

Intervention Programs and Determinant Factors of Stunting Prevalence in Indonesia: An Ecological Study

Program Intervensi dan Faktor Determinan Prevalensi Stunting di Indonesia: Studi Ekologi

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Abstract

Stunting remains a critical public health challenge in Indonesia. According to recent national reports, the prevalence still exceeds the WHO threshold, indicating a persistent burden. This study aimed to analyze the effectiveness of intervention programs and identify the determinants of stunting prevalence at the provincial level in Indonesia. This ecological study uses secondary data from 2022 covering 34 provinces, sourced from official ministry and agency reports. The study variables consisted of stunting prevalence; contributing factors (health, nutrition intake, socioeconomic); and intervention programs (nutrition, health, environment, social). Data were analyzed using Pearson and Spearman tests. The results showed a national stunting prevalence average of $23.29 \pm 6.47\%$, with 50% of provinces classified in the high category. Factors positively correlated with stunting ($p < 0.05$) included low birth weight, poverty, food expenditure, access to proper drinking water, and the family hopes program (PKH), all of which were associated with higher stunting prevalence. Conversely, factors negatively associated with stunting ($p < 0.05$) included dietary pattern score, birth certificate ownership, average years of schooling, non-food expenditure, supplementary feeding for pregnant women with chronic energy deficiency (CED) and underweight toddlers, iron supplementation for pregnant women and adolescent girls, health professional-assisted delivery, antenatal care visits, immunization, postpartum family planning, and access to proper sanitation, all of which were linked to lower stunting prevalence. In conclusion, stunting is driven by multidimensional health, nutritional, and structural factors. Thus, integrated multisectoral interventions are essential to accelerate stunting reduction.

Keywords: ecological study, malnutrition, stunting

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Abstrak

Stunting masih menjadi tantangan kesehatan masyarakat yang krusial di Indonesia. Berdasarkan laporan nasional terbaru, prevalensinya masih melebihi ambang batas WHO, yang menunjukkan beban masalah yang masih terus berlanjut. Penelitian ini bertujuan untuk menganalisis efektivitas program intervensi serta mengidentifikasi faktor determinan prevalensi stunting di tingkat provinsi di Indonesia. Desain penelitian menggunakan ecological study dengan menganalisis data sekunder tahun 2022 dari 34 provinsi yang bersumber dari laporan resmi kementerian dan lembaga terkait. Variabel penelitian mencakup prevalensi stunting, faktor kontribusi (kesehatan, asupan gizi, sosial-ekonomi), dan program intervensi (gizi, kesehatan, lingkungan, sosial). Analisis data menggunakan uji Pearson dan Spearman. Hasil menunjukkan rata-rata prevalensi stunting nasional sebesar $23,29 \pm 6,47\%$, dengan 50% provinsi berada dalam kategori tinggi. Faktor yang berhubungan positif ($p < 0,05$) dengan stunting meliputi berat badan lahir rendah, kemiskinan, pengeluaran pangan, akses air minum layak, dan program keluarga harapan yang berkaitan dengan peningkatan prevalensi stunting, sedangkan faktor yang berhubungan negatif ($p < 0,05$) dengan stunting meliputi skor pola pangan harapan, kepemilikan akta kelahiran, rata-rata lama sekolah, pengeluaran nonpangan, serta intervensi program makanan tambahan ibu hamil kurang energi kronik dan balita gizi kurang, tablet tambah darah untuk ibu hamil dan remaja putri, persalinan oleh tenaga kesehatan, kunjungan antenatal care, imunisasi, KB pascapersalinan, dan akses sanitasi layak berhubungan dengan penurunan stunting. Kesimpulannya, stunting dipengaruhi oleh faktor kesehatan, nutrisi, dan struktural yang bersifat multidimensi. Oleh karena itu, intervensi lintas sektor yang terintegrasi sangat penting untuk mempercepat penurunan stunting.

Kata Kunci: malnutrisi, studi ekologi, stunting

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Highlight:

- Stunting is closely linked to a history of low birth weight, poverty, and a high share of household spending on food.
- Stunting prevalence is lower in families with higher education, birth certificate ownership, diverse food intake, and adequate sanitation.
- Supplementary feeding, iron supplementation, antenatal care, skilled birth attendance, complete immunization, and postpartum family planning were effective in reducing stunting.

