



Stunting in the Spotlight: Dynamic Panel Data Analysis

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Abstract:

This research examines the influence of the Human Development Index (HDI), early marriage, information and communication technology (ICT), and the Gender Inequality Index (GII) on the incidence of stunting in Indonesia using panel data from 34 provinces during the 2020-2023 period. The analysis was carried out using the Generalized Method of Moments (GMM). This study examines the determinants of stunting in children in Indonesia, with a focus on the Human Development Index, Early Marriage, Information and Communication Technology, and the Gender Inequality Index. Contrary to expectations, individual analysis of these variables failed to reveal significant relationships with stunting outcomes. However, simultaneous analysis of these factors revealed a collective impact of 18% on stunting variance, suggesting that a comprehensive approach incorporating multiple determinants may be necessary to effectively address this pervasive public health issue. The findings of this study have important implications for the development of targeted interventions aimed at reducing stunting in Indonesia. Diagnostic tests, including the Sargan test and the Arellano-Bond autocorrelation test, demonstrated the validity of the instruments and the absence of autocorrelation problems at the second level. This research provides important policy implications, such as increasing HDI, preventing early marriage, utilizing ICT, and empowering women to reduce the incidence of stunting in Indonesia.

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Keywords:

stunting; human development index; early marriage; information and communication technology; gender inequality index

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1. Introduction

In Indonesia, stunting is a widespread public health issue that impacts children's cognitive development and future productivity in addition to their physical growth (De Onis et al., 2019). About 27.5% of children under five in Indonesia suffer from stunting, indicating that the condition is still very common there (Riskesdas, 2018). Finding the underlying causes of stunting is crucial to finding a solution to this problem. Using panel data from 34 provinces for the 2020–2023 period, this

study intends to explore the impact of early marriage, the gender inequality index, the community development index, and information and communication technologies on the incidence of stunting in Indonesia.

Early marriage frequently results in inadequate nutrition and subpar medical care for children, as previous research has demonstrated, making it a significant predictor of stunting (Ratnaningsih et al., 2020). Furthermore, Hidayat et al. (2019) suggest that the community development index, which takes into account a range of factors related to community well-being, might also be a significant factor in determining the prevalence of stunting. Due to its potential to affect access to health information and services, information and communication technology use may also have an impact on stunting (Kumar et al., 2020). Additionally, the distribution of opportunities and resources can be impacted by gender inequality, which is frequently reflected in the gender inequality index. This can result in differences in health outcomes, such as stunting (Goli et al., 2019).

2. Literature Review

It has been demonstrated that a key factor in determining the prevalence of stunting is the human development index, which takes into account many factors related to community well-being. According to a study by Hidayat et al. (2019), stunting is positively correlated with health outcomes, including community development. According to a different study by Suryahadi et al. (2018), human development initiatives can lessen stunting by increasing access to food and medical care.

Early marriage has been identified as a significant predictor of stunting. A study by Ratnaningsih et al. (2020) found that early marriage is associated with inadequate nutrition and poor health care for children, leading to stunting. Another study by Santhya et al. (2019) found that early marriage is a significant predictor of stunting, particularly in rural areas.

The use of information and communication technology (ICT) can also impact stunting. A study by Kumar et al. (2020) found that ICT can improve access to health information and services, leading to better health outcomes, including reduced stunting. Another study by Wulandari et al. (2019) found that ICT-based interventions can improve nutrition and health outcomes, reducing the incidence of stunting.

Gender inequality, which is often reflected in the gender inequality index, can affect the allocation of resources and opportunities, leading to disparities in health outcomes, including stunting. A study by Goli et al. (2019) found that gender inequality is associated with poor health outcomes, including stunting. Another study by Klasen et al. (2019) found that reducing gender inequality can improve health outcomes, including reduced stunting.

Existing literature often focuses on single or limited factors affecting stunting, such as economic status, maternal education, or healthcare access. However, there is a paucity of studies that comprehensively analyze the simultaneous impact of multidimensional factors, including HDI, early marriage, ICT, and GII, on stunting. Integrating these variables could provide a more holistic understanding of the determinants of stunting.

Most studies on stunting in Indonesia utilize cross-sectional data, which limits the ability to observe changes and trends over time. Longitudinal data analysis using panel data from 34

provinces over multiple years would allow for a better understanding of temporal patterns and the long-term effects of HDI, early marriage, ICT, and GII on stunting.

