

A Spatial Analysis of Stunting and Its Determinants in Indonesia

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Abstract: **Introduction:** Reducing childhood stunting is the first of six goals in the Global Nutrition Targets for 2025 and a key indicator in the second Sustainable Development Goals (SDGs) to Achieve Zero Hunger. Stunting continues to be a serious public health problem in Indonesia. Significant disparities in stunting prevalence are not only documented across various socio-economic groups but across provinces and districts as well. Therefore, the identification of spatial patterns of stunting and its determinants is important for understanding epidemiology of this public health challenge. **Methods:** Using data from Indonesian Health Profile 2021, regression and spatial analysis performed through GeoDa software. **Results:** The result indicates there are 5 variables that are significantly correlated to stunting prevalence among provinces, with the human development index being the most significant amongst all. The Moran's I for stunting is 0.182. It indicates spatial autocorrelation in stunting over the provinces of Indonesia. It is seen from the univariate LISA maps, that high-high clusters of stunting are found in East Kalimantan and South Kalimantan. Meanwhile the low-low clusters are found in Southern Sumatra provinces. **Conclusion:** Our findings reveal greater attention towards East Kalimantan and South Kalimantan is needed. Several social factors lead to the occurrence of stunting. Emphasis should be placed on improving health, education, and standard of living.

1 INTRODUCTION

Reducing childhood stunting is the first of six goals in the Global Nutrition Targets for 2025 and a key indicator in the second Sustainable Development Goals (SDGs) to Achieve Zero Hunger (WHO, 2023). Stunting itself means impaired growth and development that children experience from poor nutrition, repeated infection, and inadequate psychosocial stimulation. Stunting easily becomes one of major global health problems because stunting holds impacts to both physical and mental growth of stunted children and it can not be cured. Children with stunting will suffer for a lifetime and have a higher chance to have stunted children in the future.

World Health Organization (WHO, 2023) estimated that 22% or about 149,2 millions children around the world were suffering from stunting in 2022. Many developing countries are trying to overcome this public health problem, including Indonesia. Indonesia's Nutritional Status Survey revealed that in 2022, stunting prevalence in Indonesia was 21,6% which means there were around 4,5 millions stunted children amongst all live births (Kemenkes RI, 2023). Hence the situation, the Indonesian government has stated that stunting

prevention should be included in the national priority program. Multi-discipline institutions and various sectors are working together in finding the significant causes of stunting and how to reduce stunting incidents effectively.

Significant disparities in stunting prevalence are not only documented across various socio-economic groups but across provinces and districts as well. Therefore, the identification of spatial patterns of stunting and its determinants is important for understanding epidemiology of this public health challenge.

2 METHODS

An in-depth secondary data analysis was conducted using the Indonesian Health Profile 2021. The Indonesian Health Profile is based on routine data as well as survey data from technical units in Ministry of Health and other related institutions such as Statistics Indonesia (BPS), Social Security Agency on Health (BPJS), Ministry of Home Affairs, and The National Population and Family Planning Board (BKKBN). The Indonesian Health Profile presents a national picture, comparisons between provinces, and

trends from year to year. The data were downloaded from the Ministry of Health website. The dependent variable is stunting prevalence and there are 8 independent variables, which are human development index, iron supplementation on pregnant women, contraceptive prevalence rate, children under five-year-old growth monitoring, basic immunisation coverage, exclusive breastfeeding coverage, supplementary food for maternal malnutrition and diarrhea treatment for children under five-year-old. Data analysis was carried out by using GeoDa. The cluster levels of stunting prevalence were used to develop prevalence maps at provincial levels. Spatial heterogeneity of high prevalence/low prevalence areas of stunting was examined using the Getis-Ord G-statistic. An OLS (Ordinary Least Square) regression model was fitted to evaluate the independent variables linked to stunting prevalence.

3 RESULTS

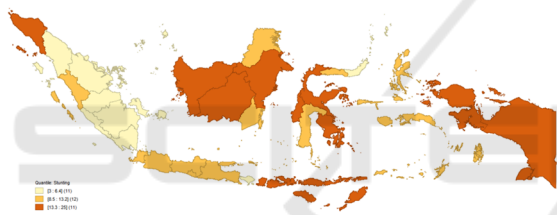


Figure 1: Distribution of Stunting Across Province.

