



## The Relationship Between the Village-Level Food Security Index and Stunting Prevalence

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### Abstract

Stunting remains a major public health challenge in Indonesia. In Penajam Paser Utara (PPU) Regency, despite being classified as food-secure overall, the stunting prevalence remains high (21.8%), suggesting disparities in food security across villages. This study examined the relationship between the village-level Food Security Index (FSI) and stunting prevalence in PPU. An ecological correlational design was conducted using secondary data from the 2023 Precision Village Data (DDP), comprising 33,321 individuals and 7,639 households, and the 2023 community-based nutrition surveillance system (e-PPGBM), including 4,976 children under five from eight community health centres. Total sampling covered 40 of 54 villages (74%). The FSI was developed from nine indicators representing food availability, access, and utilisation, standardised using z-scores and normalised to a 0–100 scale. Data were analysed using the Shapiro–Wilk test, Spearman correlation, and backward multiple linear regression. The mean village FSI was 57.81, indicating moderate vulnerability, while the mean stunting prevalence was 13.70%. FSI was significantly and inversely associated with stunting ( $\rho = -0.464$ ;  $p = 0.003$ ). Poverty emerged as the strongest predictor of stunting ( $\beta = 0.458$ ;  $p = 0.002$ ; adjusted  $R^2 = 0.261$ ). Strengthening village food security through targeted poverty reduction should be prioritised to accelerate stunting reduction in PPU Regency.

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## 1. INTRODUCTION

Stunting is a form of linear growth disorder in children characterized by height according to age less than  $-2$  standard deviations ( $TB/U < -2$  SD) and occurs due to chronic malnutrition in the long term. The impact is permanent, not only on physical growth, but also on the development of the child's cognitive, motor, and immune systems (Prendergast & Humphrey, 2014). Globally, the prevalence of stunting decreased from 33.1% in 2000 to 22.0% in 2020; however, Indonesia is still relatively high (Badan Penelitian dan Pengembangan Kesehatan, 2018). Data from the 2022 Indonesian Nutrition Status Survey (SSGI) recorded a national prevalence of 21.6%, still above the target of 14% in 2024 as stipulated in Presidential Regulation Number 72 of 2021 (Badan Kebijakan Pembangunan Kesehatan, 2022; Presiden Republik Indonesia, 2021). East Kalimantan Province recorded 23.9%, and North Penajam Paser Regency (PPU) at 21.8%, with around 1,200 toddlers experiencing stunting in the same year (Dinas Kesehatan Kabupaten Penajam Paser Utara, 2023; Badan Kebijakan Pembangunan Kesehatan, 2022). This gap between achievement and targets demands a deeper understanding of risk factors, particularly at the local level.

One of the important determinants of stunting is food security. The Food and Nutrition Security (FNS) framework expands the concept of food security by integrating the four pillars (availability, access, utilization, and stability) along with determinants of nutritional status such as parenting, sanitation, and health services (Herforth, Jones, & Pinstrip-Andersen, 2012). In this framework, nutritional status (including stunting prevalence) is an output of the functioning of the food system, so stunting is one of the indicators in the assessment of the Food Security Index (IKP). Studies confirm the close relationship between limited access to food and stunting incidence (Akombi et al., 2017; Dewi, Khomsan, & Dwiriani, 2024), with toddlers from food-insecure households at 3.5 to 10 times higher risk of stunting (Rohmawati, Akbar, & Nurfaradila, 2023).

Although PPU Regency ranks 22nd out of 385 districts in the national IKP, the prevalence of stunting remains high (Badan Pangan Nasional, 2023). This paradoxical condition indicates that the problem does not lie in food security in aggregate, but in the uneven distribution between regions. As an illustration, the percentage of households with access to decent drinking water in Penajam District reached 97.22%, while in Babulu District it was only 52.34%. This inter-village inequality is suspected to form a spatial concentration of stunting cases in areas with lower access to and utilization of food, in line with the finding that areas with high food vulnerability tend to form clusters at high risk of stunting (Satria et al., 2020). Contextual determinants at the regional level have also been shown to play a role after controlling for individual factors (Beal et al., 2018; Mulyaningsih et al., 2021).