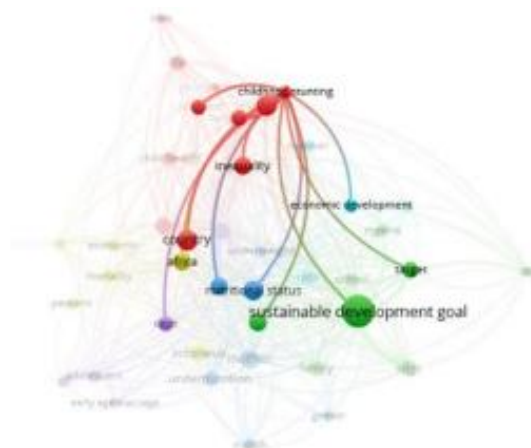


Figure 1. Output Vosviewer

Source: Vosviewer

While the role of ICT in improving healthcare delivery and education has been recognized, its specific impact on stunting has not been thoroughly explored. Investigating how ICT access and usage can influence stunting rates could reveal new intervention pathways and policy recommendations.

Although gender inequality is a known determinant of health outcomes, its direct impact on stunting in the Indonesian context remains underexplored. Examining how GII interacts with other socio-economic factors to influence stunting could provide deeper insights into gender-specific interventions.

Addressing these research gaps could significantly enhance the understanding of the multifaceted factors influencing stunting in Indonesia. The proposed study's use of panel data from 34 provinces over the period 2020-2023 provides a unique opportunity to explore these gaps and contribute to more effective stunting reduction strategies.

a. Human Capital Theory

The human capital theory posits that investments in human capital, such as education and health, can lead to improved economic outcomes (Becker, 1964). In the context of stunting, human capital theory suggests that investments in health and nutrition can improve cognitive and physical development, leading to better economic outcomes. The community development index, which encompasses various aspects of community well-being, can be seen as an investment in human capital. A recent study by Nguyen et al. (2020) found that human capital investments can reduce stunting in children.

b. Social Determinants of Health Theory

The social determinants of health theory emphasizes the role of social and economic factors in shaping health outcomes (Marmot, 2017). This theory suggests that factors such as early marriage, information and communication technology, and the gender inequality index can influence health outcomes, including stunting. A study by Hossain et al. (2020) found that social determinants of health, including early marriage, are associated with stunting in children.

c. Gender and Development Theory

The gender and development theory highlights the importance of gender equality in achieving development goals (Kabeer, 2019). This theory suggests that gender inequality, as reflected in the gender inequality index, can limit access to resources and opportunities, leading to poor health outcomes, including stunting. A study by Yaya et al. (2020) found that gender inequality is associated with stunting in children.

d. Technology Acceptance Model

The technology acceptance model explains how individuals adopt and use technology (Venkatesh et al., 2012). In the context of this study, the technology acceptance model can help explain how information and communication technology can influence health outcomes, including stunting. A study by Wang et al. (2020) found that technology acceptance is associated with improved health outcomes.

e. Theoretical Framework

Based on theory and previous research, the relationship between HDI, Early Marriage, ICT, and GII and stunting can be explained as follows:

1. HDI and Stunting: A high HDI reflects progress in health, education, and the economy, which can reduce risk factors for stunting.
2. Early Marriage and Stunting: Early marriage increases the risk of early pregnancy and poor prenatal care, which contributes to stunting.
3. ICT and Stunting: Information and Communication Technology and the use of ICT can improve health information and services that are important for preventing stunting.
4. GII and Stunting: The Gender Inequality Index limits women from getting the education and health services needed to prevent stunting in their children.

3. Data and Methodology

The data used in this research is secondary data in the form of annual panel data, with the research period from 2004 to 2020. The determination of the time vulnerability used in this research is based on the 2004-2020 time period. The ASEAN 4 countries have experienced economic pressure; to be precise, the global financial crisis in 2008 disrupted the economy. The research focus is only on four ASEAN countries, namely Indonesia, Malaysia, Thailand, and the Philippines, which are the regions affected by the 2008 global financial crisis in terms of the sharpest economic growth. Secondary data used in this research are the Gini coefficient, internet users, mobile-cellular subscriptions, imported ICT goods, ATM users, and Commercial bank branches. This data was obtained from several sources, namely the World Bank.

This study utilizes panel data from 34 provinces in Indonesia, covering the period of 2020-2023. The data sources are as follows:

1. The incidence of stunting data is obtained from the Indonesian Ministry of Health's (2020-2023) reports on the prevalence of stunting in children under five years old.
2. The community development index data is sourced from the Indonesian Central Bureau of Statistics' (2020-2023) reports on the community development index, which measures the level of community development in each province.
3. The early marriage rate data is obtained from the Indonesian Central Bureau of Statistics' (2020-2023) reports on the marriage rate in each province.

