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# The Relationship Between Zinc, Iron, and Vitamin A Intake Based on Dietary Patterns (FFQ) and the Incidence of Stunting in Toddlers Aged 24-59 Months at the Mandiangin Community Health Center, Bukittinggi City, 2026

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**ABSTRACT**

*Stunting is a chronic nutritional problem that negatively impacts the quality of human resources. In the Mandiangin Community Health Center's work area, the prevalence of stunting remains a serious concern, with 101 toddlers recorded as stunted in 2026. Low intake of micronutrients such as zinc, iron, and vitamin A is suspected to be a major risk factor for this condition. This study aims to analyze the relationship between zinc, iron, and vitamin A intake based on dietary patterns and the incidence of stunting in toddlers aged 24-59 months. This quantitative study employed an observational analytical design with a case-control approach. The sample consisted of case groups (stunted toddlers) and control groups (normal toddlers) in the Mandiangin Community Health Center (Puskesmas) work area. Nutrient intake data were collected using a semi-quantitative Food Frequency Questionnaire (FFQ) through interviews with mothers of toddlers. Data were analyzed univariately and bivariately using the Chi-Square test. The bivariate analysis revealed a significant association between zinc intake (p-value = 0.000), iron intake (p-value = 0.000), and vitamin A intake (p-value = 0.002) and stunting. Most toddlers with stunting had lower intakes of these three micronutrients compared to the normal toddler group. There was a significant association between zinc, iron, and vitamin A intake and stunting among toddlers at the Mandiangin Community Health Center. Improving nutrition education for mothers regarding balanced diets and micronutrient intake is essential as a preventative measure to combat stunting.*

## I. INTRODUCTION

Stunting remains a critical global public health challenge, particularly in developing countries, as it directly undermines human capital development. Defined by the World Health Organization (WHO) as a growth failure characterized by a height-for-age Z-score below minus two standard deviations (<-2 SD), stunting arises from chronic malnutrition and recurrent infections during the critical first 1,000 days of life. Globally, approximately 148 million children under five were stunted in 2023. While Indonesia's national stunting prevalence dropped to 19.8% in 2024, the figures in specific sub-regions, such as West Sumatra and Bukittinggi City (16.8%), indicate that local disparities persist. In 2026, the Mandiangin Community Health Center in Bukittinggi recorded a significant cluster of 101 stunted toddlers, particularly within lower socio-economic pockets like Campago Ipuh, signaling an urgent need to address localized root causes.

Linear bone growth in toddlers is heavily mediated by adequate micronutrient intake, where zinc, iron, and vitamin A act synergistically. Zinc is a vital cofactor for over 300 metalloenzymes that regulate DNA replication, cell division, and the synthesis of growth-mediating hormones like Insulin-like Growth Factor 1 (IGF-1). Iron is fundamental for hemoglobin synthesis and optimal cellular oxygenation; chronic iron deficiency causes iron deficiency anemia, which impairs tissue metabolism and induces growth retardation. Meanwhile, Vitamin A is crucial for cellular differentiation, bone remodeling, and maintaining epithelial tissue integrity. A deficiency in vitamin A severely compromises the mucosal immune system, predisposing toddlers to recurrent episodes of diarrhea and acute respiratory tract infections (ISPA), which create a state of metabolic stress and secondary nutrient malabsorption.

While national interventions heavily focus on macroeconomic solutions and general protein supplementation, the specific dietary patterns and structural deficits in micronutrient combinations (zinc, iron, and vitamin A) at the sub-district level are frequently overlooked. Most existing regional studies utilize general recall methods that fail to capture long-term habitual food frequencies specific to local cultural diets, such as the high-temperature cooking processes (e.g., *gulai* or *rendang*) typical in Minangkabau households, which degrade heat-sensitive micronutrients like vitamin A. Furthermore, how low household purchasing power interacts with dietary intake in highly populated, low-income urban families (≥ 3 children) within Bukittinggi remains insufficiently mapped using structured dietary tools.

