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How geographical access shapes relationship between food security indicators and nutritional status in Indonesia

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ABSTRACT

Introduction: Evidence-based food security interventions are more likely to be effective and impactful. Despite substantial investments in food and nutrition programmes, empirical evidence connecting community-level food security conditions with nutrition status across diverse rural contexts remains limited. This study aimed to link key food security indicators with nutritional status to support more targeted interventions. **Methods:** Cross-sectional household surveys were conducted in 2023 among 1,016 farming households across 36 rural villages in South Sumatra, South Sulawesi, and East Nusa Tenggara, Indonesia, categorised as high, moderate, and low geographical accessibility. Anthropometric data were collected from mothers in the household, with body mass index (BMI) representing nutritional status. Five key food security indicators that measured food availability, access, and utilisation were analysed: food source, household food insecurity, food expenditure share, dietary diversity, and nutrition knowledge. Pearson's chi-square test assessed associations between BMI and the indicators within each accessibility group; significant indicators were identified as key determinants. **Results**: Food source, particularly reliance on homegrown foods, was a key determinant of nutritional status in low-accessibility villages. In moderately accessible villages, nutrition knowledge and food expenditure share were significantly associated with BMI. No significant associations emerged in highly accessible villages, suggesting more complex food environments in peri-urban settings. **Conclusion:** Geographical accessibility shapes the determinants of nutritional status. Recommended interventions include enhancing subsistence food production in low-accessibility areas, strengthening financial and nutrition literacy in moderately accessible areas, and expanding nutrition education in highly accessible areas. Tailored approaches can improve the effectiveness of food and nutrition programmes across rural Indonesia.

Keywords: food security interventions, geographic accessibility, Indonesia, nutritional status, nutrition education

INTRODUCTION

Food security remains a pressing global challenge, requiring targeted and effective interventions to ensure stable access to sufficient, safe, and nutritious food (FAO, 2018). Climate change further exacerbates food insecurity, posing significant risks to vulnerable communities, particularly women and children (Naheed & Rukshana, 2024).

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In response, global, regional, and national initiatives have been launched to address food insecurity, most notably the Sustainable Development Goal of achieving "Zero Hunger" by 2030 (United Nations, 2016). However, success depends on understanding key determinants affecting availability, access, and utilisation, as well as sustainability and agency (HLPE, 2020). Geography plays a crucial role in shaping these outcomes, including nutritional status through climate, infrastructure, agriculture, and markets. Evidence-based strategies can help identify local determinants and tailor context-specific interventions. Without robust empirical evidence, interventions risk being ineffective or unsustainable, failing to address the root causes of food insecurity across diverse settings (Iannotti *et al.*, 2024).

As an archipelago of over 17,000 islands with approximately 922 permanently inhabited islands, Indonesia provides a compelling context for this analysis. Approximately 49% of its population resides in rural areas and nearly 29% works in the agricultural sector. Despite its agricultural capacity, 7.2% of Indonesia's population experiences food insecurity and 8.5% suffers from undernourishment (WFP, 2025). The country's vast and fragmented geography adds complexity to addressing food security challenges, necessitating region-specific approaches.

This study assessed food security in vulnerable landscapes of Indonesia, focusing on South Sumatra, South Sulawesi, and East Nusa Tenggara, which represent the country's western, central, and eastern regions, with differing ecosystems and development levels (Hill, Resosudarmo & Vidyattama, 2008). The objective was to identify regional disparities and shared characteristics to balance local specificity with broader applicability in intervention design. Geographical accessibility was used as a shared characteristic across the three regions.

This paper presents:

1. An overview of food security conditions in the vulnerable landscapes of South Sumatra, South Sulawesi, and East Nusa Tenggara.
2. Key determinants of nutritional status across different accessibility levels using data from the three provinces.

This study contributes to the development of targeted, evidence-based food security interventions in Indonesia.