INTRODUCTION

Stunting remains a significant public health challenge affecting millions of children under five years of age worldwide. In 2022, the global prevalence of stunting among children under five reached 22.3% of the total population of children under five years of age (UNICEF et al., 2023). In Indonesia, the prevalence of stunting decreased from 27.7% in 2019 to 21.6% in 2022; however, this figure remained high according to the WHO threshold for a public health problem (Kemenkes, 2023). This condition

emphasizes that accelerating the reduction of stunting remains a major priority in both the national development agenda and the targets of the Sustainable Development Goals (SDGs).

Stunting is defined as a condition of chronic growth failure (*growth faltering*) during the first 1,000 days of life, characterized by height-for-age below -2 standard deviations (SD) from the median growth standard, accompanied by suboptimal catch-up growth (Bappenas, 2018). This condition has multidimensional consequences that not only impede physical growth but also hinder cognitive development, reduce the quality of human resources, decrease economic productivity, and potentially reinforce the intergenerational cycle of poverty (Setiawan *et al.*, 2018; Mulyasari *et al.*, 2022). Factors contributing to the occurrence of stunting include complex multifactorial interactions among maternal and child health factors, inadequate nutritional intake, unfavorable environmental conditions, and low socioeconomic status (Siswati, 2018; Kiik and Nuwa, 2021).

The Indonesian Government has implemented an integrated multisectoral strategy through the convergence of nutrition-specific and nutrition-sensitive intervention programs as an effort to accelerate the prevention and reduction of stunting, as stipulated in Presidential Regulation Number 72 of 2021 (Khomsan *et al.*, 2023). Nutrition-specific interventions involve the health sector in directly addressing the causes of stunting through improvements in nutritional and health status, including the provision of supplementary feeding (PMT) for pregnant women and children under five, iron and folic acid supplementation through iron tablets (TTD) for adolescent girls and pregnant women, exclusive breastfeeding, complete immunization, as well as antenatal and postnatal care. Meanwhile, nutrition-sensitive interventions involve cross-sectoral coordination with non-health sectors to address the underlying causes of stunting by developing an optimal living environment, providing access to clean water and adequate sanitation, family planning, health insurance, and social assistance such as the Family Hope Program (PKH) and Non-Cash Food Assistance (BPNT) (Kemenkes, 2021). The effectiveness and coverage of these programs, both nutrition-specific and nutrition-sensitive, are highly important in determining the success of efforts to reduce stunting across various regions of Indonesia. A study by Siswati *et al.* (2022) has demonstrated that convergent interventions can significantly reduce the prevalence of stunting.

To date, numerous studies have identified factors associated with stunting; however, most previous studies have tended to focus on individual-level analyses or limited geographical areas. This approach is often less capable of capturing the dynamics and variations in policy implementation and its impacts on a broader scale, such as at the provincial level. Therefore, more comprehensive research at the provincial level is needed to identify the complexity of factors associated with stunting and to evaluate the effectiveness of intervention programs that have been implemented.

To address this gap, this study employs an ecological study design to analyze the relationships among aggregated variables at the provincial level, thereby providing an effective approach for identifying patterns and relationships among stunting-related factors that are relevant to public policy evaluation and national intervention strategies. This study aims to analyze the effectiveness of intervention programs and the determinants of stunting prevalence at the provincial level. The findings are expected to provide empirical evidence that can be used by policymakers and health practitioners to identify the most effective interventions, optimize stunting prevention and reduction strategies, and formulate more targeted and integrated policy recommendations in the future.