The analysis of food security at the village level is increasingly relevant to national policies that require an allocation of at least 20% of Village Funds for food security and nutrition programs. The village-level IKP functions not only as a measuring tool, but also as an instrument for evaluating the effectiveness of village policies and budgets (Kementerian Desa, Pembangunan Daerah Tertinggal, dan Transmigrasi Republik Indonesia, 2020). Meanwhile, most of the research still focuses on the household scale, while studies at the village aggregate level using a comprehensive composite index are still limited (Dewi, Khomsan & Dwiriani, 2024). Availability of Precision Village Data (DDP), which is collected through a spatial-based participatory census with high accuracy (Sjaf et al., 2022), opens up opportunities to fill the gap. Therefore, this study aims to analyze the relationship between village-level IKP and the prevalence of *stunting* in PPU Regency, as well as examine the most relevant indicators of food security related to *stunting* as the basis for formulating more targeted interventions.

## 2. METHODS

This study uses a correlational quantitative design at the aggregate (ecological) level to analyze the relationship between IKP and stunting prevalence in all villages/sub-districts in PPU Regency. The location was chosen based on the high prevalence of stunting (21.8%), which contrasts with the district's food security status, which is relatively good, thus indicating a gap at the local level. Data processing and analysis will be carried out from August to October 2025.

The data used is secondary data from two sources, namely the 2023 Precision Village Data (DDP) coordinated by the DDP Laboratory, Faculty of Human Ecology, IPB University (covering 33,321 individuals and 7,639 households), as well as data on stunted toddlers from the Community-Based Nutrition Recording and Reporting Electronic System (e-PPGBM) of the PPU Regency Health Office in 2023 (covering 4,976 toddlers from eight health centers). DDP is a spatial-based rural data collection method collected through a participatory census, so it has high accuracy (Sjaf et al., 2022). The study applied a total sampling technique, with analysis units as many as 40 out of 54 villages/sub-districts (74%) whose data were available in full in both sources.

The village-level IKP is composed of nine indicators representing three main aspects of food security, referring to the National Food Agency framework modified for the village scale (Badan Pangan Nasional, 2023). The availability aspect is represented by the ratio of agricultural land area to the number of population; the affordability/access aspect includes the percentage of the population below the poverty line, the percentage of households with a proportion of food expenditure of more than 65%, and the percentage of households without access to electricity; while the utilization aspect includes the average length of schooling of girls over 15 years old, the percentage of households without access to decent drinking water, the ratio of population per health worker to population density, percentage of stunted toddlers, and life expectancy. The prevalence of stunting at the village level is calculated from the TB/U z-score value for every toddler aged 24–59 months using WHO growth standards, with the stunting category if the z-score is  $< -2$  SD. All indicators are standardized using z-score and normalized to the range of 0–100 through the Distance to Scale method to have a consistent scale and direction of interpretation.

Statistical analysis is carried out gradually. Descriptive statistics were used to describe the condition of 40 villages/sub-districts, followed by a normality test using the Shapiro–Wilk method. Bivariate analysis used the Spearman correlation test to assess the direction and strength of the relationship between IKP and its constituent indicators and stunting prevalence. Multivariate analysis uses multiple linear regression of the backward method to identify the most influential indicators, preceded by a test of classical assumptions (normality, multicollinearity, and heteroscedasticity) to ensure the feasibility of the model.

## 3. RESULTS AND DISCUSSION

The results of the assessment showed that the average score of village/sub-district IKP in PPU Regency was 57.81 and was classified as "somewhat vulnerable", with an average stunting prevalence of 13.70%. The highest IKP scores were achieved in Sumber Sari Village (81.04) and Gunung Mulia (78.68), which both had a "very vulnerable" status, while the lowest scores were in Penajam Village (35.21) and Lango Beach (33.41) which had a "very vulnerable" status. The distribution of villages by IKP category is presented in Table 1, which shows that the majority of areas are concentrated in the "moderately resilient" (15 villages) and "moderately vulnerable" (13 villages) categories.

