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Spatial analysis and specific nutrition intervention factors associated with the prevalence of stunting in Aceh Province, 2022

Analisis spasial dan faktor intervensi gizi spesifik terhadap prevalensi stunting di Provinsi Aceh tahun 2022

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Abstract

Aceh is an Indonesian province with a persistently high prevalence of stunting. Spatial analysis of the prevalence of stunting and the performance of specific nutrition interventions provides essential evidence for identifying priority areas for action. Mapping intervention coverage enables local governments to determine strategic measures tailored to district needs. This study aimed to map and analyze the relationship between stunting prevalence and the coverage of specific nutrition interventions, including (1) supplementary feeding for pregnant women, (2) iron–folic acid supplementation for pregnant women, (3) iron supplementation for adolescent girls, (4) exclusive breastfeeding, (5) supplementary feeding for underweight children, (6) growth monitoring, and (7) basic immunization. A cross-sectional design was applied to 23 districts/cities in Aceh. Secondary data were obtained from the 2022 Indonesian Nutrition Status Survey (INSS) and Aceh Provincial Health Office profile. Spatial mapping was conducted using overlay techniques, followed by linear regression analysis to assess the association between intervention coverage and district-level stunting prevalence. Supplementary feeding of pregnant women was significantly associated with stunting prevalence (p= 0.040). No significant associations were observed for iron folic acid supplementation in pregnant women (p= 0.961), iron supplementation in adolescent girls (p= 0.066), exclusive breastfeeding (p= 0.559), supplementary feeding for underweight children (p= 0.347), growth monitoring (p= 0.318), or basic immunization (p= 0.219). In conclusion, supplementary feeding for pregnant women is significantly associated with stunting prevalence, underscoring its critical role in specific nutritional interventions and its relevance in developing targeted regional policies.

Keywords: Aceh province, nutritional interventions, pregnancy, spatial analysis, stunting

Abstrak

Aceh merupakan salah satu provinsi di Indonesia dengan prevalensi stunting yang tinggi. Analisis spasial terhadap prevalensi stunting dan capaian intervensi gizi spesifik memberikan bukti penting untuk menentukan wilayah prioritas intervensi. Pemetaan capaian program membantu pemerintah daerah dalam merumuskan strategi yang lebih tepat sasaran sesuai kebutuhan masing-masing kabupaten/kota. Studi ini bertujuan memetakan serta menganalisis hubungan antara prevalensi stunting dan cakupan intervensi gizi spesifik, meliputi: (1) pemberian makanan tambahan bagi ibu hamil, (2) suplementasi zat besi–asam folat pada ibu hamil, (3) suplementasi zat besi pada remaja putri, (4) pemberian ASI eksklusif, (5) pemberian makanan tambahan bagi balita kurus, (6) pemantauan pertumbuhan, dan (7) imunisasi dasar. Desain penelitian potong lintang diterapkan pada 23 kabupaten/kota di Aceh.

Data sekunder diperoleh dari Survei Status Gizi Indonesia (SSGI) 2022 serta Profil Dinas Kesehatan Provinsi Aceh. Pemetaan spasial dilakukan menggunakan teknik overlay, kemudian dilanjutkan dengan analisis regresi linier untuk menilai hubungan antara cakupan intervensi dan prevalensi stunting tingkat kabupaten/kota. Hasil, pemberian makanan tambahan untuk ibu hamil menunjukkan hubungan signifikan dengan prevalensi stunting (p=0.040). Tidak ditemukan hubungan signifikan pada suplementasi zat besi–asam folat untuk ibu hamil (p=0.961), suplementasi zat besi untuk remaja putri (p=0.066), ASI eksklusif (p=0.559), makanan tambahan balita kurus (p=0.347), pemantauan pertumbuhan (p=0.318), maupun imunisasi dasar (p=0.219). Kesimpulan, pemberian makanan tambahan bagi ibu hamil berasosiasi secara signifikan dengan prevalensi stunting, menegaskan peran penting intervensi gizi spesifik dalam penyusunan kebijakan dan penentuan prioritas program di tingkat daerah.

