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Macronutrient and micronutrient intake in stunted children: The role of household food insecurity

Asupan makronutrien dan mikronutrien pada anak-anak yang mengalami stunting: Peran kerawanan pangan rumah tangga

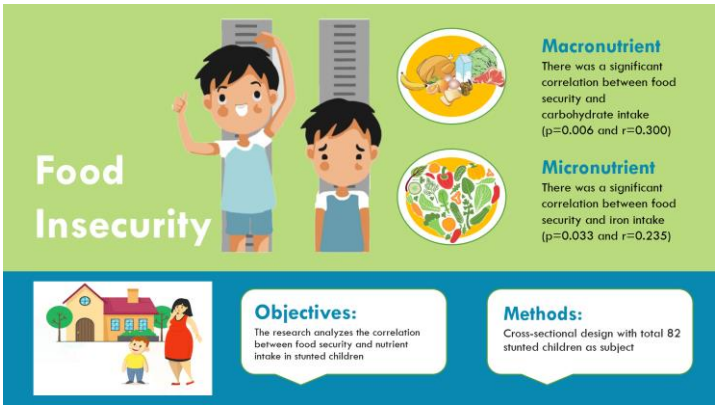
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Abstract
Insufficient nutrient intake remains a persistent determinant of child stunting, yet evidence mapping macro–micronutrient intake against household food insecurity in Indonesian urban settings is limited. This study addresses this gap by correlating nutrient intake with HFIAS scores among stunted children in Semarang. This cross-sectional study included 82 stunted children in Semarang, Indonesia. Household food insecurity was assessed using the Household Food Insecurity Access Scale (HFIAS), while macronutrient and micronutrient intakes were estimated using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Data normality informed the use of Pearson or Spearman correlation tests for bivariate analysis. Overall, 61% of households were classified as food-insecure, and most children exhibited inadequate carbohydrate intake and deficiencies in vitamin A and vitamin C. HFIAS scores were significantly correlated with carbohydrate intake (p=0.006; r=0.300) and iron intake (p=0.033; r=0.235), indicating higher food security was associated with higher intake, while no significant correlations were observed for energy, protein, fat, calcium, zinc, vitamin C, vitamin A, or vitamin B12. These findings support integrated family-based interventions combining supplementary feeding (PMT) with strategies to strengthen household food access and affordability. Programmatically, embedding Islamic values, such as *amanah* (shared responsibility for child wellbeing), *halal–tayyib* dietary guidance, and community solidarity through zakat/infaq based support that may enhance sustainable family nutrition and food security in urban contexts.

Abstrak
Kekurangan asupan gizi tetap menjadi faktor penentu utama stunting pada anak, namun pemetaan bukti mengenai asupan makro-mikronutrien terhadap kerawanan pangan rumah tangga di lingkungan perkotaan Indonesia masih terbatas. Studi ini mengatasi kesenjangan tersebut dengan mengkorelasikan asupan gizi dengan skor HFIAS pada anak-anak stunting di Semarang. Studi potong lintang ini melibatkan 82 anak stunting di Semarang, Indonesia. Kerawanan pangan rumah tangga diukur menggunakan *Household Food Insecurity Access Scale* (HFIAS), sementara asupan makro- dan mikronutrien diperkirakan menggunakan *Semi-Quantitative Food Frequency Questionnaire* (SQ-FFQ). Normalitas data menentukan penggunaan uji korelasi Pearson atau Spearman untuk analisis bivariat. Secara keseluruhan, 61% rumah tangga diklasifikasikan sebagai rawan pangan, dan sebagian besar anak menunjukkan asupan karbohidrat yang tidak memadai serta kekurangan vitamin A dan vitamin C. Skor HFIAS secara signifikan berkorelasi dengan asupan karbohidrat (p=0.006; r=0.300) dan asupan zat besi (p=0.033; r=0,235), menunjukkan bahwa keamanan pangan yang lebih tinggi terkait dengan asupan yang lebih tinggi, sementara tidak ada korelasi signifikan yang diamati untuk energi, protein, lemak, kalsium, seng, vitamin C, vitamin A, atau vitamin B12. Temuan ini mendukung intervensi berbasis keluarga yang terintegrasi, yang menggabungkan pemberian makanan tambahan (PMT) dengan strategi untuk memperkuat akses dan keterjangkauan pangan di tingkat rumah tangga. Secara programatik, pengintegrasian nilai-nilai Islam, seperti *amanah* (tanggung jawab bersama terhadap kesejahteraan anak), panduan diet *halal-tayyib*, dan solidaritas komunitas melalui dukungan berbasis zakat/infaq, dapat meningkatkan gizi keluarga yang berkelanjutan dan ketahanan pangan di konteks perkotaan.