METHODS

This study used an ecological design to analyze the effectiveness of intervention programs and the determinants of stunting prevalence at the provincial level in Indonesia. The unit of analysis covered all provinces in Indonesia, with total sampling of 34 provinces based on the availability and completeness of data. This design allows evaluation of the effectiveness of national policies and intervention programs at the population level rather than the individual level. However, it has limitations, particularly the potential for ecological fallacy, in which conclusions drawn at the group (provincial) level cannot be generalized directly to individuals. The study used secondary data from 2022 obtained from various official reports available online. Data sources included the National Institute of Health Research and Development, the Ministry of Health of the Republic of Indonesia, the Ministry of Home Affairs, the Ministry of Social Affairs, Statistics Indonesia (BPS), the National Food Agency, and the National Population and Family Planning Board (BKKBN).

The study variables comprised stunting prevalence as the dependent variable and a set of independent variables covering contributing factors and intervention programs. The contributing factors included health, nutrient intake, and socioeconomic aspects. Health factors included a history of low birth weight (LBW), diarrhea, and pneumonia. Intake factors included the energy adequacy ratio (TKE), the protein adequacy ratio (TKP), and the Desirable Dietary Pattern (PPH) score. Socioeconomic factors included adolescent pregnancy, poverty rate, sex of the household head, birth certificate ownership, mean years of schooling (RLS), and per-capita expenditure.

The intervention-program variables were grouped into nutrition, health and environment, and food and social interventions. Nutrition interventions included supplementary feeding (PMT) for pregnant women with chronic energy deficiency (CED) and for severely underweight toddlers, iron supplementation (TTD) for pregnant women and adolescent girls, and exclusive breastfeeding. Health and environmental interventions included access to health facilities, skilled birth attendance, antenatal care (ANC) visits, postpartum family planning, complete basic immunization, ownership of subsidized health insurance (JKN-PBI), and access to safe drinking water and adequate sanitation. Food and social interventions included Non-Cash Food Assistance (BPNT) and the Family Hope Program (PKH).

Data processing and analysis used Microsoft Excel and IBM SPSS version 25.0. The relationship between each independent variable and stunting prevalence was tested using the Pearson test for normally distributed data and the Spearman test for non-normally distributed data. Before the association tests, normality was assessed using the Kolmogorov–Smirnov test. A relationship was considered significant when the *p-value* was $< 0,05$. The direction of the relationship was determined by the correlation coefficient (*r*): a positive correlation indicates that an increase in the independent variable is associated with higher stunting prevalence, whereas a negative correlation indicates that an increase in the independent variable is associated with lower stunting prevalence.

RESULTS AND DISCUSSIONS

Based on the analysis of secondary data from 2022, the distribution of stunting prevalence across the 34 provinces of Indonesia showed significant variation. Table 1 presents the categorization of stunting prevalence based on the WHO thresholds. The

results showed that the majority of provinces in Indonesia (50%) were still classified as having a high prevalence, while 29.4% of provinces were classified as having a moderate prevalence and another 17.6% were classified as having a very high prevalence. Only one province managed to achieve the low-prevalence category. The mean prevalence was $23.29 \pm 6.47\%$, reflecting the still high national burden of stunting, with considerable variation across regions. The low proportion of areas with low stunting prevalence indicates that efforts to reduce stunting have not yet been optimal or evenly distributed.

Table 1. Stunting prevalence in Indonesia in 2022

Category	n	%	mean $\pm$ SD
Low (2.5 - <10%)	1	2.9	23.29 ± 6.47
Moderate (10 - <20%)	10	29.4	
High (20% - <30%)	17	50	
Very high ($\geq 30\%$)	6	17.6	

Source: Secondary data, 2022

Association between contributing factors and stunting

As shown in Table 2, several contributing factors were correlated with stunting prevalence, namely low birth weight (LBW), the Desirable Dietary Pattern (PPH) score, poverty rate, birth certificate ownership, mean years of schooling (RLS), and the share of food and non-food expenditure ($p < 0.05$).

