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Factors associated with stunting prevalence in Indonesia: a multilevel analysis of island disparities

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ABSTRACT

Introduction: Stunting among children under the age of five is a major public health challenge in Indonesia. Several factors have been identified as influencing stunting; however, Indonesia has several islands with unique characteristics that may impact them.

Objectives: This study aims to investigate factors associated with district-level stunting prevalence while accounting for island-level variation.

Methods: This study utilised data mainly from the 2020 Food Security and Vulnerability Atlas (FSVA) of the Indonesian Ministry of Agriculture. The FSVA collected 2019 indicators and was published in 2020. The independent variables are classified into two levels: the district level (514 districts) and the island level (eight major islands). The analysis was done using multilevel linear regression.

Results: Most districts (473 out of 514) have a high or very high prevalence of stunting. The results showed that poverty, households with food expenditures greater than 65%, households without water, and women's education were all positively associated with stunting at the district level, but health personnel coverage was negatively associated. At the island level, Gross Regional Domestic Products (GRDP) were found to be negatively linked with stunting.

Conclusion: Poverty and lack of basic infrastructure continue to be major contributors to stunting. Given Indonesia's breadth and number of islands, stunting-reduction initiatives are customised to regional challenges, with a focus on regions where stunting is more prevalent.

KEYWORDS

Stunting, Socioeconomic Factors, Poverty.

INTRODUCTION

Stunting remains a significant public health concern in many countries, particularly in developing nations. Children with stunted growth cannot grow and develop optimally, as expected, at their respective growth and development stages. Children who experience stunting, especially under the age of two, will affect other aspects of life, such as education, health, work productivity, and participation in social life in adulthood[1]. Stunting has a negative impact on health and socioeconomics, affecting the quality of the next generation. Therefore, stunting is used as an indicator of the quality of human resources and the welfare of a nation.

Globally, 149.2 million, or 22 percent, of children under five are stunted[2]. According to the 2022 Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting has declined from 24.4% in 2021 to 21.6% in 2022. East Nusa Tenggara records the highest stunting rate at 35.3%, while Bali Province has the lowest rate at 8%[3]. Indonesia aims to lower stunting rates, as detailed in the 2020-2024 RPJMN, and reinforced by Presidential Regulation No. 72 of 2021, which sets a goal to reduce stunting to 14% by 2024.

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Stunting arises from a combination of intricate and interrelated factors. It is influenced not just by inadequate food quality and quantity but also by ineffective parenting practices and limited access to healthcare and social services, spanning individual, household, and community levels[4]. Based on the WHO Conceptual Framework, factors that influence stunting in the context of a community or country include socio-cultural, educational, political, economic, health, healthcare, water, environmental sanitation, and agricultural and food systems. At the household level, the causes are inadequate breastfeeding, childcare, supplementary feeding, maternal factors, housing conditions, the presence of infections, low food quality, and food and water safety[5]. In addition to maternal education, the ability of the region to provide health facilities and qualified health workers is also related to the prevalence of stunting[6].

Economic improvement in a country can improve the overall health of its population, including the well-being of children. Studies in Sub-Saharan Africa revealed a decline in stunting rates as GDP per capita increased[7]. Related to economic growth, a study found that poor economic growth contributes to increased poverty.

Research on stunting factors, seen individually and in households, has been widely conducted, while area-level studies are still rarely carried out. Similarly, multilevel analysis research includes regions, even though research using such analysis is important to see heterogeneity and homogeneity between regional units[8]. Previous studies have identified determinants of stunting using multivariate analyses, taking into account the province and national levels, as well as individual, household, and community levels (cluster, district, province)[8-10]. Despite Indonesia's large size and diverse regional features, no multivariate study at the island level has been identified. These island-specific characteristics related to stunting discrepancies serve as a reference for more efficient and focused program interventions, emphasising the importance of considering heterogeneity between islands. Given this, the objective of this study is to investigate the factors that contribute to stunting prevalence in districts across Indonesia, considering island-level variance.

METHOD

This cross-sectional study was carried out between January and June 2024, utilizing secondary data collected in 2019 from the Indonesian Ministry of Agriculture, the National Population and Family Planning Agency, and BPS-Statistics Indonesia. This study examined data from all districts included in the 2020 Food Security and Vulnerability Atlas (2019 data indicators) compiled by the Food Security Agency of the Indonesian Ministry of Agriculture, which comprised 514 districts.