Understanding the specific dietary gaps through a semi-quantitative Food Frequency Questionnaire (FFQ) provides an accurate reflection of long-term nutrient intake rather than temporary dietary fluctuations. Given that the Mandiangin Community Health Center serves a community characterized by low maternal education and unstable livelihoods, identifying which specific micronutrient deficit (zinc, iron, or vitamin A) correlates most strongly with linear growth failure is critical. This localized evidence is essential for clinical midwives and public health workers to transition from generic nutritional packages to targeted, culturally adapted food-based interventions.

This study aims to analyze the relationship between zinc, iron, and vitamin A intake based on dietary patterns (FFQ) and the incidence of stunting in toddlers aged 24-59 months at the Mandiangin Community Health Center, Bukittinggi City, in 2026; based on this objective, the hypotheses formulated are that there is a significant relationship between the incidence of stunting in toddlers aged 24-59 months and low zinc intake ($H_1$),

low iron intake ($H_2$), as well as low vitamin A intake ($H_3$) determined by daily dietary patterns.

## II. METHODS

This study employed a quantitative, observational analytic design with a case-control approach to retrospectively evaluate how long-term dietary exposures differ between stunted and normal toddlers. Conducted from January to March 2026 within the working area of the Mandiangin Community Health Center, Bukittinggi City, the target population encompassed 962 toddlers aged 24–59 months. Using a purposive sampling technique based on the Lemeshow formula, a total sample of 118 participants was selected, evenly divided into a case group (59 stunted toddlers) and a neighborhood-matched control group (59 normal toddlers). Inclusion criteria required biological mothers to be permanent residents who provided informed consent, while toddlers with congenital anomalies or chronic systematic diseases were excluded. Anthropometric measurements to determine nutritional status were conducted using a standard wall-mounted microtoise with a 0.1 cm accuracy, classifying the children based on the WHO height-for-age (TB/U) index into *Stunted* (<-2 SD) and *Normal* (≥ -2SD) categories.

Data collection was carried out through structured home visits utilizing a demographic questionnaire and an adapted semi-quantitative Food Frequency Questionnaire (FFQ) accompanied by standard food models to minimize interviewer bias. The FFQ assessed the habitual intake frequency and portion sizes of food items rich in zinc, iron, and vitamin A over the past year, which were subsequently converted into daily average weights and categorized against the Indonesian Recommended Dietary Allowance (AKG) into *Low* (<80% AKG), *Adequate* (80% - 120% AKG), and *High* (>120% AKG) levels. For the analysis plan, data were processed electronically using univariate descriptive statistics and bivariate Chi-Square tests ($X^2$) with a significance threshold of $p < 0.05$ to examine the relationship between micronutrient levels and stunting. Methodological limitations include potential recall bias inherent to the retrospective nature of the FFQ and the inability to account for temporary biological nutrient malabsorption caused by subclinical infections, although the scope effectively isolates the structural correlation of long-term dietary patterns within this lower-middle-class urban community.

## III. RESULT

### 1. Characteristics of Respondents

The demographic profiles of the mothers and toddlers involved in this study are divided into categorical characteristics (Table 1 and Table 2).

Table 1. Frequency Distribution of Maternal Characteristics (n = 118)

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| **Maternal Age** | | |
| < 25 years old | 26 | 22,0 |
| 25–35 years old | 64 | 54,2 |
| > 35 years old | 28 | 23,7 |

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| **Total** | **118** | **100** |
| **Ethnicity** | | |
| Minangkabau | 102 | 86,4 |
| Javaness | 8 | 6,8 |
| Bataknese | 5 | 4,2 |
| Others | 3 | 2,5 |
| **Total** | **118** | **100** |
| **Maternal Education** | | |
| Elementary School (SD) | 30 | 25,4 |
| Junior High School (SMP) | 38 | 32,2 |
| Senior High School (SMA) | 40 | 33,9 |
| Higher Education | 10 | 8,5 |
| **Total** | **118** | **100** |
| **Maternal Occupation** | | |
| Housewife (IRT) | 72 | 61,0 |
| Entepreneur | 20 | 16,9 |
| Private Employee | 15 | 12,7 |
| Civil Servant (PNS) | 11 | 9,3 |
| **Total** | **118** | **100** |
| **Number of Children** | | |
| 1 child | 25 | 21,2 |
| 2 child | 47 | 39,8 |
| ≥ 3 children | 46 | 39,0 |
| **Total** | **118** | **100** |
| **Religion** | | |
| Islam | 115 | 97,5 |
| Others | 3 | 2,5 |
| **Total** | **118** | **100** |

Based on Table 1, more than half of the mothers fell into the reproductive age of 25–35 years old (54.2%). The vast majority belonged to the Minangkabau ethnicity (86.4%) and identified as Muslim (97.5%). In terms of socio-demographics, the largest proportion of mothers completed Senior High School (33.9%), worked primarily as housewives (61.0%), and managed households with 2 children (39.8%) or $\ge 3$ children (39.0%).