Graphical Abstract



Keyword
child; food insecurity; food security; growth disorders; nutrients

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INTRODUCTION

Stunting, defined as impaired linear growth among children under 60 months due to chronic malnutrition, remains a major public health problem because it reflects prolonged nutritional deprivation and increases the risk of lifelong deficits in health, cognition, and productivity (Mulyani et al., 2025; Taslim et al., 2023). Globally, stunting continues to affect millions of children, with a disproportionate burden in developing countries where dietary quality, infection, and socioeconomic constraints intersect (Ali, 2021; Rasheed et al., 2021). Adequate nutrition during the first years of life is essential for optimal growth; therefore, insufficient intake of energy and key nutrients is consistently implicated as a proximal contributor to stunting (Saavedra & Prentice, 2023).

This issue is closely aligned with the Sustainable Development Goals, particularly SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-Being), which emphasize ending malnutrition and improving child health outcomes. Food insecurity—conceptualized as inadequate access to sufficient and appropriate food for a healthy and active life—can undermine child nutrition through reduced food quantity, compromised dietary diversity, and unstable household food access (Sumsion et al., 2023). Evidence indicates that food insecurity remains a global concern, with large-scale crises affecting many countries (Saccone et al., 2025; Rahaman et al., 2021). In Indonesia, national statistics show modest changes in food insecurity prevalence, while regional variation persists, including fluctuations in Central Java (Badan Pusat Statistik, 2025). These patterns highlight the ongoing need to understand household-level determinants of child nutrition within specific contexts.

Household food insecurity may restrict the availability, variety, and nutritional quality of foods, thereby limiting children's access to essential macro- and micronutrients and increasing vulnerability to chronic malnutrition and stunted growth (Elegbeleye et al., 2025; Savarino et al., 2021). Economic constraints and expenditure patterns can further shape diets toward low-cost staples that prioritize satiety over nutrient adequacy, potentially masking micronutrient deficiencies even when energy intake appears sufficient (Shaheen et al., 2025). Accordingly, a plausible general solution is to strengthen household food access and affordability while simultaneously improving child dietary quality through integrated nutrition interventions, ensuring that both caloric sufficiency and micronutrient adequacy are addressed.

Prior literature emphasizes that food insecurity operates through multiple pathways relevant to child growth, including constrained dietary diversity and reduced access to nutrient-dense foods, which can compromise intake of critical vitamins and minerals necessary for linear growth (Elegbeleye et al., 2025; Inzaghi et al., 2022; Savarino et al., 2021). Research also indicates that when households allocate a large proportion of spending to food, consumption may focus on inexpensive, filling items rather than balanced diets, contributing to inadequate nutrient density (Drewnowski et al., 2021; Stewart et al., 2021). These findings support interventions that improve not only the quantity but also the quality of household diets by expanding access to diverse, nutrient-rich foods.

In addition, broader analyses propose that understanding and addressing undernutrition—including stunting—requires targeted strategies informed by context-specific evidence rather than relying solely on generalized approaches (Abdullahi et al., 2021; Chapman et al., 2024). This includes identifying vulnerable subgroups and specifying nutrient gaps that may not be apparent from energy intake alone. From a programmatic perspective, strengthening access to health and nutrition services and embedding household-focused support mechanisms are considered important mediators for improving child nutritional status in settings with persistent food access constraints (Badan Pusat Statistik, 2025).