Table 2. Association between contributing factors and stunting in 2022

Variable	mean $\pm$ SD	<i>r</i>	<i>p</i> -value
Health status			
Low birth weight (LBW)	13.06 ± 2.31	0.560	0.001 ^{a*}
Pneumonia	15.34 ± 2.26	-0.105	0.556 ^b
Diarrhea	1.15 ± 0.85	0.304	0.080 ^b
Dietary intake			
Energy adequacy ratio (TKE)	96.33 ± 6.55	-0.070	0.693 ^a
Protein adequacy ratio (TKP)	107.29 ± 9.79	-0.252	0.151 ^a
Desirable Dietary Pattern (PPH) score	86.47 ± 6.40	-0.641	0.000 ^{a*}
Socioeconomic			
Adolescent mothers	45.13 ± 8.45	0.328	0.058 ^b
Poverty rate	10.29 ± 5.29	0.497	0.003 ^{b*}
Male household head	88.05 ± 2.66	-0.223	0.205 ^a
Female household head	11.95 ± 2.66	0.223	0.205 ^a
Mean years of schooling (RLS)	9.25 ± 0.82	-0.414	0.015 ^{a*}
Birth certificate ownership	79.80 ± 11.36	-0.586	0.000 ^{b*}
Food expenditure	50.91 ± 4.40	0.392	0.022 ^{b*}
Non-food expenditure	49.09 ± 4.40	-0.392	0.022 ^{b*}

Note: ^aPearson test, ^bSpearman test; significant if p -value < 0.05 ; r = correlation coefficient

Birth weight reflects the condition of fetal growth, which has implications for child development in the future. Low birth weight (LBW) (<2.500 grams) is often caused by intrauterine growth restriction or prematurity (Saadong *et al.*, 2021). This study showed that LBW was significantly positively associated with stunting ($r = 0.560$; $p = 0.001$). Studies conducted in several countries, including Rwanda, Vietnam, and

India, have also consistently confirmed an increased risk of stunting among children with a history of LBW (Giao et al., 2019; Nshimyiryo et al., 2019; Halli et al., 2022). Children with LBW tend to be more vulnerable to impaired linear growth, malnutrition, recurrent infections, an increased risk of degenerative diseases, and a higher risk of stunting (Jana et al., 2023). Inadequate nutritional intake, unfavorable environmental conditions, and limited access to health services may further exacerbate the nutritional status of children with LBW.

A less diverse dietary pattern may lead to nutrient deficiencies and deteriorate children's nutritional status. Dietary diversity and balance can be reflected through the Expected Food Pattern (PPH) score. This study showed that the PPH score was significantly negatively associated with stunting ($r = -0.641$; $p < 0.001$). A high PPH score reflects a good level of dietary diversity and balance, which is closely associated with a reduction in stunting prevalence. Conversely, a low PPH score indicates an imbalance in nutritional intake that may potentially lead to malnutrition (Suryana et al., 2018). Prasetyo et al. (2023) also reported that dietary diversity was positively correlated with improvements in the height-for-age (HAZ) nutritional status of children under five ($r = 0.62$).

Socioeconomic factors, particularly poverty, are fundamental causes of nutritional problems and contribute to the high prevalence of stunting in various countries (Siswati, 2018). This study found a significant positive association between the poverty rate and stunting ($r = 0.497$; $p = 0.003$). A high proportion of the population living in poverty often indicates limited access to adequate nutrition, quality health services, education, and sanitation, thereby increasing the risk of stunting. Maria et al. (2020) also confirmed the existence of a causal relationship between poverty and impaired child growth in Indonesia.

Parents' educational attainment, particularly that of mothers, plays an important role in improving understanding of nutrition, childcare practices, and utilization of health services, which can ultimately help reduce the risk of stunting (Noor et al., 2022). This study showed that mean years of schooling (RLS), which is one of the indicators of educational attainment, was significantly negatively associated with stunting ($r = -0.414$; $p = 0.015$). Higher educational attainment contributes to better parental knowledge and skills in childcare practices and meeting family nutritional needs, such as providing balanced complementary feeding (MP-ASI), maintaining sanitation and hygiene, and ensuring complete immunization for children. Conversely, low educational attainment is often accompanied by limited access to nutritional information, which contributes to a higher proportion of children experiencing stunting (Amarante et al., 2018; Lukman et al., 2021).