Kata Kunci: Analisis Spasial, intervensi gizi, kehamilan, stunting, Provinsi Aceh

Introduction

Stunting is a condition of impaired growth in toddlers, characterized by suboptimal height development. It results from chronic malnutrition and recurrent infections experienced by mothers and children, particularly during the first 1,000 days of life, starting from conception until the child reaches two years of age (TNP2K, 2019). The 2022 Indonesian Nutrition Status Survey (INSS) known as *Survei Status Gizi Indonesia (SSGI)* reported that nutritional problems among toddlers in Aceh exceed the national prevalence rates. The SSGI findings indicated that the prevalence of stunting among toddlers was 31.2%, underweight was 24.3%, and wasting was 11.3% (BKPK 2023).

Stunting has profound long-term implications for human resource quality and national development. Its consequences include short adult stature due to impaired linear growth, increased susceptibility to degenerative diseases, decreased reproductive health, reduced learning capacity during school years, and lower productivity in adulthood (Barir et al., 2019). These long-term impacts are expected to significantly affect the country's economic performance (Khotimah, 2022). To address this problem, Presidential Regulation No. 72 of 2021 on the acceleration of stunting reduction mandates two broad intervention strategies: eleven specific interventions targeting direct causes and fourteen sensitive interventions addressing indirect determinants. The regulation also identifies numerous performance indicators and emphasizes cross-sectoral collaboration (Presidential Regulation No. 72, 2021).

Geographical and socioeconomic diversity across regions influences the effectiveness of stunting reduction efforts at the district and city levels. The implementation capacity of specific nutritional interventions in Aceh is notably lower than the national average. Several challenges in strengthening stunting intervention programs have been identified, including insufficient information dissemination and limited cross-sectoral coordination regarding the implementation and expected outcomes of specific interventions (Permanasari et al., 2020). Research from Aceh Jaya further indicates weaknesses in convergence efforts, particularly the uneven distribution of specific intervention services across stunting location (Nasir, 2025).

Spatial analysis provides a powerful method for visualizing the magnitude of the stunting problem and the coverage of specific interventions in each district and city. The resulting maps can guide the Aceh government in identifying priority areas that require additional support to reduce the prevalence of stunting. Given the limited intervention budgets, the government must prioritize the most effective and influential programs. This study is essential because it identifies the dominant determinant factors underlying stunting, thereby informing evidence-based, targeted interventions and policies aimed at reducing stunting in Aceh.

Methods

This study employed a cross-sectional design to map the prevalence of stunting and the coverage

of stunting-specific interventions across 23 districts/cities in Aceh Province. Secondary data were obtained from the 2022 Indonesian Nutrition Status Study (INSS) and the 2022 Aceh Health Profile (BKPK, 2023; Aceh Health Office, 2022).

The dependent variable in this study was the prevalence of stunting among children under five years of age, as reported in the 2022 Indonesian Nutrition Status Survey (INSS). A child is considered stunted when his or her height-for-age z-score is below −2 standard deviations from the World Health Organization Growth Standards median (Al Rahmad et al., 2023). The independent variables included food supplementation for pregnant women with chronic energy deficiency, iron supplementation for pregnant women, iron supplementation for adolescents, exclusive breastfeeding, supplementary feeding for children with wasting, growth monitoring, and complete basic immunization. All variables were obtained from the 2022 Aceh Health Office Profile (Aceh Health Office, 2022).

The first stage of the spatial analysis was conducted using ArcGIS to map the stunting prevalence and intervention coverage. Overlay analysis was performed using a choropleth mapping approach, in which stunting prevalence was categorized based on the World Health Organization classifications and then spatially intersected with program coverage rates defined in the 2022 Aceh Health Office Strategic Plan. In the second stage, bivariate linear regression analysis was performed using STATA to quantify the direct association between specific intervention coverage and the prevalence of stunting. Prior to running the regression models, diagnostic tests for the linearity and normality of residuals were conducted. Both assumptions were satisfied, supporting the validity of the simple linear regression analysis.

Result and Discussion

Stunting Prevalence in Aceh

The 2022 Indonesian Nutrition Status Survey (SSGI) for Aceh Province reported that the lowest stunting prevalence occurred in Aceh Jaya District, whereas the highest was found in Subulussalam City.