Although global and national evidence confirms that stunting is widespread and nutrition is a key determinant (Rahut et al., 2024; Schneider, 2025), the mechanisms linking household food insecurity to the specific macro- and micronutrient intake patterns of children who are already stunted remain insufficiently characterized. Food insecurity can reduce dietary variety and limit access to nutrient-dense foods (Beal et al., 2024; Castro et al., 2022), while economic pressure may shift diets toward inexpensive carbohydrate-dominant patterns that prioritize fullness over nutrient adequacy (Shapiro & Grajower, 2024). However, much of the existing discussion focuses on general populations or household expenditure patterns, leaving limited empirical mapping of detailed nutrient intake among stunted children, particularly within urban Indonesian contexts where food environments and purchasing behaviors may differ from rural settings (Dangerfield et al., 2021; Westbury et al., 2021).

Therefore, the research gap lies in the limited evidence that directly correlates household food

insecurity severity with quantified macro- and micronutrient intake specifically among stunted children, which is necessary to guide more precise, household-oriented interventions (Islam et al., 2025; Lopes et al., 2023; Qasrawi et al., 2024). The novelty of the present study is the focused mapping of macronutrient and micronutrient intake patterns against HFIAS scores among stunted children in an urban setting, enabling identification of nutrient domains most sensitive to household food access constraints. Accordingly, this study aims to examine the relationship between household food insecurity (measured by HFIAS) and macro- and micronutrient intake (estimated by SQ-FFQ) among stunted children in Semarang, thereby informing integrated nutrition programming and food-security strategies tailored to vulnerable urban families.

METHODS

Study Design

This study employed a cross-sectional design involving stunted toddlers aged 6–59 months. The study was conducted as a follow-up analysis of a prior cross-sectional study examining family characteristics and feeding practices among mother–child pairs with and without SCOM (stunted children–overweight/obese mothers). No health intervention was implemented. The study population comprised toddlers with stunting nutritional status residing in Semarang City, Indonesia, in 2022. Sample size was calculated using the Slovin formula based on available records of 100 stunted toddlers; a total of 82 toddlers were included, corresponding to a 10.96% margin of error. Participants were selected using purposive sampling. Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Diponegoro University (No.018/EC/KEPK/FK-UNDIP/2025).

Data and Variables

Eligibility criteria included toddlers aged 6–59 months whose mothers were healthy, toddlers who were not ill during data collection, willingness to participate until completion as indicated by signed informed consent, and stunting status defined as length-for-age (PB/U) or height-for-age (TB/U) z-score < −2 SD. The exclusion criteria were history of premature birth; severe comorbidities such as cystic fibrosis or congenital heart disease; severe gastrointestinal disorders; chronic or genetic diseases affecting growth (e.g., malabsorption); and toddlers not living with their parents. The independent variable was household food insecurity. The dependent variables were macronutrient intake (energy, carbohydrates, protein, and fat) and micronutrient intake (iron, zinc, calcium, vitamin A, vitamin B12, and vitamin C). Macronutrient intake is shown as a percentage of adequacy, while micronutrient intake is shown as a percentage of the recommended daily allowance (RDA).

Data collection and measurements

Household food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS), consisting of nine questions administered to parents/caregivers of children under five. Total HFIAS scores were categorized into four levels: food secure (0–1), mildly food insecure (2–7), moderately food insecure (8–14), and severely food insecure (15–27). Dietary intake was assessed using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which captures consumption frequency and estimated portion size over extended periods (days, weeks, months, or years). SQ-FFQ data were converted into nutrient intakes and processed using NutriSurvey software. Macronutrient adequacy was classified according to Ministry of Health cut-offs: deficit (<89%), normal (90–119%), and excess (>120%).

Data analysis

Data were analyzed using SPSS version 25. Univariate analysis was used to describe participant characteristics, household food insecurity, and nutrient intake distributions. Bivariate analysis assessed the relationship between household food insecurity (independent variable) and macro- and micronutrient intake (dependent variables). Pearson correlation was applied for normally distributed variables, while Spearman's rank correlation was used when normality assumptions were not met. Statistical significance was determined based on correlation p-values generated by these tests.