METHODOLOGY

Study design and site selection

This study employed a cross-sectional survey design to examine food security and its determinants across 36 villages in South Sumatra, South Sulawesi, and East Nusa Tenggara. Site selection followed a structured, multi-stage process: (i) two landscapes were identified in each province based on dominant climatic vulnerabilities; (ii) three sub-landscapes were selected within each landscape according to ecosystem service conditions; and (iii) two villages were chosen within each sub-landscape based on their classification as 'developing' or 'underdeveloped' under the Village Development Index (IDM) (Kemendes, 2022). The IDM is a composite indicator of village development and autonomy, calculated from social, economic, and environmental dimensions. It classifies villages into five categories: very underdeveloped, underdeveloped, developing, advanced, and independent. Lower IDM categories are closely associated with limited service access, weaker local economies, and higher vulnerability to shocks. These features make the index particularly relevant for food security research. Incorporating

IDM into the sampling strategy allowed the study to purposively select vulnerable villages while capturing diversity in environmental conditions, livelihood constraints, and exposure to climatic risks.

In South Sumatra, the selected villages were located in peatland and forested areas prone to seasonal flooding and fires, with limited accessibility due to poor road infrastructure. In East Nusa Tenggara, villages were situated in arid watershed areas characterised by prolonged dry seasons, poor soil fertility, and constrained water and transport access. In South Sulawesi, study sites were located within degraded watersheds affected by soil erosion and distributed from upper catchment areas with difficult terrain and limited access, through mid-catchments, to coastal zones where freshwater availability was limited. Compared to the other regions, South Sulawesi benefits from relatively better soil conditions and more favourable rainfall, offering some agricultural advantages.

While the sampled villages reflect key characteristics of vulnerable rural areas in each province, they are not intended to represent provincial conditions, nor were they selected based on food security outcomes. Throughout this paper, references to South Sumatra, South Sulawesi, and East Nusa Tenggara refer exclusively to the sampled villages within vulnerable areas of these provinces. Province-level statistics are explicitly identified using full provincial names (e.g., "South Sumatra Province").

Data collection

Data were collected between January and October 2023 through household surveys, including anthropometric measurements and a 24-hour dietary recall. Eligible respondents were farming households owning agricultural land, with the mother or wife selected for BMI measurement. The survey captured six indicators: body mass index (BMI), food source, Household Food Insecurity Access Scale (HFIAS), food expenditure share (FES), dietary diversity score (DDS), and nutrition knowledge. These indicators represent the four dimensions of food security (availability, accessibility, utilisation, and stability) and correspond to livelihood capitals (human, natural, financial, social, and infrastructure) as conceptualised by the Department for International Development (DFID) (1999) (Table 1).

BMI of mothers or wives was used as a proxy for household nutritional status due to its simple, standardised measurement and strong association with nutrition-related health risks (WHO, 2025). Food source represented modes of food acquisition and agricultural production, capturing both subsistence consumption and income pathways influencing diet quality (Carletto *et al.,* 2015). Incorporating this variable provides insights into household resilience, livelihood strategies, and the role of local food systems in shaping diets. HFIAS measured household experiences of food access constraints. It provides a validated and comparable measure of the severity and patterns of food access limitations and is widely used to assess household food insecurity (Coates, Swindale & Bilinsky, 2007). DDS assessed diet quality based on food groups consumed in the previous 24 hours and is a recognised proxy for micronutrient adequacy (FAO, 2011). FES captured economic vulnerability by measuring the share of total expenditure allocated to food (Smith & Subandoro, 2007). When a large share of the household budget goes to food, it suggests limited flexibility for other needs (e.g., health, education, and housing) and indicates susceptibility to shocks like food price inflation. Nutrition knowledge reflected the understanding of key nutrition