KABUPATEN	% STUNTING
SIMEULUE	37.2
ACEH SINGKIL	34.0
ACEH SELATAN	34.8
ACEH TENGGARA	36.7
ACEH TIMUR	33.6
ACEH TENGAH	32.0
ACEH BARAT	30.4
ACEH BESAR	27.0
PIDIE	27.8
BIREUEN	23.4
ACEH UTARA	38.3
ACEH BARAT DAYA	35.2
GAYO LUES	34.6
ACEH TAMIANG	27.4
NAGAN RAYA	28.8
ACEH JAYA	19.9
BENER MERIAH	37.0
PIDIE JAYA	37.8
KOTA BANDA ACEH	25.1
KOTA SABANG	23.4
KOTA LANGSA	22.1
KOTA LHOKSEUMAWE	28.1
KOTA SUBULUSSALAM	47.9
ACEH	**31.2**

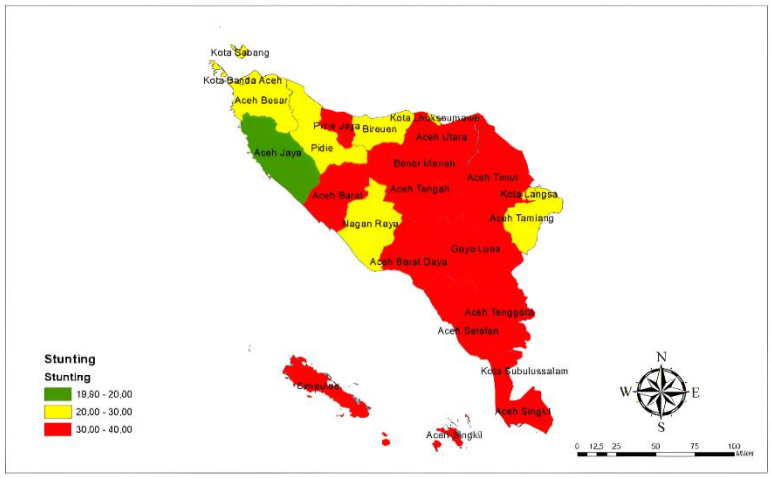


Figure 1. Stunting Prevalence in Aceh Province, 2022

As shown in Figure 1, one district (4.4%) fell within the low-prevalence category (<20%), nine districts (39.1%) were classified as medium, and thirteen districts (56.5%) were categorized as high-prevalence. The marked disparities in stunting prevalence across Aceh reflect the diverse factors that influence stunting in communities.

Stunting in Indonesia is directly affected by inadequate food intake and infectious disease. Indirect determinants include food security, social and environmental conditions, housing quality, income disparities, food systems, and social protection, all of which contribute to uneven stunting patterns across regions, including Aceh (TNP2K, 2019). Geographic

characteristics and socioeconomic status shape health outcomes. Spatial data analysis is a valuable tool for illustrating the magnitude of health problems and identifying demographic factors that influence stunting. It can also guide the selection of intervention targets or loci based on the severity of the problem (Ardian & Utami, 2020; Nurjannah et al., 2021).

Studies conducted in India and Pakistan similarly concluded that socioeconomic status, educational attainment, and geographical location significantly affect stunting, alongside maternal nutritional status, antenatal care adherence, household size, and maternal age at marriage (Akseer, 2018; Menon et al., 2016).

Presidential Regulation No. 72 of 2021 states that nutrition-specific interventions in the health sector, supported by multiple program performance indicators, play a crucial role in reducing stunting. This regulation provides a strengthened framework for planning and implementing stunting reduction strategies. Nutrition-specific interventions address the direct causes of undernutrition through the health sector, whereas nutrition-sensitive interventions are implemented across non-health sectors. Evidence shows that combining specific and sensitive interventions substantially enhances global nutrition outcomes (Abdullahi et al., 2021).