Table 2. Frequency Distribution of Toddler Characteristics (n = 118)

| Characteristics | Frequency (n) | Percentage (%) |
|---|---|---|
| **Toddler Age** | | |
| 24–35 months | 32 | 27,1 |
| 36–47 months | 41 | 34,7 |
| 48–59 months | 45 | 38,1 |
| **Total** | **118** | **100** |
| **Gender** | | |
| Male | 60 | 50,8 |
| Female | 58 | 49,2 |
| **Total** | **118** | **100** |

Table 2 demonstrates that the highest proportion of participating toddlers fell within the age range of 48–59 months (38.1%), followed by 36–47 months (34.7%). The gender distribution was nearly equal, with males accounting for 50.8% and females representing 49.2% of the total sample.

## 2. Univariate Analysis

The univariate analysis evaluates the categorical levels of the independent variables (zinc, iron, and vitamin A intake status) separated by the case group (stunted) and control group (normal).

Table 3. Distribution of Micronutrient Intake Levels by Group

| Micronutrient Intake | Case Group (Stunting) (n=118) | | Control Group (Normal) (%) | |
|---|---|---|---|---|
| | f | % | f | % |
| **Zinc Intake** | | | | |
| Kurang | 39 | (66,1%) | 6 | (10,2%) |
| Cukup | 14 | (23,7%) | 39 | (66,1%) |
| Lebih | 6 | (10,2%) | 14 | (23,7%) |
| **Total** | **59** | **(100%)** | **59** | **(100%)** |
| **Iron Intake** | | | | |
| Low | 38 | (64,4%) | 14 | (23,7%) |
| Adequate | 11 | (18,6%) | 35 | (59,3%) |
| High | 10 | (16,9%) | 10 | (16,9%) |
| **Total** | **59** | **(100%)** | **59** | **(100%)** |
| **Vitamin A Intake** | | | | |
| Low | 37 | (62,7%) | 19 | (16,9%) |
| Adequate | 15 | (25,4%) | 33 | (32,2%) |
| High | 7 | (11,9%) | 7 | (55,9%) |
| **Total** | **59** | **(100%)** | **59** | **(100%)** |

Table 4 highlights that in the stunting case group, the majority of the toddlers experienced deficient intakes, characterized by low zinc intake (66.1%), low iron intake (64.4%), and low vitamin A intake (62.7%). Conversely, the normal control group was dominated by toddlers with adequate nutritional patterns, containing 66.1% adequate zinc intake, 59.3% adequate iron intake, and 55.9% adequate vitamin A intake.

## 3. Bivariate Analysis

Bivariate analysis was performed using the Chi-Square test ($X^2$) to verify the statistical relationships between dietary micronutrient intake levels and the incidence of stunting.

Table 5. Cross-Tabulation of Micronutrient Intake and Stunting Incidence

| Micronutrient Intake | Case Group (Stunting) (n=59) | | Control Group (Tidak stunting) (n=59) | | Total (n=118) | | *p-value* |
|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | |
| **Zinc Intake** | | | | | | | **0.0000** |
| Kurang | 39 | (86,7%) | 6 | (13.3%) | 45 | (100%) | |
| Cukup | 14 | (26,4%) | 39 | (73,6%) | 53 | (100%) | |
| Lebih | 6 | (30,0%) | 14 | (70.0%) | 20 | (100%) | |
| **Iron Intake** | | | | | | | **0.000** |
| Low | 38 | (73,1%) | 14 | (26,9%) | 52 | (100%) | |
| Adequate | 11 | (23,9%) | 35 | (76,1%) | 46 | (100%) | |
| High | 10 | (50,0%) | 10 | (50,0%) | 20 | (100%) | |
| **Vitamin A Intake** | | | | | | | **0.002** |
| Low | 37 | (66,1%) | 19 | (33.9%) | 56 | (100%) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Adequate | 15 | (31,3%) | 33 | (68,8%) | 48 | (100%) |
| High | 7 | (50,0%) | 7 | (50,0%) | 14 | (100%) |