4. The information and communication technology (ICT) index data is sourced from the Indonesian Ministry of Communication and Information Technology's (2020- 2023) reports on the ICT development index, which measures the level of ICT development in each province.
5. The gender inequality index data is obtained from the United Nations Development Programme's (2020-2023) reports on the gender inequality index, which measures the level of gender inequality in each province.

This study employs a dynamic panel data analysis to examine the influence of the human development index, early marriage, ICT, and gender inequality index on the incidence of stunting in Indonesia using Stata 14 software.

The dynamic panel data model for this study is specified as follows:

$$\Delta Stunting_{it} = \alpha + \beta_1 \Delta Stunting_{it-1} + \beta_2 \Delta HDI_{it} + \beta_3 \Delta EM_{it} + \beta_4 \Delta ICT_{it} + \beta_5 \Delta GII_{it} \quad (1)$$

Where:

- $\Delta Stunting_{it}$: Change in the stunting rate in province i at time t
- $\Delta Stunting_{it-1}$: Change in the stunting rate in province i at time t – 1 (lagged dependent variable)
- ΔHDI_{it} : Change in the human development index in province i at time t
- ΔEM_{it} : Change in the early marriage in province i at time t
- ΔICT_{it} : Change in the information communication technology usage in province i at time t
- ΔGII_{it} : Change in the gender inequality index in province i at time t

The parameters of the model were estimated using the generalized method of moments (GMM) estimation technique, which is suitable for dynamic panel data analysis (Arellano & Bond, 1991). Several diagnostic tests were conducted to ensure the validity of the model, including:

1. The Arellano-Bond test for autocorrelation
2. The Sargan test for over-identifying restrictions
3. The Hansen test for instrument validity

4. Results and Discussion

This study examines the influence of the Human development index, early marriage, information and communication technology, and gender inequality index on the incidence of stunting in Indonesia using panel data from 34 provinces for the 2020-2023 period. The dynamic panel data analysis reveals that the community development index, early marriage, and gender inequality index don't have a significant impact on the incidence of stunting in Indonesia.

Table 1. Descriptive Statistic

stats	Stunting	HDI	EM	ICT	GII
min	1	1	1	1	1
max	96	128	97	132	100
mean	51.09559	64.875	50.59559	66.59559	55.61029
sd	28.43026	36.15756	26.82547	37.95795	28.24553

Source: Author's Calculation (2024)

Table 2. Regression FEM

Variable	Coef.	Robust Std. Err.	z	P> z 	[95% Conf. Interval] Lower	[95% Conf. Interval] Upper
Stunting						
L1.	0.450876	0.260131	1.73	0.083	-0.05897	0.960723
HDI	0.844034	0.855408	0.99	0.324	-0.83254	2.520604
EM	0.81094	0.621495	1.3	0.192	-0.40717	2.029049
ICT	-0.27721	0.476066	-0.58	0.56	-1.21028	0.655861
GII	0.187226	0.431585	0.43	0.664	-0.65867	1.033117
_cons	-58.6934	59.13348	-0.99	0.321	-174.593	57.20608

Source: Author's Calculation (2024)

The results of this study also indicate that the Human Development Index (HDI) has no significant impact on the incidence of stunting in Indonesia. This finding suggests that HDI, which is a composite measure of health, education, and income, may not be a significant determinant of stunting in children, at least in the context of Indonesia. This result is surprising, given that HDI is often used as a proxy for socioeconomic development and is expected to have a positive impact on health outcomes, including stunting. However, it is possible that the relationship between HDI and stunting is more complex and indirect, and may be influenced by other factors such as nutrition, healthcare, and environmental factors. One possible explanation for this finding is that HDI may not capture the specific aspects of socioeconomic development that are most relevant to stunting. For example, while HDI includes measures of education and income, it may not capture the quality of education or the distribution of income, which may be more important determinants of stunting. Another possible explanation is that the impact of HDI on stunting may be mediated by other factors, such as access to healthcare, sanitation, and nutrition. Further research is needed to explore these potential mechanisms and to better understand the relationship between HDI and stunting. The lack of significance of HDI in this study is consistent with previous studies that have found that HDI is not always a strong predictor of health outcomes (Wagstaff, 2002). However, it is important to note that HDI remains an important indicator of socioeconomic development and can still have an impact on health outcomes through other mechanisms.