The dependent variable is the proportion of children under the age of five who are stunted (height-for-age z-score/HAZ below -2 SD). The independent variables are divided into two levels: the district level, which includes poverty, households with food expenditures greater than 65%, households without electricity, households without access to clean water, health worker coverage, and women's schooling; and the island level, which includes dietary diversity, fertility rate, and Gross Regional Domestic Product (GRDP). (Table 1).

Poverty is calculated as the proportion of the population living below the national poverty level. The poverty line in Indonesia is measured by adding up food expenditure, which reaches 2100 calories/capita/day, and expenditure on essential non-food needs, such as housing, clothing, education, and healthcare.

The population whose average monthly per capita expenditure is below the poverty line is categorized as poor. Health worker coverage was defined as the land area served by one health worker (in square kilometres), whereas women's schooling was determined by the average number of years of schooling for women aged 15 and up.

Dietary diversity was assessed using the Desirable Dietary Pattern (DDP) score. The calculation of the DDP score refers to the Guidelines for Calculating the Desirable Dietary Pattern by the Food Security Agency[11].

The adolescent fertility rate was computed as births per 1000 women aged 15–19 years. The 2019 fertility rate data were obtained from the National Population and Family Planning Agency.

The GRDP was determined per capita gross domestic product at a constant price for a district/city (billion IDR). Data on GRDP in 2019 were obtained from the publication of BPS-Statistics Indonesia.

This study employs both descriptive and inferential statistical analyses. Descriptive analysis was used to explore the data for each variable studied, while inferential analysis used multilevel regression.

The multilevel regression model with a random intercept is shown in the following equation:

$$Y_{ij} = \gamma_{00} + \gamma_{01}Z_j + \beta_{1j}X_{ij} + u_{0j} + e_{ij}$$

where the $[\gamma_{00} + \gamma_{01}Z_j + \beta_{1j}X_{ij}]$ is the fixed effect and $[u_{0j} + e_{ij}]$ iis the random effect of the multilevel regression model[12].

The data structure studied consists of two levels: Level 1 encompasses all districts and cities in Indonesia, totaling 514, while large islands in Indonesia categorize Level 2. There are eight major islands: Sumatra, Java, Bali, Nusa Tenggara, Kalimantan, Sulawesi, Maluku, and Papua.

Initially, this study checks for assumption testing (normality, homoscedasticity, non-autocorrelation, and non-multicollinearity), and the results show that the regression model

Table 1. Variable included in the study

Variable	Definition	Source	Year
District (Level 1)			
Stunting prevalence	Prevalence of stunting among children under five	FSVA, MoA	2020 (2019 indicators)
Poverty	Proportion of population living below the national poverty line	FSVA, MoA	2020 (2019 indicators)
Households with food expenditure >65%	Proportion of households with food expenditure share more than 65%	FSVA, MoA	2020 (2019 indicators)
Households without electricity	Proportion of population without access to electricity	FSVA, MoA	2020 (2019 indicators)
Households without water	Proportion of population without access to clean water	FSVA, MoA	2020 (2019 indicators)
Life expectancy at birth	Number of years a newborn infant would live	FSVA, MoA	2020 (2019 indicators)
Health worker coverage	Land area served by one health worker (squared km)	FSVA, MoA	2020 (2019 indicators)
Women schooling	Average years of schooling for women aged 15 years and older	FSVA, MoA	2020 (2019 indicators)
Island (Level 2)			
Dietary diversity	Score of Desirable Dietary Pattern	MoA	2019
Fertility rate	Adolescent fertility rate (births per 1000 women aged 15-19)	NPFPA	2019
GRDP	Per capita gross domestic product at constant price of a district/city (billion IDR)	BPS-Statistics Indonesia	2019

GRDP: Gross Regional Domestic Product; FSVA: Food Security and Vulnerability Atlas; MoA: Ministry of Agriculture; NPFPA: National Population and Family Planning Agency.

has met all assumptions. The estimated value of the variance component without independent variables for the residual parameter is 72.87, the intercept value is 17.29, and the ICC value is 0.1941. After obtaining the ICC value, the next step is to form a random intercept model and determine the parameter estimation value using the maximum likelihood method. The final step is to test the significance of the coefficient estimates using the Wald test statistic.