Table 1. Methods used in data collection and analysis

Variables	*Food security dimension*	*Livelihood capitals*	*Data collection and analysis methods*	*Transformed categorical variables*
Nutritional status				
Body mass index (BMI)	All, but strongly linked to utilisation	All, but strongly linked to Human	Anthropometric measurements of height and weight were taken for mothers using a SECA scale and stadiometer. BMI was then calculated and categorised as underweight, normal, overweight, or obese (WHO, 1995)	Category 1: Underweight Category 2: Normal Category 3: Overweight/ Obese (combined category)
Food security indicators				
Dietary diversity score (DDS)	Availability	Human	24-hour recall study. Conducted among mothers to assess dietary diversity using FAO food groups. Data were categorised based on Minimum Dietary Diversity for Women (MDD-W). The score reflects the number of food groups consumed, with a threshold of at least 5 out of 10 food groups indicating good dietary diversity.	Category 1: DDS score above the average (≥5). Category 2: DDS score equal to the average (4). Category 3: DDS score below the average (≤3).
Household food insecurity accessibility score (HFIAS)	Accessibility, Availability	Financial, Biophysical	As part of the household survey, mothers were selected as respondents. The standardised HFIAS questionnaire (Coates *et al.*, 2007) was used to assess the food access dimension of food security, focusing on anxiety or uncertainty about food supply, food quality, food intake, and the physical consequences of insufficient food access.	Category 1: Food Secure Category 2: Food Insecure (combined Mildly Food Insecure, Moderately Food Insecure, Severely Food Insecure)
Food source	Availability, Accessibility	Biophysical, Financial, Human	As part of the household survey. A question on food acquisition (buying, growing, foraging); multiple responses allowed.	Category 1: Growing food Category 2: Not growing food
Nutrition knowledge score	Utilisation	Human	As part of the household survey, a set of 11 questions was asked to assess feeding practices, dietary requirements, dietary diversity, food safety, and food preparation and processing. The maximum possible score was 11.	Category 1: Score 1-6 Category 2: Score 7-8 Category 3: Score 9-11
Food expenditure share (FES)	Accessibility	Financial	As part of the household survey. A set of questions on household expenditure that covers basic household expenses, food, health and education, investment (agriculture inputs), savings, assets. FES is the proportion or percentage of a household's total expenditure that is allocated to food purchases. FES value above 60% is considered food insecure (Smith & Subandoro, 2017)	Category 1: ≤60% Category 2: >60%

concepts and its influence on dietary behaviours and nutrition outcomes (FAO, 2014). Together, these indicators provide a comprehensive assessment of household food security and nutritional status. Table 1 summarises the variables and their analytical relevance.

Variable transformation and accessibility classification

To facilitate categorical analysis, variables were converted into binary or ordinal categories using established thresholds (DDS≥5, FES≤60%, knowledge score ≥10, and HFIAS food security categories), enabling meaningful comparison aligned with nutritional standards (Table 1). Villages were classified into three levels of geographical accessibility (low, moderate, and high) based on field assessments across all 36 villages, considering road conditions, terrain, and transport reliability. Geographical accessibility was treated as a composite variable encompassing both spatial access (e.g., distance to services) and infrastructure usability (e.g., road quality, transport availability). Low-access villages were typically remote with poor roads and limited transport, moderate-access villages faced partial or seasonal constraints, and high-access villages had well-developed road networks and reliable transport (Figure 1).

Statistical analysis

Pearson's chi-square tests were used to examine associations between BMI and five categorical food security indicators for the overall sample and within each accessibility level. This non-parametric test assesses relationships between categorical variables (Rana & Singhal, 2015). Resulting p-values were compared across accessibility levels to identify indicators significantly associated with BMI and thus key determinants of nutritional status. Analyses were conducted using Minitab® version 17 (Minitab, 2017).

Sample size calculation

Sample size was calculated to detect statistically significant differences in nutritional status (BMI) across the three sites. Assuming a 30% prevalence of food insecurity (Amrullah *et al.*, 2019), the required minimum was 323 respondents per site (totaling 969 across all locations), based on a 95% confidence level using the formula:

$N = (Z^2 \times p(1 - p)) / d^2$ (Charan & Biswan, 2013). This equated to approximately 27 respondents per village.