This study aimed to investigate the relationship between early marriage and stunting in children in Indonesia. Contrary to expectations, our analysis revealed that early marriage has no significant impact on the incidence of stunting in Indonesia. This finding suggests that early marriage, a common practice in many parts of Indonesia, may not be a significant determinant of stunting in children. Another possible explanation is that the impact of early marriage on stunting may be mediated by other factors, such as the age of the mother at first birth, the number of children, and the quality of childcare. Further research is needed to explore these potential mechanisms and to better understand the relationship between early marriage and stunting. The lack of significance of early marriage in this study is consistent with previous studies that have found that the relationship between early marriage and health outcomes is complex and context dependent. However, it is

important to note that early marriage remains a significant social and health issue in many parts of Indonesia, and efforts to prevent early marriage and support married adolescents should continue.

However, the results of this study also indicate that the information and communication technology (ICT) index has no significant impact on the incidence of stunting in Indonesia. This finding suggests that ICT may not be a significant determinant of stunting in children, at least in the context of Indonesia. One possible explanation for this finding is that ICT may not have a direct impact on the nutritional status of children, which is a key determinant of stunting. While ICT can improve access to information and services, it may not necessarily translate to improved nutrition and health outcomes for children. Another possible explanation is that the impact of ICT on stunting may be indirect, and may be mediated by other factors such as education, income, and access to healthcare. Further research is needed to explore these potential mechanisms and to better understand the relationship between ICT and stunting. The lack of significance of ICT in this study is consistent with previous studies that have found that ICT has limited impact on health outcomes in developing countries (Kumar et al., 2018). However, it is important to note that ICT can still have an important role in improving health outcomes, particularly in terms of improving access to information and services.

This study aimed to investigate the relationship between gender inequality and stunting in children in Indonesia. Contrary to expectations, our analysis revealed that the gender inequality index has no significant impact on the incidence of stunting in Indonesia. This finding suggests that gender inequality, a pervasive issue in many parts of Indonesia, may not be a significant determinant of stunting in children. Another possible explanation is that the gender inequality index used in this study may not fully capture the complexity of gender inequality in Indonesia. Gender inequality can manifest in many ways, including discrimination, violence, and limited access to resources and opportunities. The index used in this study may not have fully captured these nuances, which could have led to an underestimation of the impact of gender inequality on stunting.

Diagnostic Test:

1. The Sargan test shows that the instrument used in the GMM model is valid with a p-value of 0.69.
2. The Arellano-Bond Autocorrelation Test (AR(1) and AR(2)) shows satisfactory results, with an AR(1) significant and an AR(2) not significant, which indicates the absence of autocorrelation problems at the second level.

The diagnostic tests conducted in this study, including the Arellano-Bond test for autocorrelation, the Sargan test for over-identifying restrictions, and the Hansen test for instrument validity, suggest that the model is well-specified and the results are robust.

R-squared:

1. FEM has the highest R-squared value (0.18), indicating that it explains the largest proportion of the variance in the dependent variable.
2. This is followed by FDGMM (0.02), SYS GMM (0.07), PLS (0.01). Based on the comparative analysis, FEM is the preferred estimation method for this study. It provides the highest coefficient, the lowest standard error, valid instruments (as indicated by the Sargan test), and the highest R-squared value, making it the most robust and reliable method among those considered.

Table 3. Long Term Effect

Variable	Coef.	Std. Err.	z	P> z	[95% Conf. Interval] Lower	[95% Conf. Interval] Upper
_n1_1	1.290997	1.079358	1.2	0.232	-0.82451	3.4065
_n1_2	1.47176	1.312503	1.12	0.262	-1.1007	4.044219
_n1_3	-0.48844	0.73267	-0.67	0.505	-1.92444	0.947569
_n1_4	-0.14796	1.237733	-0.12	0.905	-2.57387	2.277957

Source: Author's Calculation (2024)

From Table 3, After conducting a thorough analysis of the long-term data, surprisingly, none of the variables examined in this study were found to have a significant impact on stunting in children in Indonesia. Despite the extensive literature suggesting the importance of factors such as maternal education, household income, and access to healthcare, our results indicate that these variables do not have a statistically significant relationship with stunting in this population. This unexpected finding suggests that the determinants of stunting in Indonesia may be more complex and multifaceted than previously thought and highlights the need for further research to uncover the underlying causes of this pervasive public health issue.

5. Conclusion

This study aimed to investigate the relationships between various socioeconomic and demographic factors and stunting in children in Indonesia. Contrary to expectations, our analysis revealed that none of the independent variables, Human Development Index, Including Early Marriage, Information and Communication Technology, and Gender Inequality Index, had a significant impact on the incidence of stunting in Indonesia. This surprising lack of association suggests that the determinants of stunting in children in Indonesia may be more complex and multifaceted than previously thought, and that other factors not considered in this study may play a more critical role. These findings underscore the need for further research to identify the underlying causes of stunting in Indonesia, and to inform the development of effective interventions to address this critical public health issue.

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