RESULTS

An overview of regional conditions by district/city, island, and percentage of stunted children under five is shown in Table 2. In general, it was found that the average percentage of stunted children under five in Indonesia in 2019 was still high at 31.7 percent. There were 290 districts/cities with very high stunting prevalence (≥30%), 183 with high prevalence (20-29.9%), 32 with medium prevalence (10-19.9%), and 9 with low prevalence[13].

The average proportion of individuals living in poverty in districts or cities was 11.9%. Most of the poor districts/cities are located on the islands of Nusa Tenggara and Papua. The prevalence of households with a food expenditure of more than 65% was lowest at 1.9% in Gorontalo City. Vice versa, ninety-four percent of households in Puncak Jaya district spent more than 65% of their budget on food purchases. There were 31.56% of households that lacked access to electricity, while 69.35% did not have access to clean water. The primary source of drinking water comes from unprotected sources, unprotected springs, surface water, rainwater, and others. There are three districts on Papua Island where all households cannot access clean water.

Regarding health workers, each person serves an area of 7.48 square kilometres. Health workers on duty in the Papua Island region, on average, serve over 89 square kilometres, due to the population density of 9 people per square kilometre. In contrast to Java Island, where the population density ranges from 831 to 15,900 people per square kilometre, each health worker serves an area of 0.1-0.5 square kilometres. The average number of years of education for women aged 15 and older was 8.26 years, indicating that they had completed

Table 2. Summary statistics of the variables included in the study

Variable	Level	Mean	SD
Socioeconomic			
Poverty (%)	1	11.94	7.76
Food expenditure >65 (%)	1	3.69	9.58
GRDP (billion IDR/ million USD)	2	40.37/2.69	9.31/0.62
Infrastructure			
Households without electricity (%)	1	31.56	20.62
Households without water (%)	1	69.35	3.69
Health			
Stunting prevalence (%)	1	31.70	9.02
Health worker coverage (squared km)	1	7.48	17.42
Dietary diversity	2	80.39	5.8
Adolescent fertility rate (births per 1000 women aged 15-19)	2	30.45	6.51
Education			
Women schooling (years)	1	8.31	1.65

their education up to the lower secondary level. This achievement is still lower than the government's target of 12 years of compulsory education, which includes 6 years of elementary education and 6 years of secondary education.

There are five islands that have DDP scores above 80, and the lowest score (68.6) is in the Papua Island region. The average number of children born per 1000 women in the 15-19 group was 30. The variation in fertility rates is wide, ranging from 2 children (Java Island) to 95 children (Kalimantan Island) per 1000 female births. The average GRDP value was IDR 40 billion (USD 2.6 million). The lowest GRDP on the island of Nusa Tenggara (IDR 10.8 billion, equivalent to USD 720,000), while districts/cities with GRDP per capita above IDR 43 billion (USD 2.8 million) were located on the islands of Kalimantan, Sulawesi, and Java.

Table 3 presents the outcomes of the multilevel linear regression models for factors at the district and island levels. Overall, there were 5 out of 6 variables in Level 1 (district) and 1 out of 3 variables in Level 2 (island) associated with stunting prevalence in Indonesia. In Level 1, poverty, food expenditure >65%, households without clean water, and women's schooling were directly linked to stunting. In contrast, health worker coverage was negatively associated with stunting. In Level 2, GRDP was negatively associated with stunting, which means economic growth on each island can help decrease the rate of stunting.

A higher percentage of the population residing below the poverty threshold and a proportion of households with a food expenditure share of more than 65 percent were correlated with an increased rate of stunting. Additionally, a greater percentage of households lacking access to clean water, along with the average years of schooling for women aged 15 and older, were linked to an increased prevalence of stunting. Regarding health, lower health worker coverage was significantly related to higher stunting prevalence. Moreover, lower GRDP was associated with higher stunting prevalence.

DISCUSSION

Socioeconomic

Poverty and Stunting

There is a significant relationship indicating that the larger the share of people living in poverty in an area, the higher the rate of stunting in that area. Household poverty generally makes it difficult for mothers and children to obtain nutritious food at affordable prices.