RESULTS

As presented in Table 1, 61% of respondents were classified as experiencing household food insecurity. Specifically, 35.4% (n=29) were mildly food insecure, 12.2% (n=10) were moderately food insecure, and 13.4% (n=11) were severely food insecure. The observed HFIAS score ranged from 0 to 27, indicating that the sample covered the full spectrum of household food access conditions. Regarding

Table 1
Characteristics of subject

Variable	n (%)	Mean (SD) / Median (min-max)
Family Food Insecurity		3 (0-27)
Food secure (0-1)	32 (39.0%)	
Mildly food insecure (2-7)	29 (35.4%)	
Moderately food insecure (8-14)	10 (12.2%)	
Severely food insecure (15-27)	11 (13.4%)	
Energy Intake of Toddlers (kcal)		1260.3 (273.5)
Deficit (<89%)	37 (45.1%)	
Normal (90-119%)	41 (50.0%)	
More (>120%)	4 (4.9%)	
Protein Intake of Toddlers (grams)		149.3 (43.6)
Deficit (<89%)	-	
Normal (90-119%)	-	
Excess (>120%)	82 (100.0%)	
Fat Intake of Toddlers (grams)		45.455 (13.5-3952.0)
Deficit (<89%)	40 (48.8%)	
Normal (90-119%)	33 (40.2%)	
Excess (>120%)	9 (11.0%)	
Carbohydrate Intake of Toddlers (grams)		56.1 (18.8)
Deficit (<89%)	82 (100.0%)	
Normal (90-119%)	-	
Over (>120%)	-	
Calcium Intake		11.9 (2.1-32.9)
Deficient, if <77% of RDA	-	
Adequate, if ≥77% RDA	82 (100.0%)	
Iron Intake		771.7 (40.2-1984.5)
Deficient, if <77% RDA	55 (67.1%)	
Adequate, if ≥77% of RDA	27 (32.9%)	
Zinc intake		4.4 (0.4-11.0)
Deficient, if <77% RDA	-	
Adequate, if ≥77% RDA	82 (100.0%)	
Vitamin A intake		1090.1 (12.6-9443.4)
Deficient, if <77% RDA	63 (76.8%)	
Adequate, if ≥77% of RDA	19 (23.2%)	
Vitamin B12 intake		19.3 (0.5-274.0)
Deficient, if <77% RDA	14 (17,07%)	
Adequate, if ≥77% RDA	68 (82,93%)	
Vitamin C Intake		53.1 (5.4-81.2)
Deficient, if <77% RDA	70 (85,37%)	
Adequate, if ≥77% of RDA	12 (14,63%)	

dietary adequacy, most children exhibited deficits in carbohydrate intake as well as vitamin C and vitamin A. In contrast, the majority of children demonstrated adequate intake of protein, calcium, vitamin B12, and zinc, suggesting that nutrient gaps were not uniform across dietary components and were concentrated in particular macro- and micronutrients.

Table 2 shows that correlation testing for energy and protein intake used Pearson's correlation due to normally distributed data. No statistically significant association was observed between food insecurity and energy intake (p=0.475; r=0.080), although the direction of association was positive and the strength was weak. Similarly, no statistically significant association was found between food insecurity and protein intake (p=0.769; r=−0.033), with a weak inverse correlation. Fat intake was analyzed using Spearman's rank correlation because the data were not normally distributed; no statistically significant association was identified (p=0.637; r=−0.053), and the correlation was weak and negative. In contrast, carbohydrate intake showed a statistically significant association with household food insecurity using Pearson's correlation (p=0.006; r=0.300), indica-

Table 2
Correlation test of food insecurity with macronutrient and micronutrient intake

Variable	Food security	
	p	r
Energy intake	0.475[a]	0.08
Protein intake	0.769[a]	-0.033
Fat intake	0.637[b]	-0.053
Carbohydrate intake	0.006[a]	0.3
Calcium intake	0.136[a]	0.166
Iron Intake	0.033[a]	0.235
Zinc Intake	0.131[a]	0.138
Vitamin A intake	0.172[b]	0.152
Vitamin B12 Intake	0.114[b]	0.176
Vitamin C intake	0.193[b]	0.145

Note: [a] Pearson correlation test, [b] Spearman correlation test

ting a positive, moderate-strength relationship in which higher food security tended to correspond with higher carbohydrate intake.