**Table 1.** Distribution of villages/sub-districts by IKP category and average stunting prevalence.

| Category IKP        | Number of villages | Percentage (%) | Average stunting (%) |
|---------------------|--------------------|----------------|----------------------|
| Highly Resistant    | 2                  | 5.0            | 9.72                 |
| Resistant           | 2                  | 5.0            | 21.32                |
| Quite Resistant     | 15                 | 37.5           | 8.67                 |
| Somewhat Vulnerable | 13                 | 32.5           | 12.26                |
| Vulnerable          | 6                  | 15.0           | 23.64                |
| Highly Vulnerable   | 2                  | 5.0            | 27.44                |
| Total               | 40                 | 100            | 13.70                |

Table 1 shows a gradient trend: the average prevalence of stunting tends to increase as the food security category decreases, from 9.72% in "very vulnerable" villages to 23.64% in "vulnerable" villages and 27.44% in "very vulnerable" villages. The prevalence of stunting varies greatly between villages, from 0% (Sidorejo Village and Pejala Village) to 36.17% (Buluminung Village). This wide variation confirms that the determinants of stunting are multidimensional and unevenly distributed, thus requiring a region-specific intervention approach.

The results of the Spearman correlation test (Table 2) showed that the overall IKP was negatively and significantly correlated with the prevalence of stunting ( $\rho = -0.464$ ;  $p = 0.003$ ). This means that the increase in village food security scores is related to reducing the prevalence of stunting. This relationship is associative, not directly causal, but consistent with the affirmation that food security is one of the important determinants of chronic malnutrition prevention (Badan Pangan Nasional, 2023; FAO, IFAD, UNICEF, WFP & WHO, 2023). These findings are in line with a household-level study that reported an increase in stunting risk of up to 3.1 times in food-insecure households in Kudus Regency (Rahmatika, Pangestuti, & Asna, 2024) and with research that places food security as a strong predictor of children's nutritional status (Yuliantini et al., 2024).

**Table 2.** Spearman Correlation Test Results Of IKP Indicators On Stunting Prevalence.

| KPI Indicator                                   | Coefficient $\rho$ | p-value |
|-------------------------------------------------|--------------------|---------|
| Ratio of agricultural land area per capita      | -0.002             | 0.992   |
| Population below the poverty line (%)           | 0.529              | <0.001* |
| RT with food expenditure >65% (%)               | 0.420              | 0.007*  |
| Average length of schooling for girls (years)   | -0.356             | 0.024*  |
| RTs without access to decent drinking water (%) | 0.053              | 0.745   |
| Population to health worker ratio               | -0.016             | 0.922   |
| RT without electricity access (%)               | 0.427              | 0.006*  |
| Life expectancy (years)                         | -0.233             | 0.148   |
| Food Security Index (IKP)                       | -0.464             | 0.003*  |

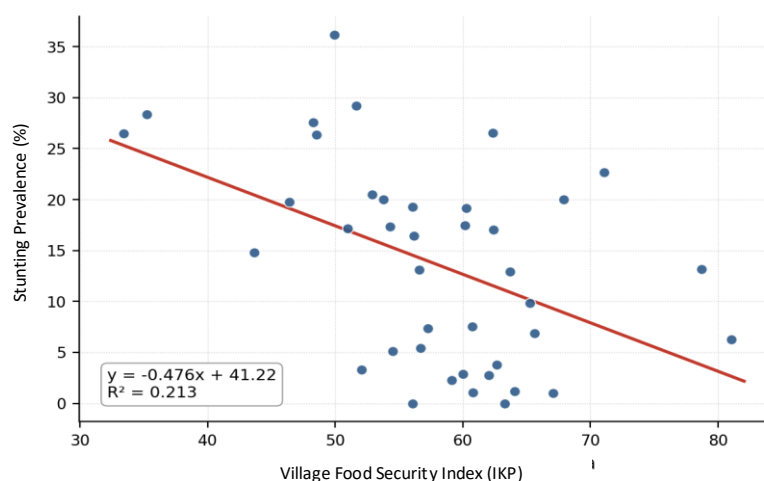
**Remarks:** \* significant at  $p < 0.05$  (2-tailed). The stunting percentage indicator of toddlers is not displayed because it is identical to the dependent variable.

