Regional Economic Development and Stunting: A Panel Data Analysis 2005 and 2010–2019

by Wilson Rajagukguk

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Abstract

Stunting is one of indicators to be achieved in Goal 2 of sustainable development goals (SDGs), that to end hunger, attain food security and better nutrition security, and promote sustainable agriculture in 2030. This study aims to examine the trends and factors that affect stunting in six economic development regions, that is low income, low and middle income, lower middle income, middle income, upper middle income, and high income. The data used in this study came from the World Bank Indicators in 2005 and 2010–2019 . The outcome variable was the prevalence of stunting, that is height for age. The independent variables included the number of physicians per 1,000 people, access to electricity (% of population), GDP (current US$), and prevalence of anemia among pregnant women (%). The data was analysed using bivariate regression and random effect multiple generalized least square. The results of the study show that lower stunting prevalence was associated with better economic development, higher number of physicians per 1,000 people, higher access to electricity (% of population), higher GDP (current US$), and lower prevalence of anemia among pregnant women.

Key Words
Regional economic development, Malnutrition, Stunting, Children under five years of age, Random effect generalized least square regression.

1. Introduction

Stunting is an indicator of Goal 2 of Sustainable Development Goals (SDGs) that is targeted to be achieved in 2030. The goal is to end hunger, achieve food security and good nutrition, and improve sustainable agriculture. In 2012, the World Health Assembly Resolution 65.6 (WHO 2014) issued a comprehensive implementation plan on maternal, infant, and young child nutrition (1), which specified six global nutrition targets for 2025 (2). This policy included the first target, that is to reduce stunting prevalence by 40% in 2025 and then end all forms of malnutrition by 2030.

Undernutrition and stunting prevalence is declining in most developing countries, but the challenge is still big in a number of countries (Hoffman et al. 2017). Globally, the percentage of stunted children aged under five years declined from 32.4% in 2000 to 21.3% in 2019. There were about 144 million (133.5 – 154.5 million) children aged under five years who were stunted in 2019 and two thirds of them lived in Africa and South-East Asia regions (WHO 2020).

The prevalence of stunting varied across economic development regions. It was lowest in high income countries and highest in low income countries. As it can be seen from Figure 1, in 2005, the stunting prevalence was above 40% in low and lower middle income countries, while it was less than five percent in high income countries. In 2019, it was still high in low and lower middle income countries, above 30%, and still below five percent in high income countries. It shows that lower stunting prevalence is associated with better economic development achievement.
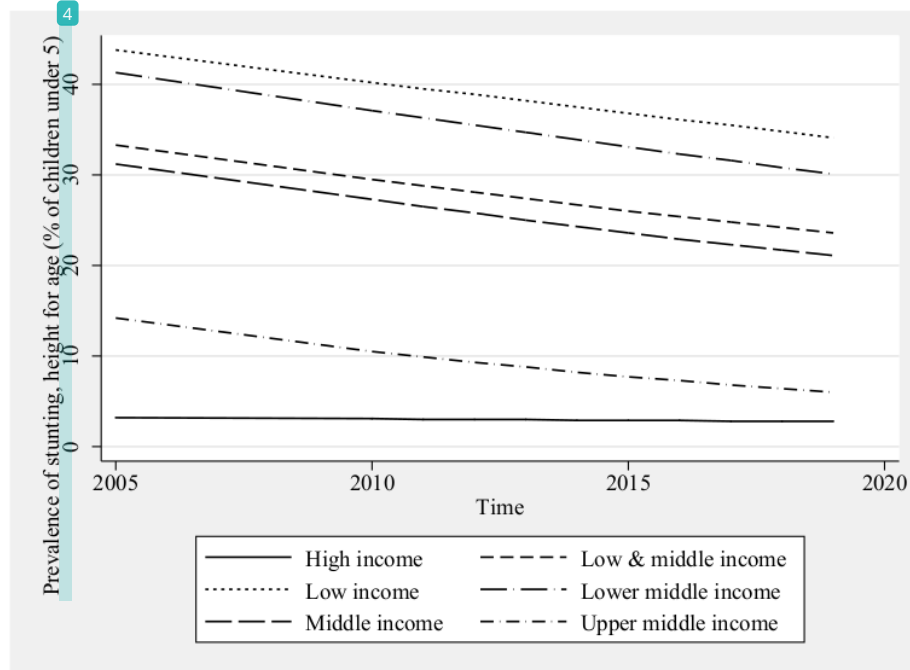
Source: World Bank (2020) (Authors' compilation).