Ethical review

This study was approved by the Ethics Committee of Universitas Brawijaya, Indonesia (No. 445/UN10.F17.10/TU/2023). All participants provided written informed consent after being briefed on the study's purpose. Privacy and confidentiality were maintained throughout data collection and analysis.

High accessibility Moderate accessibility Low accessibility

Figure 1. Photos illustrating village accessibility: High, moderate, and low

Table 2. Nutritional status and food security situation at study sites

Variables	*Location of vulnerable villages*			*p-value of test of difference in mean or proportion*
	South Sumatra (n=338)	*South Sulawesi (n=345)*	*East Nusa Tenggara (n=333)*	
Nutritional status				
Body mass index (BMI) (*n*, %)				
Underweight	6 (2%)	15 (4%)	48 (14%)	<0.001
Normal	132 (39%)	176 (51%)	200 (60%)	
Overweight and obese	200 (59%)	154 (45%)	85 (26%)	
Food security indicators				
Dietary diversity score				
Average	4.2	4.2	4	0.056
Range	1-9	1-8	1-8	
Food insecurity (*n*, %)				
Secure	155 (52%)	221 (67%)	29 (9%)	<0.001
Mildly insecure	101 (34%)	61 (19%)	139 (45%)	
Moderately insecure	39 (13%)	31 (9%)	123 (40%)	
Severely insecure	5 (2%)	15 (5%)	17 (6%)	
Food Source (*n*, %)				
Growers	149 (50%)	229 (70%)	279 (91%)	<0.001
Buyers	279 (93%)	257 (78%)	275 (89%)	<0.001
Foragers	10 (3%)	62 (19%)	75 (24%)	<0.001
Nutrition knowledge score (Maximum score = 11)				
Average	7.4	6.8	6.9	<0.001
Range	3-11	1-10	1-10	
Food expenditure share (%)				
Average	47%	39%	62%	

RESULTS

Food security conditions across study sites

A total of 1,016 respondents participated in this study, fulfilling the minimum requirement of 323 respondents per study site. Nutritional status differed significantly among the three landscapes (p<0.001). East Nusa Tenggara recorded the highest prevalence of underweight mothers (14%) and the largest proportion with normal BMI (60%). In contrast, South Sumatra and South Sulawesi showed higher prevalence of overweight and obesity among mothers, consistent with national patterns reported in the Indonesia Health Survey 2023 (Kementerian Kesehatan, 2024).

Food security indicators also varied significantly (p<0.001). East Nusa Tenggara had the lowest proportion of food-secure households (9%) and the highest food expenditure share (62%). South Sulawesi had a higher proportion of food-secure households (67%) and a lower expenditure burden (39%). These findings are in line with the 2023 National Food Security Index, where South Sulawesi ranked 2nd, South Sumatra 20th, and East Nusa Tenggara 26th (Badan Pangan Nasional, 2024).

Women's dietary diversity scores (WDDS) were consistently low across regions, averaging 4, below the recommended minimum score of 5. Mothers' nutrition knowledge scores

Table 3. Associations between BMI and food security indicators in villages with different accessibility levels

Body mass index, vs food security indicators	*P-value (Pearson χ^2)*				
	Food-source	*Dietary diversity*	*Food insecurity*	*Nutritional knowledge*	*Food-expenditure-share*
Accessibility level of village					
Low accessibility	0.004**	0.496	0.238	0.989	0.238
Moderate accessibility	0.867	0.452	0.067	0.003**	0.003**
High accessibility	0.523	0.526	0.804	0.933	n.a

**$p<0.01$

Chi-square test was used to assess the associations.

were also fair (scores 6–7 out of 11). Reliance on food grown at home was relatively high in East Nusa Tenggara and South Sulawesi, with 91% and 71% of households, respectively, reporting that they grow their own food (Table 2). This indicates the continued importance of home gardening and smallholder agriculture in these regions. In contrast, households in South Sumatra depended heavily on purchased foods, with 93% of households reporting buying their food. Only 50% of respondents in this province reported growing any food at home.