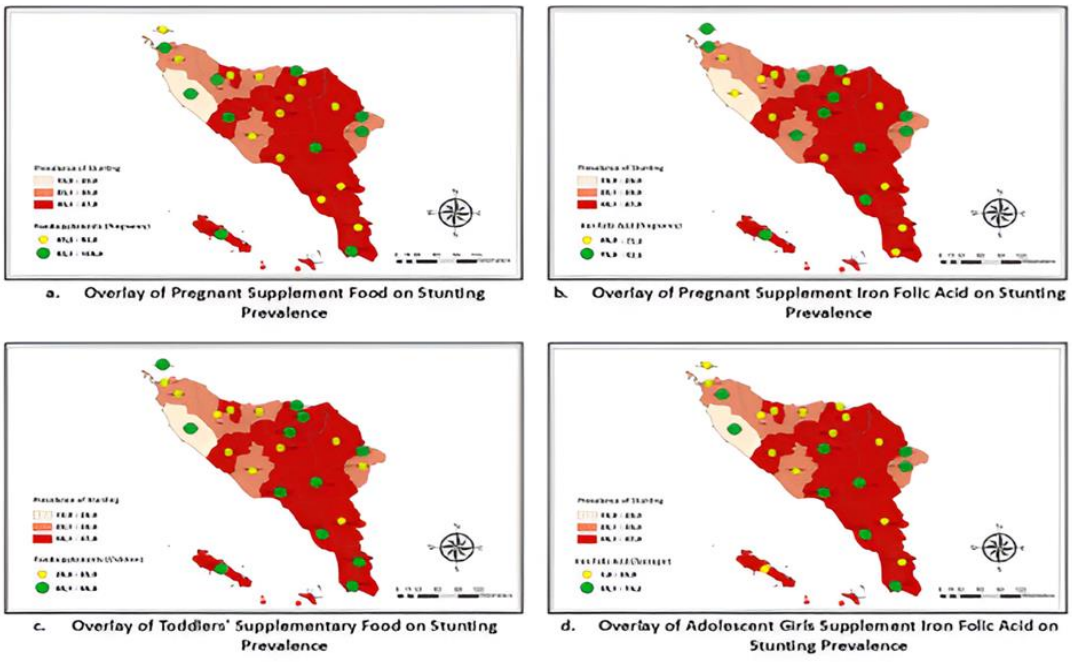
Based on the Provincial Report (*Profil Kesehatan Aceh*) from the Aceh Health Office, several specific intervention indicators have not yet met the expected performance targets. The summary statistics for these indicators are presented in Table 1.

Table 1. Characteristics of data (n = 23)

Variables	Minimum	Maximum	Mean	SD
Stunting (%)	19.9	47.9	31.41	6.59
Food supplements for pregnancy (%)	45.25	100	85.74	14.67
Iron supplements for pregnancy (%)	1.58	74.22	30.2	21.18
Iron supplements for adolescents (%)	26.57	96.81	82.02	15.71
Food supplements for toddlers (%)	49.03	92.7	74.58	14.03
Exclusive breastfeeding (%)	22.43	82.34	56.43	15.5
Growth monitoring (%)	62.42	98.63	85.51	9.93
Basic immunization (%)	4.8	100	50.1	25.46

Map Overlay Analysis

Spatial data analysis is an important method for visualizing the magnitude of health issues. It helps identify demographic characteristics that influence stunting and supports the selection of intervention targets or loci based on the severity of the problem (Ardian & Utami, 2020; Nurjannah et al., 2021).