Figure 1 Stunting prevalence by region: 2005–2019

Meanwhile, the children global pandemic and obesity influence all countries in the world, including in countries where undernutrition is still high. In 2016, 155 million of children experienced stunting, 52 million experienced wasting, and 41 million were obese (WHO 2017).

Stunting is associated with child mortality and morbidity. 20% of child death was still related with malnutrition. Meanwhile, overweigh or obesity has physical and mental health on children and teenager, such as cardiovascular disease, diabetes, and premature death among adults. A paradox is that a low birth weight or stunting history is a risk factor for children to be overweight or obese and cardiovascular disease or diabetes in the later life. Stunting and anemia is a health public problem (Tine et al. 2010).

The World Health Organization proposed the conceptual framework of the causes and context of stunting (Stewart et al. 2013). The causes include maternal factor, such as poor nutrition during pregnancy. The context consists of access to healthcare, infrastructure, and income. This conceptual framework was used in this study.

1.1. Objectives

The presence of underweight and obesity in population, community, and even in the same family becomes a double burden of malnutrition that is related to women's nutrition during pregnancy and the early and later life of a child. Therefore, it is important to study the factors that affect stunting. Thus, in general the objective of this study is to investigate the factors that affect stunting. The specific objectives are to study the influence of maternal factor, access to healthcare, infrastructure, and income on stunting.

2. Literature Review

Studies have been carried out to examine the factors of stunting (e.g. Samosir et al. 2021). Soheylizad et al. (2016) studied the role of human development that represents resources allocation and health policy on malnutrition among under five years of age children using the human development index and its components. They found negative and significant correlation between stunting and wasting prevalence with the number of physicians per 1,000 people and positive and significant correlation with overweight and maternal mortality ratio.

Using a two-stage data envelopment analysis method Saiah and Saputra (2019) carried out an analysis to measure the efficiency of public fund for health to reduce stunting prevalence in Indonesia. They found that the accumulation of the expenditure for health services of state and local government, number of physicians, number of hospital bed, percentage of deliveries assisted in healthcare facilities, and coverage of complete infant immunization were important factors of stunting in Indonesia.

Meanwhile, Aday et al. (2016) studied the impacts of sanitation, hygiene, and other behaviors that can be the intervention source to eradicate stunting in Kaltangi in Kenya. They found that positive behaviors, such as mothers who utilized community health workers when their children got ill, had positive impacts on child's health. They also found that using soap in food preparation, the availability of child caregiver, the availability of physicians, breastfeeding commitment, and increasing feeding during sickness, and mother's education could have impacts of stunting eradication.

High inequality of opportunity is a main challenge in Arab region (Hlasny and Intini 2018). They carried out a study in 14 Arab countries using a number of indicators on mother's care during pregnancy and delivery, such as children access to minimum nutrition, parental care, and development activities. They found that in those regions children were population segment that did not receive adequate qualified prenatal and delivery care. A number of children failed to receive adequate vaccination and iodine. As the results, many children became stunted, underweight, or died before their first birthday. The main cause was the access limitation to cognitive development, such as enrolment in nurseries and pre-school program, cognitive stimulation at home, such as violent discipline and child exploitation in the household. Opportunities for children's development were limited in Iraq, Mauritania, Morocco, Somalia, Sudan, and Somalia. In those regions, there was a number of opportunity disparities in the households across countries, from variation in health strata, education background, mother's access to physicians, child's access to healthcare (nursery), pre-school education. Immunization, iodine intake, and stunting among children were worse in Djibouti and Morocco. Inequality in child mortality, school enrolment rate, participation rate in pre-school program, involvement in activity development at home, violent discipline, and child exploitation at home were worse in all countries in the study.

Hoffman et al. (2017) carried a study on the factors affecting childhood nutrition in Kenya and Zambia using data from the national demographic and health surveys from the World Bank for Kenya (1998-2009) and Zambia (1996-2014). They utilized a multiple linear regression to analyze data from 2,901 and 11,355 children in Kenya and Zambia respectively to find the relationship between socioeconomic factors and nutrition status (wasting, stunting, and overweight). The results of their study show that higher stunting risk in Kenya and Zambia, in particular among population with lower literacy, with lack of education, who were without electricity, who lived in rural areas, who had not toilet, who had no car, and who had lower health index. They also found that educated mothers were more likely to have less stunted children, the girls were less likely to experience stunting than the boys, and electricity had impacts in stunting.

