutritional status, breastfeeding practices, and household food security cannot be excluded.

This study shows that child undernutrition in Indonesia results from a combination of geographic disparities, parental socioeconomic challenges, and specific environmental factors. The persistent regional gaps and socioeconomic influences across stunting, wasting, and underweight highlight the need for multisectoral policies that target both structural inequalities and household-level issues. Priorities should include increasing investments in underserved areas, enhancing parental education and economic opportunities, and expanding access to safe sanitation. These actions are essential for speeding up progress toward national nutrition targets and the Sustainable Development Goals.

## CONTRIBUTIONS TO NURSING SCIENCE

This study contributes to nursing science in three ways. First, it demonstrates at a national scale that modifiable household hygiene and socioeconomic factors independently predict child undernutrition. Second, it links classical nursing theories with contemporary population-level data. Third, it supports the integration of environmental and social assessment into routine community nursing practice.

By conceptualizing child undernutrition as a nursing-sensitive outcome, the study positions nurses as central actors in preventing growth failure. Nurses can identify environmental risks, strengthen caregiver knowledge, and connect families with social resources.

## STRENGTHS AND LIMITATIONS

The study uses nationally representative data from the 2022 Indonesian Nutritional Status Survey, thereby strengthening external validity and enabling population-level inference. The large sample size increases statistical precision. Multivariable modeling reduces confounding by key demographic variables.

However, the cross-sectional design limits causal inference. The analysis identifies associations but cannot establish directionality. Household hygiene variables rely on reported indicators rather than direct observation, which may introduce measurement bias. The dataset also lacks detailed psychosocial measures such as caregiving self-efficacy and health literacy. Future longitudinal and intervention studies should explore these mechanisms.

## Conclusion

Using nationally representative survey data analyzed with appropriate survey-weighted methods, this study provides robust evidence that geographic inequality, parental socioeconomic disadvantage, and selected household environmental conditions are independently associated with child undernutrition in Indonesia. The findings indicate that the determinants of stunting, wasting, and underweight are distinct, underscoring the need for nutrition policies tailored to specific forms of undernutrition while also addressing broader structural inequalities. Future interventions should integrate nutrition-specific and nutrition-sensitive strategies, with particular attention to disadvantaged regions and vulnerable households, to achieve equitable improvements in child nutritional status across Indonesia.

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## Availability of data and materials

The accompanying author can provide the data supporting the study's conclusions upon reasonable request. Due to ethical or privacy concerns, the data are not accessible to the general public.

## Consent for publication

The final manuscript has been read, approved, and published with the approval of all authors.

## Ethical approval

This study used anonymized secondary data obtained through formal approval from the Center for Data and Information Technology (PUSDATIN), Ministry of Health of the Republic of Indonesia. Data access was granted upon signing a confidentiality agreement (Document No. FRM/SMKI-PUSDATIN/70/0129/2024). The dataset contained no personal identifiers, and all analyses complied with national data protection regulations and ethical standards for secondary data research.

## Conflict of interest statement

The author declares no conflict of interest.

## Authors' contributions

YBP and RKH: Conceptualization, Methodology, Software. YBP and WM, HH: Data curation, Writing-Original draft preparation. RKH and NM: Visualization, Investigation. HD: Supervision. IR: Software, Validation. YBP and RKH: Writing- Reviewing and Editing.

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**Correspondence:** Yoyok Bektı Prasetyo. Department of Community Nursing, Faculty of Health Sciences, University of Muhammadiyah Malang, Indonesia. E-mail yoyok@umm.ac.id.

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