In terms of affordability, the percentage of poor people showed the strongest positive correlation with *stunting* ( $\rho = 0.529$ ;  $p < 0.001$ ), followed by the percentage of households without access to electricity ( $\rho = 0.427$ ;  $p = 0.006$ ) and the proportion of food expenditure above 65% ( $\rho = 0.420$ ;  $p = 0.007$ ). Poverty limits household purchasing power for nutritious food, especially animal proteins that play a role in the synthesis of the hormone Insulin-like Growth Factor-1 (IGF-1) as a stimulator of linear bone growth (Headey, Hirvonen, & Hoddinott, 2018). Limited access to electricity also reduces the ability of households to

store fresh food hygienically and hampers microeconomic productivity (Fujii, Shonchoy, & Xu, 2018; Samuda, 2023), Meanwhile, the high proportion of food expenditure reflects the low economic flexibility of the family.

In terms of utilization, the average length of women's schooling was significantly negatively correlated with *stunting* ( $\rho = -0.356$ ;  $p = 0.024$ ). Higher levels of women's education are related to better nutritional knowledge and parenting practices, thus becoming a protective factor against the risk of *stunting* (Beal et al., 2018; Hamzah, Sofilda, & Kusairi, 2025). On the other hand, a number of indicators were not significantly correlated, namely the ratio of agricultural land area ( $p = 0.992$ ), access to decent drinking water ( $p = 0.745$ ), ratio of health workers ( $p = 0.922$ ), and life expectancy ( $p = 0.148$ ). The insignificance of the agricultural land ratio is suspected to be related to structural transformation due to the determination of the Nusantara Capital City (IKN), which shifted the economic focus from the agricultural sector to the construction and service sectors, so that land ownership is no longer the main determinant of household welfare. Relatively even access to drinking water in most regions also decreases its variation as a predictor, although theoretically sanitation and clean water remain important determinants of *stunting* (Nizaruddin & Ilham, 2022; Olo, Mediani, & Rakhmawati, 2020; Torlesse et al., 2016).

The negative relationship between KIP and *stunting* prevalence is also visually depicted in Figure 1. A simple linear regression analysis yielded an equation of  $y = -0.476x + 41.22$  with a determination coefficient of  $R^2 = 0.213$ , which means that the variation in IKP was able to explain about 21.3% of the variation in *stunting* prevalence between villages, while the rest was influenced by other factors outside the model.



**Figure 1.** Scatter diagram of the relationship between village IKP and *stunting* prevalence

The multiple linear regression analysis using the backward method (Table 3) included five indicators with  $p < 0.25$  in the correlation test, then gradually eliminated the insignificant variables. The final model left two variables, namely the percentage of the poor population and life expectancy, with the equation  $Y = 50.840 + 0.379$  (poverty)  $- 0.722$  (life expectancy) and the *Adjusted R*<sup>2</sup> value = 0.261 (26.1%). Poverty was proven to be the most dominant and very significant determinant ( $\beta = 0.458$ ;  $p = 0.002$ ): every 1% increase in the poverty rate was followed by an increase in *stunting* prevalence by 0.379%, assuming other variables were constant. Life expectancy had a negative but insignificant effect at 5% ( $p = 0.077$ ), although significant at 10%.