Malnutrition is still a health problem in developing countries. Anderson et al. (2010) studied the risk factors of malnutrition among pre-school children in Akwapim-North District in the Eastern Region of Ghana. Among 305 preschool children in the sample it was found that children from family with electricity and radio had lower stunting prevalence. Education on nutrition empowered mothers with exclusive breastfeeding and nutritious food feeding for preschool children.

High undernutrition prevalence in Medhya Pradesh contributed to high mortality and morbidity among children (Kodavalla et al. 2015). A study among 22,895 children (12,379 males and 10,516 females) with the mean age of

26.1 months) found that 52% of children were underweight, 49% were stunted, and 26% were wasted. The risks of underweight, stunting, and wasting were higher among male children than among female children. The risk of stunting was higher among children with illiterate parents, landless laborer, family with no electricity, and family with no adequate sanitation. In this case, electricity significantly was the risk factor of stunting.

Stunting among children in Latin America and the Caribbean declined from 22.9% to 9.6% in 2017. As the prevalence of stunting declined, access to electricity and refrigerator increased in those areas (Martinez et al. 2021). It was found that electricity through refrigerator availability had important role in explaining malnutrition and stunting decline that was observed in low and middle income countries in the last decade.

Davenport et al. (2017) carried out a research to compare the change in low birth weight and child malnutrition in 13 countries in Africa under the climate change scenario versus socioeconomic development scenario. Under these scenarios it was found that global warming and drought had negative effect on stunting among children. This stunting then can be mitigated with positive development trend that was associated with mother's education and household access to electricity. It was also found that under global warming scenario and drought, the risk of malnourished among children was higher among children with lower weight. Child malnutrition can be prevented in the region by improving access to education and basic infrastructure, including electricity.

Mary (2018) carried out a research using a dataset of 74 developing countries observed during 2008–2014. She found that an increase of 10% in gross domestic product (GDP) per capita would reduce stunting by 2.7%. In addition, it was found that economic growth became pro-poor. It was also found that an increase of one percent in childhood stunting prevalence would reduce GDP per capita by 0.4%. Further, it was found that to prevent stunting, the budget was 13.5% of GDP per capita in developing countries.

Yaya et al. (2020) carried out a study to test whether economic growth was associated with childhood stunting in low and middle income countries in Sub-Sahara Africa regions using the results of the Demographic and Health Survey carried out in 1987 and 2016 covering 490,536 children. Employing a multilevel logistic regression, it was shown that GDP per capita was associated with stunting. Stunting prevalence declined as GDP per capita increased. The strength of the association was stronger among children from highest quintile. After adjustment was made, the association was not significant for the lowest quintile. The association strength was stronger in low income countries. The adjustment was done for the child's age, survey year, child's gender, birth order, and country effect random. The association between GDP per capita and childhood stunting was significant. An increase in GDP per capita by 1,000 US$ would reduce childhood stunting 12%.

Stunting occurred caused by a complex interaction of various factor, not only at individual level, but also at household and community level. Wicaksono and Harsanti (2020) carried out a study of the determinants of childhood stunting in Indonesia. Using the results of the 2013 Indonesia Basic Health Research Survey covering 76,165 under five years of age children the analysis was carried out using a multilevel logistic regression. The prevalence of stunting was 36%. It was higher significantly among male children, in slum areas, and in larger household size. The prevalence of stunting was lower among children with better education, who lived in urban areas, who live in provinces with higher GDP per capita, and who lived in provinces with higher ratio of professional workers per 1,000 people.

de Jesus Silva et al. (2020) also carried out a study on the factors of stunting and obesity in municipalities in Brazil. He found that an increase of GDP per capita contributed to an increase of childhood stunting among children from socioeconomically vulnerable strata in the population.

Meanwhile, Ruaida and Soumokil (2018) conducted a research on the relationship between chronic energy deficiency (CED) status among pregnant mothers and childhood stunting prevalence in Ambon City in Indonesia. They found that maternal nutrition status before and during pregnancy affected fetus growth that consequently could increase the risk of low birth weight.