Ownership of a birth certificate, as a form of protection of children's civil rights, was also significantly negatively associated with stunting ($r = -0.586$; $p < 0.001$). Children with birth certificates tend to have easier access to health services, nutritional intervention programs, and other forms of social protection, thereby contributing to improved child nutritional status and reducing the risk of stunting. Agustina et al. (2023) also reported that birth certificate ownership influences children's nutritional status. However, geographical and administrative barriers in remote areas remain challenges in increasing the coverage of birth certificate ownership in Indonesia.

Household economic conditions are also reflected in per capita expenditure patterns, which serve as an indicator of a family's ability to meet basic needs, including food, health, and education. According to Engel's Law, an increase in income is followed by a decrease in the proportion of food expenditure and an increase in non-

food expenditure (Randani et al., 2022). The proportion of food expenditure was significantly positively associated with stunting ($r = 0.392$; $p = 0.022$), while non-food expenditure was negatively associated with stunting ($r = -0.392$; $p = 0.022$). A high proportion of food expenditure often reflects economic constraints and household food insecurity, which may lead to reduced dietary diversity and poorer nutritional intake quality, thereby causing growth impairment that may result in stunting (Titalley et al., 2019). Consistent with this finding, an increase in the proportion of non-food expenditure reflects improved household welfare, allowing resources to be allocated to health, education, and sanitation needs that contribute to reducing stunting prevalence. Amaral et al. (2018) in Uganda also showed that every 1% increase in food expenditure was associated with a 0.7% increase in the risk of stunting.

Association between intervention programs and stunting

Intervention programs represent strategic government efforts to prevent and address stunting. The analysis presented in Table 3 showed that various intervention programs, including supplementary feeding (PMT) for pregnant women with chronic energy deficiency (CED) and undernourished children under five, iron and folic acid supplementation through iron tablets (TTD) for pregnant women and adolescent girls, deliveries assisted by health personnel, fourth antenatal care (ANC K4) visits, complete basic immunization, postpartum family planning (FP), access to safe drinking water and adequate sanitation, as well as the Family Hope Program (PKH), were significantly associated with stunting prevalence ($p \leq 0.05$).

Table 3. Association between intervention programs and stunting in 2022

Variabel	mean $\pm$ SD	<i>r</i>	<i>p-value</i>
Intervensi gizi			
PMT bumil KEK	91,06 $\pm$ 8,58	-0,488	0,003 ^{b*}
PMT balita gizi kurang	80,61 $\pm$ 17,08	-0,648	0,000 ^{b*}
TTD ibu hamil	79,55 $\pm$ 16,59	-0,661	0,000 ^{b*}
TTD remaja putri	46,04 $\pm$ 21,99	-0,567	0,000 ^{a*}
ASI eksklusif	68,89 $\pm$ 7,33	0,064	0,719 ^a
Intervensi kesehatan dan lingkungan			
Akses faskes dasar	78,83 $\pm$ 9,64	-0,294	0,092 ^b
ANC K4	81,86 $\pm$ 12,69	-0,535	0,001 ^{b*}
Kelahiran ditolong	94,53 $\pm$ 6,08	-0,520	0,002 ^{b*}
KB pascapersalinan	46,05 $\pm$ 22,08	-0,389	0,023 ^{a*}
Imunisasi dasar	62,18 $\pm$ 13,53	-0,352	0,041 ^{b*}
JKN-PBI	42,39 $\pm$ 12,79	0,273	0,118 ^a
Akses minum layak	87,64 $\pm$ 7,85	0,377	0,028 ^{a*}
Akses sanitasi layak	80,73 $\pm$ 9,95	-0,591	0,000 ^{a*}
Intervensi pangan dan sosial			
BNPT	16,62 $\pm$ 8,56	0,128	0,472 ^a
PKH	15,04 $\pm$ 6,62	0,458	0,006 ^{a*}

Note: ^aPearson test, ^bSpearman test; significant if $p\text{-value} < 0.05$; r = correlation coefficient

The Supplementary Feeding Program (PMT) is one of the nutritional interventions commonly provided in the form of fortified biscuits for 90 days. PMT intervention for pregnant women with Chronic Energy Deficiency (CED) ($r = -0.488$; $p = 0.003$) and undernourished children under five ($r = -0.648$; $p < 0.001$) showed a significant

negative association with stunting. Increased coverage of PMT has a positive impact on improving maternal nutritional status, reducing the risk of low birth weight (LBW), and improving children's nutritional status (Khomsan et al., 2023). Studies in China and Brazil have shown that greater weight gain during pregnancy is positively associated with infant birth weight. A study by Fajar et al. (2022) also found an increase in body weight among children under five following PMT intervention. These findings indicate that PMT intervention plays an important role in improving the nutritional status of pregnant women and children under five, as well as supporting efforts to prevent stunting.