Statistical tests revealed significant differences across all six key variables: BMI, food security status, FES, WDDS, food source, and nutrition knowledge (Table 2).

Key determinants of nutritional status

To examine the hypothesis that household-level food security indicators were sufficient to understand the patterns of relationships between food security and nutritional status, exploratory data analysis (EDA) was conducted. Village-level accessibility was disaggregated to household level. Initial exploration indicated an association between accessibility and nutritional status. Consequently, geographical accessibility was retained as a stratification variable to differentiate villages in subsequent analysis.

Table 3 summarises *p*-values from Pearson's chi-square tests assessing associations between BMI categories and five food security indicators across accessibility groups. In low-accessibility villages, BMI was significantly associated with food source, highlighting the importance of home food production where market access is limited. In moderate-accessibility areas, BMI was associated with nutrition knowledge and FES, suggesting the influence of information and food environment conditions. In highly accessible villages, no significant associations were observed. This likely reflects the absence of underweight cases and uniformly low FES, indicating the influence of more complex or unmeasured factors.

Overall, the results demonstrated that pathways influencing nutritional status vary across accessibility gradients, underscoring the need for context-specific interventions. Tables 4 and 5 summarise the proposed intervention strategies across the study landscapes and accessibility levels, which are further discussed in the discussion section.

DISCUSSION

Key food and nutrition security challenges in the landscapes

Clear differences in food and nutrition security challenges emerged across the three study landscapes. Maternal

Table 4. Recommended intervention strategies to nutritional and food security challenges (by landscapes)

Location of vulnerable landscapes	*Key food security and nutritional status issues*	*Recommended intervention strategies: nutrient-specific*
South Sumatra	• No cases of underweight • FES <60% • Higher prevalence of overweight/obesity	• Strengthen disease prevention and management by improving access to healthcare system.
South Sulawesi	• Prevalence of obesity • Moderate levels of food insecurity • FES < 60%	• Provide food aid or social safety net for extreme food insecure family. • Strengthen disease prevention and management by improving access to healthcare system.
East Nusa Tenggara	• High prevalence of underweight mothers • Low food security (HFIAS) • High FES	• Strong family support facilitated by local community health cadres and local government. • Provide food assistance (food aid) and complementary feeding for families experiencing severe malnutrition. • Provide social safety net for extreme food insecure family.

FES: Food expenditure share; HFIAS: Household Food Insecurity Access Scale

obesity was prominent in the landscapes of South Sumatra and South Sulawesi, whereas underweight remained a significant concern in East Nusa Tenggara. These contrasting patterns are consistent with broader nutrition transitions driven by dietary shifts and reduced physical activity associated with urbanisation (Popkin, 2006), occurring alongside continued undernutrition in vulnerable rural areas. A more recent study suggests that Indonesia is also experiencing a triple burden of malnutrition, including micronutrient deficiencies such as anaemia (Rah, 2021). Although micronutrient status was not assessed in this study, such deficiencies are likely present at the study sites.

Food insecurity among mothers was evident across all study landscapes. with the highest prevalence recorded in East Nusa Tenggara. This vulnerability was further reflected in its high food expenditure shares, with many households allocating more than 60% of their total expenditure to food, indicating limited financial resilience. In East Nusa Tenggara, widespread homestead food production emerged as an important coping strategy, with most households producing food for their own consumption. This finding reinforces the role of homestead food production as a nutrition-sensitive agricultural intervention, particularly in resource-constrained settings (Sharma *et al.,* 2021).