Mother's health has important impacts on child's health, in this case stunting prevalence (Destarina 2018; Nainggolan and Siagian 2019, Warsini et al. 2016, and Lubis and Santi 2020). Naingolan and Siagian (2019) studied the relationship between anemia and maternal health and child health in Indonesia. They found that anemia in pregnant women had a potency to harm mother and child. Anemia is among important health problem in developing countries, including in Indonesia. In Indonesia, 48.9% of pregnant women were anemic and 40% of childbearing women were anemic. A research warried in Sumedang in West Java of Indonesia show that there was relationship between anemia prevalence among pregnant mothers and childhood stunting prevalence. Meanwhile, in her study in Kulon Progo, Yogyakarta, Indonesia, Destarina (2018) found that childhood stunting

was influenced by the history of maternal malnutrition, such as chronic energy deficiency (CED) and iron deficiency anemia. Anemia status among pregnant mothers was a risk factor of stunting at childbirth.

Based on the above literature review, in this study it was hypothesized that maternal factor, access to healthcare, infrastructure, and income affects childhood stunting prevalence.

3. Methods

This study used data from the World Bank (2020) for 2005 and 2010–2019 (panel data of 11 years). Countries were grouped into six groups based on their economic development achievement. These are (i) low income, (ii) low and middle income, (iii) lower middle income, (iv) middle income, (v) upper middle income, and (vi) high income. The unit of analysis of the study was the economic development achievement group (six groups). Therefore, there were 66 observations in this study.

The dependent variable in the study was the prevalence of stunting (height for age, percentage of children under 5). Meanwhile, the independent variables included the number of physicians per 1,000 people, access to electricity (percentage of population), GDP (current US$), and prevalence of anemia among pregnant women (%).

The data in this study was analyzed employing univariate, bivariate, and multivariate analysis. The summary statistics of variables in the study were presented for univariate analysis. Two random effect simple generalized least square regressions were carried out between the economic development category and stunting and between the year and stunting. The purpose to examine the effects of economic development and time on stunting. Multivariate analysis was carried out to investigate the factors of stunting utilizing a random effect multiple generalized least square regression.

4. Results and Discussion

The results of univariate analysis were presented in Table 1. It can be seen that during the observation period the stunting prevalence varied from a low of only 2.8 in high income countries to a high of 44% in low income countries. Meanwhile, the number of physicians per 1,000 people ranged from 0.31 to 3.12, access to electricity differed from 21% to universal, GDP (current US$) varied between 200 hundred billion to 50 trillion, and prevalence of anemia among pregnant women ranged from 22% to 50%.

Table 1 Summary statistics of variables in the study: number of observation (*n*), mean, standard deviation, minimum, and maximum

Variable	*n*	Mean	Standard deviation	Minimum	Maximum
Prevalence of stunting, height for age (% of children under 5)	66	22.562	13.058	2.8	43.8
Physicians (per 1,000 people)	66	1.409	0.846	0.31	3.12
Access to electricity (% of population)	66	80.293	22.78	21.37	100.00
GDP (current US$)	66	2.11e+13	1.66e+13	2.00e+11	5.51e+13
Prevalence of anemia among pregnant women (%)	66	37.977	8.264	22.08	49.83

Source: World Bank (2020) (Authors' compilation).

The results of random effect simple generalized least square regressions were presented in Table 2. For the first regression, the reference category was the low income countries, while for the second regression, the reference category was 2005. It can be seen that there were significant association between economic development and time with stunting. The stunting prevalence was lower by, respectively, 10.7%, 3.5%, 13.0%, 29.1%, and 34.8% in low and middle income, lower middle income, middle income, upper middle income, and high income countries than in low income countries. In addition, the prevalence stunting was lower by, respectively, 3.2%, 3.8%, 4.4%, 4.5%, 5.6%, 6.2%, 6.7%, 7.2%, 7.7%, and 8.2% in 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019 than in 2005. These findings show that economic development achievement was an important factor of stunting reduction. Meanwhile, time represents other development achievement that also essential for ending stunting.