For micronutrients, correlation analysis indicated no statistically significant relationship between household food insecurity and calcium intake ($p>0.05$), consistent with the reported non-significant association ($p=0.136$; $r=0.166$). In contrast, iron intake demonstrated a statistically significant correlation with household food insecurity ($p=0.033$; $r=0.235$), reflecting a weak positive association. Further analyses of zinc, vitamin A, vitamin C, and vitamin B12 intake showed no statistically significant associations with food insecurity (all $p>0.05$). Although both positive and negative correlation directions were observed across Pearson and Spearman approaches, these relationships did not reach statistical significance, suggesting that any observed trends may be weak, heterogeneous, or potentially non-linear within the sample and were insufficient to support a definitive association in this population.

DISCUSSION

Carbohydrate intake has a correlation with food insecurity ($p = 0.006$). Carbohydrate is the primary nutrient needed by the brain during the metabolic process. Carbohydrates such as glucose are also required and play a role in producing energy in the body (Campos et al., 2022; Clemente-Suárez et al., 2024). Carbohydrates can be used to support daily activities. Insufficient carbohydrate intake can cause a reduced energy requirement (Henselmans et al., 2022). Carbohydrates are divided into complex and simple carbohydrates. Simple carbohydrates contain less glucose and are more easily absorbed than complex carbohydrates. Whole sources of complex carbohydrates and fiber provide good dietary fiber and micronutrients and can contribute to nutritional status (Ahsan, 2021).

Food insecurity is caused by economic deprivation and lack of physical access to food. Families with lower economic status will pay more attention to food prices' economic value than nutritional adequacy (Ravikumar et al., 2022). When food insecurity occurs, prioritized food is cheaper, namely carbohydrate sources (Hwalla et al., 2021). The income level of the family will be inversely proportional to the intake of carbohydrates consumed. If the income is higher, the carbohydrate intake will be lower, and the use of other foods will increase. If income is low, carbohydrate intake is higher (Shabnam et al., 2021). An increase in revenue does not increase carbohydrate intake and has the same intake value as before. Carbohydrate intake is deficient because, in food-insecure families, the impact leads to a lack of staple foods (Chiu et al., 2024). This is because food-insecure families prefer to spend more on food, so they choose cheaper food sources.

Indonesians are dependent on carbohydrates because they are easy to process. In previous research, some people are oriented towards satisfying hunger compared to fulfilling nutritional value (Kokkoris & Stavrova, 2021) . This cultural pattern is inherited from previous communities and persists today. People who have low incomes will reduce their budgets to be shared with other needs. In addition, it prioritizes basic needs compared to other needs. If a family has a high level of consumption, the level of economic consumption and welfare is also higher (Martínez & Camara, 2022).

Children's nutritional status can be influenced by energy intake. Physical activity and functional body functions can be obtained from energy intake. Energy can play a role in cognitive and social-emotional

functions in toddlers (Vandesande et al., 2022). Insufficient energy intake can cause chronic energy deficiency (CHD), and linear growth will be disrupted (Dagne et al., 2021). In addition, energy deficiency causes reduced plasma insulin and decreased Liver Insulin Growth Factor (IGF) synthesis. It can affect the performance of IGF binding protein-1, thyroid hormone, and other systemic factors that affect Fibroblast growth factor (FGF-21), which all play a role in toddler growth (Velingkar et al., 2023) .

Based on the Pearson test, there was no relationship between food insecurity and energy intake in stunted toddlers (p=0.475). In this study, stunted toddlers received a program called Supplementary Feeding (PMT). PMT focuses on energy and protein intake. The average energy intake of toddlers is normal because they get energy from PMT. If toddlers lack energy intake, it is not caused by food insecurity. Food insecurity leads to more problems with the nutritional status of toddlers. Food consumed by toddlers can affect energy intake and the nutritional status (Jun et al., 2021).

Based on the Pearson test, no relationship exists between food insecurity and protein intake in stunted toddlers (p=0.769). This can be because the toddlers in this study were also targeted by the PMT program, so that the toddlers' protein intake was more due to the protein intake from the PMT. Previous research states that protein adequacy has no relationship with family food security. The consumption of protein sources depends on the food ingredients that parents at home provide. The amount of parents' income can influence food ingredients. However, this study did not have data on vegetable and animal protein intake. However, the focus of this study was on food-insecure families. Food-insecure families consume a less varied diet than food-insecure families. Food-insecure families will consume animal protein sources, while food-insecure families will consume vegetable protein (Betancourt-Núñez et al., 2023).