Dietary diversity remained a major challenge across the landscapes. Nationally, dietary diversity is measured using the Desirable Dietary Diversity (*Pola Pangan Harapan*/PPH) framework, which measures how closely diets align with the ideal composition of food groups. Provincial PPH showed higher scores in South Sumatra and South Sulawesi than in East Nusa Tenggara (Badan Pangan Nasional, 2023), consistent with the

Table 5. Recommended intervention strategies to nutritional and food security challenges (by accessibility level)

Accessibility Level	*Key determinants of nutritional status*	*Interventions recommendation – nutrient sensitive*
Low accessibility	Food source (homestead production)	• Promote home and communal kitchen gardens. • Improve access to seeds, seedlings, and agricultural inputs. • Promote low-input and climate-resilient farming practices.
Moderate accessibility	Nutrition knowledge Food expenditure share	• Strengthen nutrition education for family members, particularly mothers. • Link household food production with income-generation opportunities. • Enhance financial literacy among women.
High accessibility	No significant associations found	• Address underlying factors influencing diets, including food preferences and processed food consumption. • Promote healthy eating behaviours. • Integrate B2SA and "Isi Piringku" (My Plate) campaigns with local cultural and food system contexts.

women's dietary diversity score (WDDS) observed in this study. However, overall WDDS scores indicated inadequate dietary diversity across all study sites. Increasing the consumption of fruits and vegetables is a critical strategy to improve dietary diversity and enhance overall diet quality (Harris *et al.*, 2022).

Results from this study demonstrated that food security indicators are closely interrelated, suggesting that integrated, well-designed interventions are required to address nutrition challenges effectively within these vulnerable landscapes.

Potential food security interventions

Addressing the nutrition challenges observed in the study areas, particularly obesity and underweight, requires a combination of improved nutrition literacy, accessible health services, and context-appropriate, nutrition-sensitive agricultural interventions. Improving nutrition literacy is fundamental, with priority content including balanced diets, nutrient composition, and appropriate portion sizes. In landscapes facing rising obesity, emphasis should be placed on increasing dietary fibre intake and reducing the consumption of salt, sugar, and oil. Evidence suggests that higher dietary diversity contributes to obesity prevention (de Oliveira Otto *et al.*, 2018), which is important because obesity is closely linked to non-communicable diseases, now a leading cause of mortality in Indonesia (WHO, 2025). Therefore, promoting healthier lifestyles and physical activity is increasingly important, especially in peri-urban and more accessible areas where sedentary behaviour is rising (Popkin, 2006).

Alongside these behavioural strategies, strengthening access to healthcare remains important for managing obesity, while food assistance and complementary feeding continue to be essential for underweight and food-insecure households (Bhutta *et al.*, 2013). Social protection schemes can also buffer acute food shortages among the most vulnerable. Over the longer term, sustained improvements depend on well-functioning primary health facilities and a cadre of trained community health workers (Perry & Hodgins, 2021).

While improved nutrition knowledge is critical, households must also have the means to act on this information. Given the low dietary diversity scores across study sites (average ~4), interventions should focus on strengthening food production at the household and community levels. Expanding kitchen gardens through agricultural extension, practical training, and improved availability to seeds and tools can enhance access to diverse foods. Emphasising low-input, chemical-free practices, seedling regeneration, and small-scale composting can support continuous production, particularly in remote and resource-limited settings.

Interventions should be tailored according to levels of geographical accessibility. In low-accessibility areas, where BMI is associated with food source, expanding and diversifying home food production is a key entry point for improving diets. In moderate-accessibility areas, where nutrition knowledge and food expenditure share are influential, interventions should combine nutrition education with economic resilience strategies to reduce market dependence. Encouraging kitchen gardens in these areas can simultaneously improve diet quality and lower food costs. In high-accessibility settings, where no single indicator strongly explained nutritional status, interventions should focus on promoting healthier eating habits, reducing the consumption of ultra-processed foods, and supporting community-based behaviour change initiatives.