Iron and folic acid supplementation through iron tablets (TTD) is an important intervention for stunting prevention because it plays a role in preventing anemia and improving the nutritional status of pregnant women. Anemia in pregnant women reduces oxygen supply to the placenta, resulting in nutritional deficiencies in the fetus (Khomsan et al., 2023). TTD supplementation for pregnant women should be provided at a minimum of 90 tablets throughout pregnancy. TTD supplementation among pregnant women was significantly negatively associated with stunting ($r = -0.661$, $p < 0.001$). TTD consumption has a linear correlation with child growth. Mothers who consume TTD during pregnancy have a lower risk of anemia as well as a lower risk of preterm birth and LBW, which ultimately reduces stunting. A study in Ethiopia showed that pregnant women who did not consume iron supplements had a higher risk of giving birth to children who experienced stunting (Ejigu and Tafese, 2023).

TTD supplementation is also provided to adolescent girls to prevent anemia and prepare them for future pregnancies. Adolescent girls are recommended to consume TTD once a week or at least 52 tablets per year (Khomsan et al., 2023). TTD supplementation among adolescent girls was also significantly negatively associated with stunting ($r = -0.567$, $p < 0.001$). Simbolon et al. (2021) also found a negative association between TTD supplementation among adolescent girls and stunting. Adequate iron intake during the preconception period and throughout pregnancy not only reduces the prevalence of anemia but also supports optimal child growth and long-term stunting prevention.

ANC visits are an important indicator of health services provided during pregnancy. Ideally, antenatal examinations should be conducted at least four times (K4) during pregnancy. The coverage of K4 ANC visits was significantly negatively associated with stunting ($r = -0.535$, $p = 0.001$). ANC visits that meet established standards play an important role in monitoring maternal and fetal health and reducing the risk of complications during pregnancy, including LBW and stunting. ANC services also contribute to reducing stunting through education regarding appropriate breastfeeding and complementary feeding practices, growth and development stimulation, as well as the prevention and control of infections that may hinder growth (Camelia et al., 2020; Fitranier et al., 2022). A study by Amaha and Woldeamanuel (2021) in Ethiopia showed that each ANC visit could reduce the odds of stunting by 6.8% ($p < 0.001$).

The involvement of health personnel during childbirth was significantly negatively associated with stunting ($r = -0.520$, $p = 0.002$). Delivery assisted by health personnel not only ensures a safe delivery process but also improves the quality of postpartum care and childcare practices, thereby contributing to improvements in children's nutritional status. Health personnel are expected to have adequate knowledge and education to provide education regarding health care, nutritional fulfillment, and monitoring of child growth and development as efforts to prevent stunting (Karki et al.,

2023). A study by [Buisman et al. \(2019\)](#) in Sub-Saharan Africa showed that the presence of skilled health personnel during childbirth could reduce the risk of stunting by 5.2%. Children born with the assistance of non-health personnel have a higher risk of stunting than children delivered with the assistance of health personnel, such as doctors, midwives, or nurses ([Ezeh et al., 2021](#)).

Immunization is a preventive intervention aimed at increasing immunity against diseases that can hinder child growth. Complete basic immunization coverage was significantly negatively associated with stunting ($r = -0.352$, $p = 0.041$). [Ariati \(2019\)](#) reported a significant association between immunization and the incidence of stunting. Children who are not immunized or who have incomplete immunization tend to be more vulnerable to infectious diseases, such as diarrhea, measles, and pneumonia, which can cause impaired nutritional status and hinder growth ([Piniliw et al., 2021](#); [Danso and Appiah, 2023](#)).