a. Overlay of Pregnant Supplement Food on Stunting Prevalence

b. Overlay of Pregnant Supplement Iron Folic Acid on Stunting Prevalence

c. Overlay of Toddlers' Supplementary Food on Stunting Prevalence

d. Overlay of Adolescent Girls Supplement Iron Folic Acid on Stunting Prevalence

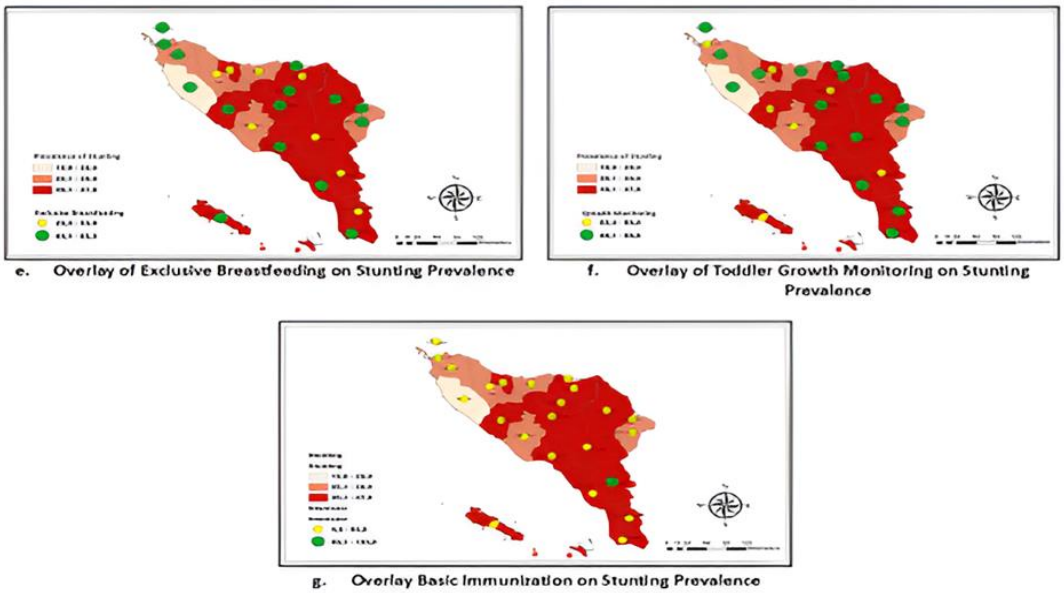


Figure 2. Spatial clustering and overlay specific interventions

Figure 2 presents the spatial overlay between stunting prevalence and the coverage of specific interventions, revealing notable mismatches between program coverage and nutritional outcomes across Aceh's districts. High stunting prevalence persisted in several districts despite strong coverage of key interventions, including supplementary feeding for pregnant women (>92%) in Singkil, Gayo Lues, and West Aceh; iron supplementation for pregnant women (>75%) in Simeulue, South Aceh, Gayo Lues, Central Aceh, and Bener Meriah; and supplementary feeding for toddlers (>85%) in Simeulue, Singkil, Southwest Aceh, Gayo Lues, Bener Meriah, and North Aceh. Additional discrepancies were observed in adolescent iron supplementation (>75%), exclusive breastfeeding (>53%), growth monitoring (>80%), and complete basic immunization (>95%) in multiple districts.

These patterns indicate that achieving high program coverage does not necessarily reduce stunting prevalence. The persistence of high stunting in well-covered districts suggests the presence of contextual barriers, including geographical limitations, cultural norms, socioeconomic factors, and variable service quality, that may hinder the effectiveness of nutrition interventions. These findings underscore the need to strengthen program implementation, improve service quality, and tailor interventions to district-specific challenges.

Correlation Analysis

A correlation test was used to analyze the relationship between the achievement of specific interventions and the prevalence of stunting. This analysis was conducted to determine the direction of the relationship and the line equation model that illustrates the magnitude of the relationship between the achievement of specific interventions and the prevalence of stunting in each district/city.

Table 2. Relationship between specific interventions and stunting prevalence

Intervention	Direction of Association	Estimated Effect Size	Interpretation
Supplementary feeding for pregnant women	Negative	A 10% increase reduces stunting by 1.9%	Strong association; maternal nutrition greatly influences fetal growth
Iron supplementation for pregnant women	Negative	A 10% increase reduces stunting by 1.8%	Strong association; maternal iron status predicts birth outcomes
Supplementary feeding	Negative	A 10% increase	Weak association; toddler

for toddlers		reduces stunting by 0.5%	feeding alone less influential than maternal factors
Iron supplementation for adolescents	Negative	A 10% increase reduces stunting by 0.6%	Weak-to-moderate association; relevant for future maternal health
Exclusive breastfeeding	Negative	A 10% increase reduces stunting by 0.6%	Small association; varies by birth conditions and feeding context
Growth monitoring	Negative	A 10% increase reduces stunting by 1.5%	Moderate association; reflects effectiveness of early detection
Basic immunization	Negative	A 10% increase reduces stunting by 0.7%	Small association; protects against infection-related growth faltering

The analysis revealed consistent negative correlations between stunting prevalence and all specific nutritional interventions examined. A 10% increase in intervention coverage was associated with a 0.5%–1.9% reduction in stunting. The strongest associations were observed for interventions targeting pregnant women, particularly supplementary feeding (–1.9%) and iron supplementation (–1.8%), emphasizing the central role of maternal nutrition and antenatal care in preventing early childhood growth faltering. Child-focused interventions, including toddler supplementary feeding, exclusive breastfeeding, growth monitoring, and basic immunization, also demonstrated negative associations, albeit with smaller effect sizes. These findings underscore the importance of prioritizing maternal nutritional support as a key strategy for reducing the prevalence of stunting.