Figure above is a province-based distribution map of stunting prevalence in Indonesia. Provinces with darker colour bear higher prevalence of stunting while the opposite, provinces shown with lighter colour have lower prevalence of stunting. The results of the 2021 Indonesian stunting prevalence mapping showed a pattern of the spread of the prevalence of stunting. The maps showed that the highest prevalence tends to be in the eastern region, while the lowest is in the western region. So, there's supposedly a spatial factor that affects the spread of stunting prevalence in Indonesia in 2021.



Figure 2: Clustering of Stunting.

There are two important informations to extract from univariate LISA maps above. Provinces with blue colour in southern Sumatra are called cold spots, where prevalence of stunting is low and surrounded by another province with similar characteristics. Meanwhile, provinces with red colour, which are East and South Kalimantan, are marked as hotspots, where prevalence of stunting is remarkably high and they are surrounded by another province with similar situation and characteristics. This findings is important to help the government set priorities in stunting prevention programs. Government may need to put special attention to the hot spot and use the cold spot as pilot model.

Tabel 1: Spatial Regression Model.

Variable	Coefficient	Std. Error	Z-value	P-value
CONSTANT	69.7456	11.4449	6.09402	0.00000
Human Development Index	-0.745111	0.168568	-4.42025	0.00001
Iron Supplementation on Pregnant Women	0.156379	0.0944754	1.65524	0.09788
Contraceptive Prevalence Rate	-0.16277	0.0746856	-2.1794	0.02930
Children-under-five-year-old Growth Monitoring	-0.154217	0.0562428	-2.74198	0.00611
Basic Immunization Coverage	-0.0482479	0.0627331	-0.769097	0.44184
Exclusive Breastfeeding Coverage	-0.197083	0.050896	-3.87227	0.00011

Supplementary Food for Maternal Malnutrition	- 0.10804 7	0.06 3770 6	- 1.69 431	0.09021
Children-under-five-year-old Diarrhea Treatment	- 0.14105 5	0.05 6251	2.50 759	0.01216
LAMBDA	0.67907	0.12 7585	5.32 251	0.00000

The spatial regression model revealed that amongst 8 independent variables in this study, only five variables are significantly correlated to stunting prevalence. Those variables are human development index, contraceptive prevalence rate, children under-five-year-old growth monitoring, exclusive breastfeeding and diarrhea treatment for children under-five-year-old. Human development index variables turn out to be the most statistically significant to stunting prevalence amongst all variables.

4 DISCUSSION

According to the World Health Organization (WHO), stunting is the result of inadequate physical and cognitive development experienced by millions of children worldwide. Rooted in a complex interplay of socio-economic, nutritional, and environmental factors, stunting's consequences extend far beyond mere height disparity. Its impact can be observed in compromised cognitive abilities, weakened immune systems, and reduced economic productivity later in life. Tackling stunting requires a comprehensive approach that addresses not only nutritional interventions but also emphasizes the importance of clean water, sanitation, maternal and child healthcare, and early childhood stimulation (WHO, 2015). By recognizing the multifaceted nature of stunting and implementing a holistic strategy, societies can work towards breaking the cycle of intergenerational undernutrition and fostering healthier and more prosperous futures for children (Kemenkes RI, 2022).

This study has projected the clustering of stunting in Indonesia based on provinces with Southern Sumatra as cold spot, meanwhile East and South Kalimantan as hotspot. The discovery holds significance in aiding governmental prioritization for

stunting prevention initiatives. Special emphasis might be necessary for addressing the areas of hot spot, while utilizing the areas of cold spot as a potential model for pilot programs. The identification of potential determinants are necessary to design the most effective and efficient stunting prevention programmes. There are 5 (five) variables in this study statistically proven significant in reducing stunting prevalence. Those variables are human development index, contraceptive prevalence rate, children under-five-year-old growth monitoring, exclusive breastfeeding and diarrhea treatment for children under-five-year-old.