**Table 3.** Multiple linear regression end model (backward method).

| Variable                | B      | $\beta$ | t      | p      |
|-------------------------|--------|---------|--------|--------|
| Constant                | 50.840 | –       | 2.016  | 0.051  |
| Poverty (%)             | 0.379  | 0.458   | 3.309  | 0.002* |
| Life Expectancy (Years) | –0.722 | –0.252  | –1.817 | 0.077  |

*Description:* \* significant at  $p < 0.05$ ; adjusted  $r^2 = 0.261$ .

The dominance of poverty as a root cause emphasizes that stunting is a problem rooted in socio-economic determinants. Poverty triggers a domino effect in the form of low purchasing power of animal protein, poor sanitation, and limited access to electricity and information (Doloksaribu, Doloksaribu, & Nainggolan, 2022; Karyati & Julia, 2021; Resfaliza, Kamarni, & Purwasutrisno, 2024). These findings corroborate previous studies that placed poverty and family socio-economic status as significant predictors of stunting (Kharisma et al., 2026; Sihite et al., 2021). Thus, structural poverty alleviation is a key strategy for reducing stunting in PPU Regency.

The case of Penajam Village clarifies the paradox of distribution. As the capital of the district and the buffer area of the IKN, this region recorded the highest poverty (63.22%) and the highest proportion of food expenditure (41.18%). Development pressures and local inflation increase food prices without adequate local supply chains, making low-income households particularly vulnerable. On the other hand, Sumber Sari Village, as an ex-transmigration area with independent land ownership, good irrigation, and adequate sanitation, was able to achieve the highest IKP (81.04) and the lowest stunting prevalence (6.25%), far exceeding the national target of 14%.

Additional findings related to budget allocation show that the large percentage of the Village Fund for food security is not always in line with the achievements of the IKP. Some villages with high allocation (above 80%) are actually in the vulnerable category, while villages with low allocation such as Sidorejo are able to achieve a fairly resilient status through the use of yard land and independent agriculture. This indicates that non-financial factors, such as the initial condition of the village, institutional capacity, and community habits, also determine the effectiveness of food security programs.

This research has a number of limitations. Ecological design at the aggregate level cannot be used to draw causal conclusions or inferences at the individual level (potential ecological fallacy). The use of cross-sectional secondary data from a single district also limits the generalizability of the findings, so interpretation needs to be done carefully, taking into account contextual differences across regions.

#### 4. CONCLUSION

Village food security in North Penajam Paser Regency remains vulnerable, while the prevalence of stunting varies considerably across villages. A stronger village-level Food Security Index was associated with a lower prevalence of stunting, indicating that disparities in food access and utilization, rather than overall food availability, play a central role in shaping nutritional outcomes. Among the food security indicators, poverty emerged as the strongest determinant of stunting, followed by household access to electricity, the proportion of food expenditure, and women's educational attainment.

These findings highlight the need for local and village governments to prioritize poverty reduction and strengthen food security interventions in vulnerable communities as a key strategy for accelerating stunting reduction. Policies should be tailored to local conditions and supported by regular evaluations of Village Fund utilization to ensure that investments effectively improve household food security and child nutrition. Future studies should employ individual-level or spatial-temporal analytical approaches across broader

geographic settings to provide stronger evidence on the causal pathways linking food security and stunting.

### **CONFLICT OF INTEREST**

The authors declare no conflict of interest.

### **AUTHOR CONTRIBUTIONS**

Muhammad Rafki Pratama conceived and designed the review study, conducted the literature search, screened and extracted the data, and drafted the initial manuscript. Dodik Briawan provided conceptual framework guidance, supervised the literature selection process, and critically revised the manuscript for intellectual content. Cesilia Meti Dwiriani contributed to the synthesis and analysis of the reviewed articles, provided valuable input on data interpretation, and participated in refining the manuscript. All authors reviewed and approved the final version of the manuscript for submission.

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### **DECLARATION OF ARTIFICIAL INTELLIGENCE USE**

The authors used generative artificial intelligence (AI)-assisted technology solely to improve the language quality, sentence structure, readability, and overall organization of this manuscript, including paraphrasing selected text to enhance clarity while preserving the original scientific meaning.

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