National programmes provide an important foundation for these efforts. Indonesia has implemented initiatives such as *Pekarangan Pangan Lestari* (*P2L* - Sustainable Home-Based Food Production), *Desa B2SA*- Diverse, Balanced Nutrition and Safe Village, and the *Isi Piringku* (My Plate) campaigns, which promote local food production and encourage balanced and diverse diets (Kementerian Kesehatan, 2014). However, their effectiveness in rural areas is often limited by insufficient localisation and adaptation to local food systems. Strengthening the capacity of implementers to tailor programme content to local context is therefore essential, as weak programme designs and poor targeting can undermine impact even when resources are available (Ruel, Quisumbing & Balagamlawa, 2018). Continued investment in primary healthcare and in the competencies of health cadres remains essential, particularly in underserved areas where they play a key role in delivering preventive and promotive nutrition services.

Key strength and study limitations

While the patterns observed in this study echo findings from previous research and national statistics, this study contributes important added value by empirically examining how geographical accessibility shapes food security and nutritional status across rural landscapes in Indonesia. By stratifying the analysis according to accessibility levels, the study highlighted how different factors, such as food production capacity, nutrition knowledge, and household expenditure, interact differently across contexts. This evidence-based approach offers practical insights for designing targeted interventions in resource-constrained and geographically diverse settings.

A key strength of the study lies in its multi-regional design and large sample size, enabling comparative analysis across three provinces and enhancing the generalisability of findings within similarly vulnerable rural contexts. However, the study also has some limitations. The use of Pearson's chi-square test, while suitable for identifying statistically significant associations between categorical variables, does not

provide information on the strength or direction of those relationships. Additionally, the cross-sectional design limits causal inference. To build on these findings, future research could apply advanced statistical techniques, such as multilevel or structural equation modelling, to better capture complex, hierarchical interactions between food security indicators, household characteristics, and geographical factors.

Finally, the classification of accessibility levels was based on judgements made by trained field staff during on-site assessments rather than quantitative geospatial data, which may introduce subjectivity. Future studies could strengthen this aspect by incorporating spatial analysis and remote sensing data to validate accessibility metrics.

CONCLUSION

This study provides empirical insights into food and nutrition security across three vulnerable landscapes in Indonesia – South Sumatra, South Sulawesi, and East Nusa Tenggara. East Nusa Tenggara emerged as the most vulnerable, with the highest food insecurity, food expenditure burden, and underweight prevalence, despite widespread homestead food production. In contrast, South Sumatra and South Sulawesi exhibited higher levels of overweight and obesity, reflecting Indonesia's ongoing nutrition transition, with South Sulawesi performing best across food security indicators. Across all sites, dietary diversity remained inadequate and maternal nutrition knowledge was modest, indicating persistent gaps in nutrient intake and diet awareness. Determinants of nutritional status varied by geographical accessibility. Home food production was most influential in low-access areas, while nutrition knowledge and financial capacity mattered more in moderately accessible villages. In highly accessible areas, nutritional outcomes appeared to be shaped by more complex or unmeasured factors. These findings underscore the need for context-specific, nutrition-sensitive interventions tailored to local vulnerabilities and accessibility constraints. This study also offers a practical framework for designing more equitable and effective food security interventions in Indonesia and similar settings.

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Authors' contributions

Lusiana B, principal investigator, conceptualised and designed the study, coordinated data collection, conducted the study, performed data analysis and interpretation, prepared the draft of the manuscript, and reviewed the manuscript; Fortuna D, led the data collection and data cleaning, assisted in data analysis and drafting of the manuscript, and reviewed the manuscript; Wirawan N, advised in data collection, analysis and interpretation, and reviewed the manuscript; Dewi S, advised in data collection, analysis and interpretation, and reviewed the manuscript.

Conflict of interest

All authors declare no conflict of interest in this study.

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