Hypothesis Analysis

Table 3. Regression coefficients to reduces stunting prevalence

Variable	B	p-value	95% CI (Lower–Upper)
Food supplements for pregnancy	–0.193	0.04	–0.377 to –0.009
Iron supplements for pregnancy	–0.183	0.066	–0.380 to 0.013
Iron supplements for adolescents	–0.064	0.347	–0.202 to 0.074
Food supplements for toddlers	–0.005	0.96	–0.195 to 0.186
Exclusive breastfeeding	–0.054	0.561	–0.246 to 0.137
Growth monitoring	–0.145	0.318	–0.438 to 0.149
Basic immunization	–0.069	0.219	–0.182 to 0.044

The linear regression results indicated that supplementary feeding for pregnant women significantly reduced the prevalence of stunting ($p < 0.05$). However, other intervention indicators, including iron supplementation for pregnant women, iron supplementation for adolescents, toddler supplementary feeding, exclusive breastfeeding, growth monitoring, and complete basic immunization, did not show statistically significant associations ($p > 0.05$). This suggests that in Aceh Province, only maternal supplementary feeding has a sufficiently strong impact on meaningfully reducing stunting.

Supplementary feeding of pregnant women was significantly negatively associated with stunting prevalence ($p = 0.040$). Adequate macronutrient and micronutrient intake during pregnancy improves fetal health and supports optimal birth outcomes (Salmuth et al., 2021). Maternal malnutrition contributes to complications during childbirth, low birth weight (LBW), preterm birth, congenital anomalies, and other infant health issues (Lassi et al., 2022). This study aligns with previous evidence demonstrating that maternal nutritional status and height are strongly associated with newborn length and weight, which subsequently affects the risk of stunting (Rosha et al., 2013; Sartika et al., 2021). Providing 1,500 kcal of supplementary food and increasing the dietary diversity of pregnant

women have been shown to improve nutritional status and reduce the prevalence of anemia (Javadi et al., 2024; Tabrizi et al., 2019).

Iron supplementation in pregnant women showed a negative but borderline significant effect ($p = 0.066$). Maternal anemia substantially increases the risk of delivering stunted infants (Tampy et al., 2020). Although the present study did not find a statistically significant association, other studies have demonstrated the significant effects of iron supplementation and antenatal care on stunting reduction (Fentiana et al., 2022). Studies have also indicated that anemia during pregnancy is mediated by factors such as birth spacing and maternal nutritional status (Al Rahmad & Shavira, 2024; Shifti et al., 2022).

Supplementary feeding for toddlers showed a negative but insignificant association with obesity. This intervention typically targets children aged 6–59 months who experience inadequate weight gain, are underweight, or are malnourished (Keats et al., 2020). Feeding patterns, including timing, dietary diversity, and meal frequency, are associated with stunting, although the impact varies across populations (Hanum, 2019; Rosita, 2021; Toma et al., 2023).

Iron supplementation in adolescents also showed a negative but nonsignificant relationship. This intervention aims to reduce anemia among adolescent girls, an essential factor in preventing LBW and stunting in future pregnancies. Anemic adolescents are more likely to give birth to LBW infants, who are at a significantly higher risk of becoming stunted (Yani et al., 2023; Nabila, 2020; Nasution et al., 2014).

Exclusive breastfeeding showed a negative but insignificant association with stunting. While exclusive breastfeeding has clear benefits for infant health, evidence regarding its direct impact on stunting is mixed and may depend on factors such as birth weight and prematurity (Barir et al., 2019; Febriani et al., 2020; Hadi et al., 2021).

Growth monitoring coverage was also not significantly associated. Monitoring alone may not directly influence stunting without accompanying caregiver knowledge, health promotion, and timely intervention (Bukari et al., 2020; Hidayat, 2022; Muse et al., 2019).

Complete basic immunization showed a negative but nonsignificant effect on mortality. Although immunization prevents infectious diseases linked to growth faltering, several studies have found no significant association between immunization coverage and stunting prevalence (Veri et al., 2025; Maria et al., 2020; Sutriyawan et al., 2020).

Conclusion

Supplementary feeding in pregnant women was significantly associated with reduced stunting prevalence, indicating its substantial contribution to improving early childhood growth outcomes. Other specific interventions, including iron–folic acid supplementation for pregnant women and adolescents, supplementary feeding for toddlers, exclusive breastfeeding, growth monitoring, and routine immunization, were negatively associated with stunting; however, these relationships were not statistically significant.

Overall, these findings suggest that most interventions have not yet yielded measurable population-level impacts on stunting. This may be attributed to inconsistent program implementation, suboptimal community participation, and the influence of broader socioeconomic and environmental determinants that extend beyond the health care sector. Strengthening the quality, coverage, and integration of these interventions, particularly those targeting maternal nutrition, may enhance efforts to further reduce stunting in Aceh Province.

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