Indonesians consume more vegetables than animal protein. Data from this research related to protein intake is minimal, so it is necessary to re-explore the vegetable and animal protein intake of toddlers. Based on the 2014 Individual Food Consumption Survey (SKMI) analysis, vegetable protein consumption dominates over animal protein consumption. Animal protein has a relatively high price when compared to vegetable protein. This causes Indonesian people to consume vegetable protein more often. Sources of processed vegetable protein include mushrooms, beans, and their preparations such as tempeh, tofu, oncom, and so on (Khusun et al., 2022).

This study show there was correlation between food insecurity and iron intake. Iron deficiency and anemia are prevalent among children residing in food-insecure households. A study indicated that 29.1% of children aged 6-24 months were anemic, with 12.2% experiencing iron deficiency. Food insecurity is correlated with reduced nutrient intake, including iron, which is essential for the prevention of anemia and the support of growth and development in toddlers (Moosavian et al., 2025). Correlation between food insecurity and iron deficiency is multifaceted and influenced by a range of factors, including dietary intake, socioeconomic status, and maternal health. For instance, maternal anemia and food insecurity have been identified as significant predictors of anemia in toddlers. Households experiencing food insecurity frequently have restricted access to foods rich in iron, thereby increasing the risk of iron deficiency. Toddlers residing in such households often consume fewer vegetables and fruits, which are crucial for iron absorption, and instead consume more soda, which can adversely affect overall nutrition (Habib et al., 2025).

There was no relationship between food insecurity and fat intake. Most of the subjects in this study had normal fat intake, even though most of the subjects experienced food insecurity. Food security is not the cause of the lack of fat intake. Foods consumed by toddlers can affect fat intake and the nutritional status (Cheikh Ismail et al., 2022). However, previous studies have reported that food-secure families have high fat intake. This reflects that an increase in income can lead to changes in food consumption. Food-insecure families are more likely to consume animal foods with a higher fat content than plant foods (Betancourt-Núñez et al., 2023)

The analysis showed that food insecurity was not associated with micronutrient intake, except iron. Most families in this study experienced food insecurity. However, most children had adequate protein, calcium, vitamin B12, and zinc intakes. The intake of vitamin C and vitamin A was mostly deficient. Food insecurity is often associated with poorer diet quality, but not all studies show a direct link between food insecurity and micronutrient deficiencies. For example, some studies show that despite food insecurity, there are not always significant differences in the intake of certain micronutrients such as folate, vitamin C, and zinc (Jun et al., 2021).

Income, education, and other socio-economic conditions can also affect nutrient intake more than food insecurity. For example, low-income families may have limited access to nutritious foods despite not experiencing severe food insecurity. Food insecurity is also often associated with consuming foods higher in calories but low in nutrients, such as processed foods. This can lead to micronutrient deficiencies even though total calorie intake may be sufficient (Lopes et al., 2023). Another contributing factor is that social programs and interventions addressing food insecurity may not always focus on increasing micronutrient intake. Instead, some programs may focus more on providing sufficient food in quantity rather than quality. Differences in measuring and reporting dietary intake methods can also affect research results. Some studies suggest that food intake reporting can be inaccurate, especially among households experiencing food insecurity (Hutchinson & Tarasuk et al., 2022).

The study uses the Household Food Insecurity Access Scale (HFIAS), developed by FANTA in 2007, to identify household food insecurity based on perceptions and experiences related to physical and economic access to food. HFIAS is considered practical, inexpensive, and easy to apply, with high sensitivity in detecting food insecurity (Kolog et al., 2023). This instrument captures conditions such as anxiety about food availability, reduced quantity and quality of food intake, and the social burden or shame caused by limited access to food. Therefore, HFIAS is regarded as an effective method for assessing household food insecurity, especially in developing-country settings (Shuvo et al., 2025).