As shown in Table 5, the Chi-Square test results reveal significant statistical associations across all monitored variables: out of 45 toddlers with low zinc intake, 86.7% were stunted, whereas 73.6% with adequate zinc intake fell into the normal growth category, yielding a *p*-value of 0.000 ($p < 0.05$) and confirming a significant relationship between zinc intake based on dietary patterns and the incidence of stunting; similarly, for iron intake, 73.1% of the 52 toddlers categorized with low iron intake experienced stunting, while 76.1% with adequate iron intake showed normal development, yielding a *p*-value of 0.000 ($p < 0.05$) which demonstrates a significant relationship between iron intake and stunting; furthermore, a highly significant relationship was also proven for vitamin A intake ($p = 0.002$; $p < 0.05$), where 66.1% of the 56 toddlers with low vitamin A intake suffered from stunting, whereas 68.8% of those with adequate intake successfully maintained normal biological height.

## IV. DISCUSSION

The clinical and public health implications of this study emphasize that addressing stunting requires moving beyond caloric quantity toward optimizing essential micronutrient intake. Clinically, community midwives and healthcare practitioners must transition from generalized nutritional monitoring to precise, culturally sensitive dietary counseling. In communities like the Minangkabau, this involves teaching mothers practical strategies to minimize nutrient degradation from extended cooking times and maximizing the use of bioavailable animal proteins within tight family budgets.

The primary research contribution of this study lies in providing localized, micro-level empirical data on the synergistic deficits of zinc, iron, and vitamin A using a semi-quantitative Food Frequency Questionnaire (FFQ). Unlike broad national surveys, this study isolates specific dietary gaps within highly populated, lower-middle-class urban settings like Campago Ipuh. It demonstrates how structural socio-demographic factors—such as low maternal education, restricted household income, and high parity (≥ 3 children)—directly limit micronutrient security, offering a clear framework for targeted grassroots interventions.

Methodological limitations of this study include the inherent risk of recall bias, as the retrospective case-control design relied entirely on maternal memory of a child's dietary frequency and portion sizes over the past year. Furthermore, while the semi-quantitative FFQ effectively measures long-term dietary patterns, it does not evaluate real-time biochemical serum levels of zinc, iron, or vitamin A. The methodology also cannot account for underlying biological nutrient malabsorption caused by subclinical or recurrent child infections, which may independently hinder linear growth.

Strategic suggestions based on these findings include the establishment of micronutrient-focused educational campaigns and local cooking workshops using affordable, nutrient-dense ingredients at the Mandiangin Community Health Center. Public health programs should also prioritize routine dietary tracking during monthly *posyandu* visits, specifically targeting large families from vulnerable socioeconomic backgrounds. For future researchers, it is highly recommended to employ prospective

cohort designs and incorporate laboratory blood serum or ferritin testing to gain a more rigorous physiological understanding of stunting pathways.

## V. CONCLUSION

In conclusion, this study successfully demonstrates a strong biological and statistical compatibility with the initial hypotheses stated in the introduction, confirming that structural deficits in daily dietary patterns are directly associated with linear growth failure. The empirical evidence from the Mandiangin Community Health Center establishes a highly significant relationship between the incidence of stunting in toddlers aged 24–59 months and low daily intakes of zinc ($p=0.000$), iron ($p=0.000$), and vitamin A ($p=0.002$), which are heavily driven by lower-middle socioeconomic status and cultural food preparation habits. Looking forward, the application prospects of these findings provide a critical baseline for local health centers to pivot from generic food aid to precise, micronutrient-targeted counseling and community-based cooking workshops that optimize affordable, bioavailable local ingredients. Furthermore, the future developmental prospect of this research lies in its transition into prospective cohort studies and the integration of direct biochemical serum testing, which will offer a more comprehensive physiological framework to eradicate chronic childhood malnutrition at the grassroots level.

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