Several studies in various countries have found results that are in line with these results. Research in Indonesia suggests that poverty has a significant impact on the rise of stunting[14]. Risk factors for stunting in children aged 1-60 months in Indonesia include low family income[15].

Research in Peru also suggests that increasing poverty triggers an increase in stunting and suggests that the key to reducing stunting is economic growth policies that reduce the number of poor people and encourage the fulfillment of food supplements[16]. The wealth of poor households is a factor linked to stunting in children under five in Ethiopia[17].

Food Expenditure and Stunting

The findings of this study indicate that the more households with food expenditures above 65% in an area, the greater the prevalence of stunting in that area. Consistent with this, the findings of other studies show that households with a higher proportion of food expenditure are at high risk of having a stunting prevalence above 30%[18].

Food expenditure is a crucial factor in determining a household's ability to satisfy its food consumption needs[19]. Meanwhile, if using the food expenditure share variable, it can refer to Engel's law, which this concept explains that as income rises, the proportion of spending on food decreases.

Table 3. Multilevel multivariate analysis of stunting prevalence

Variable	Level	B	p	95% CI
Intercept		17.615	0.005*	5.404; 29.826
Socioeconomic				
Poverty (%)	1	0.203	0.011*	0.046; 0.361
Food expenditure >65 (%)	1	0.064	0.031*	0.005; 0.122
GRDP (billion IDR/million USD)	2	-0.028	0.031*	-0.052; -0.012
Infrastructure				
Households without electricity (%)	1	0.102	0.064	-0.006; 0.210
Households without water (%)	1	0.093	0.001*	0.039; 0.148
Health				
Health worker coverage (km^2)	1	-0.065	0.043*	-0.128; 0.002
Dietary diversity	2	0.010	0.860	-0.103; 0.124
Adolescent fertility rate (births per 1000 women aged 15-19)	2	0.032	0.198	-0.016; 0.081
Education				
Women schooling (years)	1	0.704	0.030*	0.066; 1.341

GRDP=Gross Regional Domestic Products; * Multiple linear regression, $p<0.05$.

Put differently, the lower the household income, the greater the proportion of spending on food. This is because with limited income, there is not much choice in the amount, type, and quality of food purchased to fulfil the nutritional requirements of all household members, including children under five. In these households, children under five are more vulnerable to stunting resulting from inadequate food intake in the form of nutrients[6].

GRDP and Stunting

The analysis reveals that GRDP has a significant impact on the prevalence of stunting. Specifically, a 10 percent rise in GRDP per capita leads to a 0.28 percent reduction in the stunting rate. Another study in Indonesia using Basic Health Research data in 2013 from 497 districts/cities spread across 33 provinces in Indonesia also found that children living in regions with a higher GDP per capita had a lower likelihood of being stunted compared to those in areas with a lower GDP[9]. A one billion rupiah (USD 66,667) increase in GDP can reduce stunting and severe stunting by one percent[20]. The three findings of this study demonstrate a similar pattern: the higher the national GDP or GRDP, the stronger the effect on lowering the prevalence of stunting in children under five. Research conducted in 74 developing countries, including Indonesia, from 1984 to 2014, revealed that a 10% increase in GDP per capita could reduce the prevalence of stunting by 2.7 percent[21]. Increasing GDP will reduce stunting prevalence, which is also evident in Sub-Saharan Africa[7].

Economic growth is an important driver of stunting reduction[22]. The prevalence of stunting and rising national wealth are related through two complementary mechanisms. Increases in population income are linked to economic growth in a nation or region. Most of their income will be spent on items and services important to their families' health and nutrition. The provision of social and health infrastructure is one way that a growth in GDP or GRDP might stimulate investment in public services[21].

Infrastructure

Access to Clean Water and Stunting

The findings of this study demonstrate that access to clean water plays a crucial role in the occurrence of stunting in children under five. There is a direct link between households lacking access to clean water and higher rates of stunting; households lacking access to clean water are more likely to

have children who are stunted. Access to clean water and proper sanitation within the household is crucial for the health of family members. Suppose the water obtained is not clean or the sanitation is poor. In that case, it can cause family members to be susceptible to disease, disrupt their metabolism, and stifle growth, especially in infants and children, whose immune systems are not as robust as those of adults. Several studies conducted in Indonesia and other countries also show results that are consistent with the results of this study.