Table 2 Coefficient, standard error, z statistic, p-value, and 95% confidence interval of the random effect simple generalized least square regressions

Variable		Coefficient	Standard error	z-statistic	p-value	[95% Confidence interval]	
Region	Low & middle	-10.69	0.49	-21.94	< 0.001	-11.65	-9.74
	Lower middle	-3.52	0.49	-7.22	< 0.001	-4.47	-2.56
	Middle income	-13.0	0.49	-26.81	< 0.001	-14.02	-12.11
	Upper middle income	-29.12	0.49	-59.75	< 0.001	-30.07	-28.16
	High income	-34.82	0.49	-71.45	< 0.001	-35.77	-33.86
Year	2010	-3.22	0.66	-4.87	< 0.001	-4.51	-1.92
	2011	-3.83	0.66	-5.81	< 0.001	-5.13	-2.54
	2012	-4.40	0.66	-6.67	< 0.001	-5.69	-3.11
	2013	-4.98	0.66	-7.55	< 0.001	-6.28	-3.69
	2014	-5.58	0.66	-8.46	< 0.001	-6.88	-4.29
	2015	-6.15	0.66	-9.32	< 0.001	-7.44	-4.86
	2016	-6.68	0.66	-10.13	< 0.001	-7.98	-5.39
	2017	-7.20	0.66	-10.91	< 0.001	-8.49	-5.91
	2018	-7.72	0.66	-11.69	< 0.001	-9.00	-6.42
	2019	-8.22	0.66	-12.45	< 0.001	-9.51	-6.92
Constant		43.03	0.56	76.48	< 0.001	41.93	44.14

Source: World Bank (2020) (Authors' compilation).

The results of random effect multiple variate generalized least square regression were given in Table 3. It can be seen that the number of physicians and GDP had significant effects on stunting statistically at the 10% significance level, while access to electricity and prevalence of anemia among pregnant women had significant effects on stunting statistically at the less than 1% significance level.

The results of this study show that other things being the same, the higher the number of physicians, access to electricity, and GDP, the lower the prevalence of stunting. An increase of one physician per 1,000 people was associate with a decline in stunting by 3.7%. In addition, an increase of one percent in access to electricity among the population would reduce stunting prevalence by 0.2%. Further, an increase in GDP was related to a decline in stunting prevalence. Furthermore, the prevalence of anemia among pregnant women was positively associated with stunting. An increase of one percent in anemia prevalence among pregnant women would cause an increase in stunting prevalence by 0.6%.

Table 3 Coefficient, standard error, z statistic, p-value, and 95% confidence interval of the random effect
multiple generalized least square regression

Prevalence of stunting, height for age (% of children under 5)	Coefficient	Standard error	z statistic	p-value	[95% Confidence interval]	
Physicians (per 1,000 people)	-3.739	1.936469	-1.93	0.053	-7.534681	0.0561401
Access to electricity (% of population)	-0.207	0.0330311	-6.26	< 0.001	-0.2716309	-0.1421512
GDP (current US$)	-1.09e-13	6.21e-14	-1.75	0.080	-2.30e-13	1.31e-14
Prevalence of anemia among pregnant women (%)	0.575	.1104067	5.21	< 0.001	.3586552	0.7914414
Constant	24.896	5.686682	4.38	< 0.001	13.74984	36.04122

Source: World Bank (2020) (Authors' compilation).

5. Conclusion

The results of this study confirm the findings from previous studies on the importance of maternal factor (Destarina 2018; Nainggolan and Siagian 2019, Warsini et al. 2016, and Lubis and Santi 2020), healthcare access (Saiah and Saputra 2019; Aday et al. 2016; Hlasny and Intini 2018), infrastructure (Hoffman et al. 2017; Anderson et al. 2010; Kodavalla et al. 2015; Martinez et al. 2021; Davenport et al. 2017), and income (Mary 2018; Yaya et al. 2020; Wicaksono and Harsanti 2020; de Jesus Silva et al. 2020; Ruaida and Soumokil 2018) on stunting reduction. Non-anemic pregnant mothers would reduce the probability of stunting among for children aged under five years by giving birth to healthier and more nourished babies. Access to healthcare through adequate physicians improve child's nutrition intake through more and better counselling on sufficient feeding practice information and guidance as well as early stunting diagnosis. Access to electricity can also reduce stunting through increase access to nutritious feeding practice information among mothers with under five years of age children. Better economic development achievement could prevent stunting through better resources to nutritious food for children aged under five years. Therefore, countries, in particular low and lower and middle income countries, should improve maternal health, access to healthcare, infrastructure, and income in order to eradicate stunting.

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