Short birth intervals are a risk factor for stunting. Postpartum family planning (FP) coverage was significantly negatively associated with stunting ($r = -0.389$, $p = 0.023$). The use of postpartum FP not only optimizes birth spacing but also supports maternal recovery, improves children's nutritional status, and promotes optimal growth and development. Longer birth intervals also improve the quality of childcare and fulfillment of children's nutritional needs, thereby contributing to a reduction in the risk of stunting ([Khomsan et al., 2023](#); [Sirage et al., 2024](#)). Postpartum FP also plays a role in preventing unintended pregnancies and high parity, which can limit household resources and increase the risk of stunting ([Lukman et al., 2022](#)). This is consistent with a study in Southern Ethiopia, where the use of FP reduced the risks of stunting, preterm birth, and short birth intervals ([Dake et al., 2019](#)).

Environmental health conditions, particularly the availability of access to safe drinking water and adequate sanitation, play an important role in preventing stunting by reducing the risk of infection. Water and sanitation interventions in low- and middle-income countries have been shown to improve height-for-age Z-scores and reduce the risk of stunting by up to 13% ([Gera et al., 2018](#); [Aramico et al., 2020](#)). However, access to safe drinking water in this study was significantly positively associated with stunting ($r = 0.377$, $p = 0.028$). This finding may be related to other factors, such as the indicator of access to safe water not fully reflecting the microbiological quality of the water, including potential contamination and household-level water management practices, as well as its indirect and long-term effects on reducing stunting.

Different results were observed for access to adequate sanitation, which was significantly negatively associated with stunting ($r = -0.591$, $p < 0.001$). Adequate sanitation plays a role in preventing exposure to disease-causing pathogens, such as diarrhea-causing organisms and intestinal worms, which can interfere with nutrient absorption and child growth. Studies conducted in various low- and middle-income countries have also emphasized that poor sanitation is one of the major risk factors for stunting ([Zhu et al., 2021](#)).

Low family income often limits the fulfillment of health and nutritional needs, thereby increasing the risk of stunting. The Family Hope Program (PKH) is a conditional social assistance intervention designed to support stunting reduction through poverty alleviation, improved access to food and health services, and monitoring of child growth and development ([Rahmawati et al., 2020](#)). However, the percentage of PKH coverage was significantly positively associated with stunting ($r = 0.458$, $p = 0.006$). This finding differs from the study by [Munawaroh et al. \(2024\)](#), which demonstrated a negative association, in which every 1% increase in social assistance

coverage was associated with a 0.256% reduction in stunting prevalence. This difference may be attributable to suboptimal program targeting, particularly among high-risk families with children during the first 1,000 days of life, thereby reducing the effectiveness of PKH in directly reducing stunting (Bappenas, 2018).

CONCLUSIONS

This study identified several variables that were associated with stunting prevalence at the provincial level. Increases in factors such as low birth weight (LBW), the poverty rate, and food expenditure were positively associated with stunting prevalence, whereas increases in the Expected Food Pattern (PPH) score, mean years of schooling (RLS), birth certificate ownership, and non-food expenditure were negatively associated with stunting prevalence. Meanwhile, increases in intervention programs such as access to safe drinking water and the Family Hope Program (PKH) were positively associated with stunting prevalence. Conversely, increased coverage of interventions such as supplementary feeding (PMT) for pregnant women with chronic energy deficiency (CED) and undernourished children under five, iron and folic acid supplementation through iron tablets (TTD) for pregnant women and adolescent girls, deliveries assisted by health personnel, fourth antenatal care (ANC K4) visits, postpartum family planning (FP), complete basic immunization, and access to adequate sanitation were negatively associated with stunting prevalence. These variables consistently represent health determinants that are closely associated with the nutritional status of children under five at the population level. Based on the findings of this study, strengthening integrated multisectoral interventions, particularly during the first 1,000 days of life, is necessary. In addition, improving the quality of health services, enhancing sanitation, as well as implementing poverty alleviation and educational improvement policies are key to accelerating the reduction of stunting. Future research is recommended to examine contextual factors such as the quality of health services, parenting practices, cultural aspects, and spatial analysis to determine priority areas for intervention.

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