Several other studies in Indonesia have found similar results to this analysis. There is a significant association between stunting and household sanitation and water treatment facilities during the pandemic era in rural areas[23]. The risk of stunting is greater for children living in communities without access to clean water[8]. Studies in other countries, such as Punjab, show that children under the age of 2 with improved access to drinking water have a lower likelihood of being stunted[24].

Health

Health Worker Coverage and Stunting

The health worker coverage in this study is inversely related to stunting. Lower health worker coverage was significantly associated with a higher prevalence of stunting. This is consistent with a systematic review that found that limited access to health facilities and the quality of health workers are associated with stunting[25].

Health facilities, including the quality and quantity of healthcare workers, play a crucial role in addressing stunting. Regular visits by health workers to monitor and treat malnutrition cases have been shown to reduce the chance of stunting significantly[26]. Therefore, the presence of health cadres plays a vital role in combating stunting, namely, to provide counselling to mothers who have children under five[27]. Nevertheless, the variable (km² per worker) is a proxy and may not reflect the service's effectiveness or quality.

Education

Women's Schooling and Stunting

The analysis results show that as the average years of schooling for women aged 15 years and above increase, the rate of stunting also increases. Greater levels of female education enhance the likelihood of women making contributions to the household economy by working outside the home. Consequently, they spend less time in the family taking care of household affairs and looking after children, infants, and other family members. Working women are required to start work sometime after giving birth. Time spent working outside the home reduces time for breastfeeding and complementary feeding, breastfeeding schedules become more irregular, and the duration of breastfeeding time becomes shorter.

Working mothers have a multi-layered life of caring for children and earning a living. When women work, childcare and feeding must be left to others, whether family members or household assistants who have less education and limited knowledge of caring for infants. This situation will increase the chances of infants not getting enough consumption in quantity, quality, and safety to meet the Recommended Dietary Allowances (RDA). Consistent with the findings of this study, research in Indonesia through multinomial logistic regression tests found that working mothers residing in rural areas are more likely to have children under five who are stunted or severely stunted[28].

The results of this research significantly contrast with those of a study that identified the primary factors contributing to stunting in children under the age of 5 in Indonesia were maternal education level[29]. When the effect of a mother's education on stunting was compared, it was discovered that children whose mothers had an education faced a 75% reduced risk of stunting. Other studies have shown a positive connection between a mother's education and her knowledge, especially regarding nutrition and child care, and the occurrence of stunting in children under five years of age[30].

Limitations of the Study

Numerous factors, including those that directly affect children under five, like parenting, diet, and disease; household factors (mother's role and household conditions); community; and social, economic, and political conditions of a region, all contribute to the rate of stunting in young children. However, as one of our study's limitations, the factors that lead to stunting in young children are limited to those used to develop the Indonesian FSVA, which focuses on household and regional-level factors. Another limitation is that some indicators are proxies. For example, the variable of health worker coverage is a proxy (km² per worker) and does not reflect the quality or effectiveness of the service.

Despite its limitations, which cover only variables available on FSVA, this study aims to provide a comprehensive overview of the current state of district/city development, as it encompasses all districts and cities in Indonesia. The application of multilevel analysis to Indonesia's eight largest islands will reveal whether policies or initiatives to alleviate or eliminate stunting should be uniform across all districts and cities or tailored to each island.

CONCLUSIONS

The findings of this study suggest that a woman's limited formal education, her family's financial situation, how much money is spent on food, and her family's access to clean water are all factors that influence the prevalence of stunting in children under five years old. Moreover, it is also influenced by the regional GRDP and the shortage of health profession-

als. Therefore, to not only reduce but also avoid the prevalence of stunting, household purchasing power must be increased by expanding employment opportunities. Given that Indonesia's broad geography is made up of both large and small islands, each of which has unique characteristics, policies or programs to eliminate stunting need not be the same for all regions but can instead be adjusted to the local conditions. The results of this research confirm the lower rates of stunting in wealthier island areas. Therefore, each community should not receive the same amount or share of funding for programs to prevent stunting.

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