To assess food consumption and macronutrient intake, the study uses the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), which describes the frequency and habits of food intake over a certain period and can estimate average daily intake (Amsah et al., 2023). SQ-FFQ is considered valid, widely used in Indonesia, and applicable across various age groups, including toddlers. However, this method has limitations, particularly recall bias, social desirability bias, and possible errors in reporting food types and portion sizes. In addition, household food expenditure and consumption patterns are influenced by factors such as income, family size, and maternal education, while other unmeasured factors—such as sanitation, infection history, and breastfeeding or complementary feeding practices—may still contribute to nutritional outcomes like stunting.

Families bear the primary responsibility for ensuring that toddlers receive adequate and high-quality nutrition as a foundation for optimal growth and development (Daelmans et al., 2021). This obligation aligns with Qur'anic guidance on parental stewardship and the duty to protect and nurture family members, including meeting children's physical needs such as sufficient dietary intake to prevent chronic undernutrition and stunting. The Qur'an, in Surah An-Nisa/4:9, emphasizes this responsibility through the following verses:

> "And let those fear (Allah) who, if they left behind them, would leave behind weak offspring, whom they would fear for (their welfare)..."

These verses support the ethical principle that parents should not allow children to become "weak," which can be interpreted in the present health context as preventing avoidable vulnerability—including impaired growth—through adequate nutrition, care, and protection.

In addition to household responsibility, Islamic teachings emphasize social solidarity to protect vulnerable families experiencing food insecurity (Bagasra, 2021). Food assistance and charity are framed as acts of devotion and compassion, encouraging communities to share resources to reduce deprivation that may contribute to nutrient deficiencies and stunting. This is reflected in Surah Al-Baqarah/2:273:

> *"(Give charity) to the poor who are bound (by jihad) in the way of Allah; they cannot (work) on earth..."*

Within the context of this study, these values provide a coherent rationale for integrating zakat, infaq, and sadaqah-based support with nutrition-specific programs (e.g., supplementary feeding/PMT and dietary counseling). Such integration may improve household food access and strengthen community participation, thereby enhancing the sustainability and cultural acceptability of stunting prevention strategies in urban settings.

CONCLUSIONS

This study highlights that household food insecurity remains common among families of stunted toddlers in urban Semarang, indicating that nutritional vulnerability is strongly embedded within household food access constraints. The findings show that most children experienced deficits in key nutrients—particularly carbohydrates and several micronutrients—illustrating that chronic growth failure may coexist with persistent dietary inadequacies. Importantly, household food insecurity was significantly associated with carbohydrate intake and

iron intake, suggesting that improved food access may increase consumption of selected nutrients, while other macro- and micronutrients did not demonstrate statistically significant relationships in this sample. These results imply that interventions should not only aim to increase food availability but also improve diet quality and micronutrient density, recognizing "hidden hunger" as a critical risk for impaired child growth and development.

From a family health perspective, the results support the need to integrate nutrition interventions—such as education on complementary feeding, food selection, and micronutrient fortification—with household food security strategies so benefits extend beyond toddlers to the entire family. Strengthening collaboration between community health centers and integrated health posts is necessary to ensure consistent implementation of supplementary feeding (PMT), nutrition counseling, and routine monitoring and evaluation. Partnerships with cross-sector and external stakeholders are also needed to sustain interventions and improve program coverage.

Future research should examine the type and quality of carbohydrate sources consumed by stunted children in food-insecure households, distinguishing between simple and complex carbohydrates and assessing overall dietary quality using longitudinal designs. Further analyses should apply multivariate models to control for household determinants such as income, maternal education, family size, and exposure to food assistance or supplementary feeding programs. Expanding these variables will strengthen causal inference and guide the development of targeted nutrition and food security interventions that improve access to quality carbohydrate sources and micronutrient-rich foods to support stunting prevention and recovery.

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AUTHORS' CONTRIBUTIONS
Rachma Purwanti designed the study, developed the concept, wrote the draft, recruited participants, collected data, revised the manuscript, did fieldwork, supervised, and approved the final manuscript. Najwa D. K. Arfinanda and Cicilia Laura contributed to data analysis, wrote the draft, and revised the manuscript. Mursid T. Susilo, Ahmad Syauqy, Etika R. Noer and Lilis Wijayanti contributed to writing the draft and supervised the manuscript.

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COMPETING INTERESTS
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