Human Development Index (HDI) variable has been identified as a most significant factor influencing stunting prevalence in children. The HDI, a composite measure encompassing health, education, and income indicators, reflects the overall development status of a country. Countries with higher HDI scores tend to have lower stunting rates due to improved access to healthcare, education, and economic opportunities. As the HDI captures various dimensions of human well-being, including health services and education quality, its positive relationship with stunting reduction underscores the importance of holistic development approaches in combating malnutrition and promoting child growth. Ssentongo, et al demonstrated that a combination of HDI and a proxy for geographical variation explained 54% of the variation in stunting (Ssentongo et al., 2021).

Results have suggested that higher contraceptive prevalence rate (CPR) can also have a positive impact on reducing stunting prevalence among children. For instance, increased contraceptive use allows women and couples to better plan and space their pregnancies, leading to improved maternal health and nutrition. This, in turn, can contribute to healthier fetal development and reduced risk of stunting in children. Family planning programs not only empower women with reproductive choices but also enable them to provide better care and nutrition to their children, thus influencing the reduction of stunting prevalence.

A study by Kundu, et al found that increased contraceptive use was correlated with better child health outcomes, including reduced stunting prevalence, highlighting the essential role of family planning in addressing malnutrition and stunting (Kundu et al., 2022). Another study by Migang et al stated that by limiting the number of births, parents can pay more attention to the growth of their children. It is important to put extra care to children until they are two years old as that time is known as the golden

period where the child's growth and development process occurs optimally (Migang et al., 2022).

Children's growth monitoring plays a crucial role as well in addressing and mitigating stunting prevalence. Regular and systematic monitoring of children's growth, including height and weight measurements, provides valuable data for early detection and intervention in cases of stunted growth. By identifying children who are at risk or already experiencing stunting, healthcare systems and policymakers can implement targeted interventions, such as nutritional supplementation, counselling on proper feeding practices, and access to healthcare services.

Fink, et al revealed that growth monitoring had modest positive effects on children with stunted growth. Growth monitoring is significant in reducing stunting prevalence, highlighting its potential to facilitate timely interventions that positively impact child development and health outcomes. This intervention may be a cost-effective tool for reducing children's physical growth deficits (Fink et al., 2017).

This study has also demonstrated a significant correlation between exclusive breastfeeding coverage and stunting prevalence. Research by Pimpin, et al indicated that infants who were exclusively breastfed had a lower risk of stunting compared to those who received mixed feeding. Exclusive breastfeeding supports optimal infant nutrition and ensures that infants receive the appropriate nutrients needed to prevent stunting and promote healthy physical and cognitive development (Pimpin et al., 2019).

A more recent study by Anindya, et al stated that infants aged 6 months who got exclusive breastfeeding had lower risk of stunting by 0.6 times than non-exclusive breastfeeding infants. Exclusive breastfeeding, where infants are fed only breast milk for the first six months of life, provides essential nutrients and antibodies that are crucial for healthy growth and development (Anindya et al., 2020).

The last variable correlated to stunting prevalence is diarrhea treatment for children under-five-year-old. Diarrhea, often caused by poor sanitation and hygiene practices, can lead to nutrient loss, dehydration, and overall compromised nutritional intake. Timely and appropriate treatment of diarrhea not only prevents the immediate adverse effects but also plays a vital role in preventing long-term consequences like stunting. When children's health is managed well during episodes of diarrhea, their ability to absorb nutrients improves, which in turn supports their growth and development, ultimately reducing the risk of stunting (Lee, et al., 2016).

Modern, et al emphasizes the importance of comprehensive diarrhea treatment programs in safeguarding child health and promoting growth, contributing to the overall reduction of stunting prevalence. The interaction between undernutrition and infection creates a lethal cycle of worsening illness and deteriorating nutritional status (Modern et al., 2020).

5 CONCLUSIONS

The findings reveal greater attention towards East Kalimantan and South Kalimantan is needed. Several social factors may lead to the occurrence of stunting. Spatial analysis showed that Human Development Index, contraception use, exclusive breastfeeding coverage, diarrhea treatment, and children's growth monitoring had a significant effect on decreasing the prevalence of stunting in Indonesia.

It is important for the government to put special attention on East and South Kalimantan while designing stunting prevention programmes. Furthermore, the optimization of Posyandu, enhancing multi-sectoral partnership, and conducting Communication, Information, and Education (KIE) activities with innovative methods are strongly encouraged to increase programme coverage.

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