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The Effect of Sanitation on Stunting Prevalence in Indonesia

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Abstract

Preparing children from birth can boost productivity and competitiveness later in their lives. However, the occurrence of malnutrition and stunting during childhood period will reduce their productivity and increases the risk of non-communicable diseases later in their lives. This study examines the effect of sanitation, drinking water sources, and drinking water treatment on stunting in Indonesian children (0-59 months). This study analyses cross-sectional data from the 2014 Indonesia Family Life Survey (IFLS) 5 with 3,834 children living with their biological mothers. The Logistic Regression to estimate the coefficients is applied here. The results show that the variables of sanitation, drinking water sources, and drinking water treatment before consuming affected stunting. Children who consume tap water are less likely to be stunted (OR=0.81, 95% CI 0.66-0.99). Birth weight, economic conditions, and mother's level of education also affect risk of stunting. Hence, to overcome the risk of stunting, the government have to accelerate the supply of basic sanitation, to protect the good quality of drinking water sources, and to promote the awareness of boiling water before consumption.

Keywords: stunting; sanitation; drinking water; logistic regression

Introduction

Human resources development consist of three aspects which are quality, quantity, and mobility. Meanwhile the level of population welfare reflects the quality of the community, one of which is the standard of health and nutrition.[1] However, a significant and growing population will become a problem for human resources in the future. According to Population Survey (SP) 2020 released by the Central Bureau of Statistics (BPS), in 2015 the population of Indonesia reached 270 million more, in which the population aged 0 to 4 years (under five) become the primary target of nutrition reached 22.79 million people.

Malnutrition in the early childhood period will imply the development of children and the development of self-potential at a productive age. If all populations get enough nutrition to grow and develop optimally, they will possess a high quality indivudual which is the core element in development.[2] According to Adioetomo (2017), one of the requirements to reap the demographic bonus which occurred since the late 1980s and the window of opportunity opened in 2020-2030

1 Law No. 17 of 2007 on National Long-Term Development Plan 2005-2025

2 http://www.depkes.go.id/article/print/15021300004/status-gizi-pengaruhi-kualitas-bangsa.html

is to prepare the human capital in early life to increase productivity and competitiveness in productive age. They are expected to become the driver of the economy as well as able to bear the increasingly unproductive age population, especially the elderly (65+) who have reached 32.4 million in 2035 or 10.6 percent of the total population of Indonesia.

In general, Indonesia has achieved major progress in the field of human capital development, one of which is successfully reducing the under-five mortality rate. Within 31 years (1971-2012), the under-five mortality rate in Indonesia has dropped from 218 to 26 deaths per 1,000 live births. However, like other countries in the world, Indonesia is also experiencing growth and developmental problems in children under the age of five according to the Ministry of Health's Basic Health Research (RISKESDAS). The prevalence of stunting in Indonesia from 2007 to 2013 tends to increase. In 2007, the prevalence of stunting in Indonesia was 36.8 percent; by 2010, the rate had dropped to 35.6 percent, while in 2013, the prevalence of stunting increased to 37.2%. Therefore this will be indicating that approximately 8 million Indonesian children under the age of five were stunted. The percentage decreased to 30.8% in 2018. Nevertheless, even though it has decreased, according to WHO (1995), the prevalence of stunting in Indonesia is still alarmingly high at over 30 percent.

The previous studies mentioned that stunting is an indicator of malnutrition which brings the short-term and long-term effects on individuals and nations. Stunting contributes to poor quality of life, morbidity (Kossmann, et.al., 2000; Olofin, et.al., 2013) and mortality (Olofin, et.al., 2013; Bhutta, et.al., 1997). Even though it was estimated that the occurrence of stunting contributed to 2.2 million deaths and 21 percent of under-five disabilities (Black, et.al., 2008). Besides, stunting also caused a decrease in cognitive abilities (Berkman, et.al., 2002; Mendez and Adair, 1999), physical capacity, neurodevelopment, and an increase in the risk of metabolic diseases in elderhood (Prendergast and Humphrey, 2014).

The previous studies found that environmental factors significantly influence the occurrence of stunting in children in some countries, which is related to sanitation and the use of clean water. Smith and Haddad (2015) mentioned that during the period 1970-2012, at a global level, access to proper sanitation and clean water and enhancement of food supplies are the reliable drivers for reducing stunting. According to the World Bank, prefenting children to experience the stunting is a multisectoral challenge. Investment in water and sanitation has the tremendous potential to improve nutritional outcomes.[3]

In developing countries, children have better health and nutrition when their mothers have higher education level. Study by Semali (2015) to 678 households with children ages 0 to 59 months found that children whose mothers had a high level of education were less likely to be stunted than those whose mothers had a low level of education. Also, Wamani, et.al. (2004) in Uganda found that stunting was 2.5 times more common among mothers who did not attend school.

Agedew and Chane (2015) assume that a mother who works daily is more likely to have a child who is short in height for their age than a mother who did not work. Meanwhile, Urke, et.al. (2011), which observed Peru during 2004–2006, presented the high risk of stunting faced by children of working mothers. Willey, et.al. (2009) concluded that the working mothers had a small chance of having stunting children by the age of 30 months because of the positive impact of working on their income.

Stunting is identified by assessing a child's length or height (recumbent length for children less than 2 years old and standing height for children aged 2 years or older) and

3 http://blogs.worldbank.org/voices/stunting-face-poverty

interpreting the measurements by comparing them with an acceptable set of standard values. There is the international agreement which stated that children are stunted if their length/height is below 2 Standard Deviation (SD) from the WHO Child Growth Standards median for the same age and sex. Similarly, children are considered severely stunted if their length/height is below 3 SDs from the WHO Child Growth Standards median for the same age and sex (WHO, 1978). To determine the extent of low prevalence in a country or region, WHO (1995) has set a threshold related to several indicators such as underweight, stunting, and waste, as presented in Table 1.

Table 1. Prevalence Threshold of Nutritional Status

Indicator	Threshold and its category
(1)	(2)
Stunting	< 20 percent: Low prevalence
	20-29 percent: Medium prevalence
	30-39 percent: High prevalence
	>= 40 percent: Very high prevalence

Source: WHO (1995)

The first thousand days of life represent a period that a human has passed from the formation of the fetus until the age of two years, to be precised. The first thousand days of life include 270 days in the womb and 730 days after birth. The first thousand days of life is the critical period in the life cycle because during this time, i the organs, the nervous system and the peak of development of the human senses are formed. If malnutrition occurs during this period, the impact will be permanent and severe (Achadi, 2014).

The importance of the first thousand days of life has also been the focus of government efforts to improve human resources. The effort is regulated in Presidential Regulation (*Perpres*) No. 42/2013. The regulation established has the primary objective to accelerate the improvement of nutrition of the priority community in the first thousand days of life. It is a form of government responsibility in raising public awareness about the importance of improving the nutrition status of children under-five, especially in their early of life. In the first thousand days of life, the nutritional need is substantial enough to support rapid growth and development, more susceptible to infection, and dependent on others for nutritional needs, care, and social interaction (Unicef, 2013).

The failure of growth in the first thousand days of life causes a decrease in height when they reach adulthood unless there is intervention in later periods. Prentice, et.al. (2013) commented that by not excluding the importance of the first 1,000 days of birth, child growth is still fluctuating after two years of their longitudinal study in Brazil, Guatemala, India, the Philippines, and South Africa. Their research indicates that there has been a significant decrease in height from 0 to 24 months, then also an increase in the age of 24 to 48 months in all countries, except India.

Dorman and Georgiadis (2015) mentioned that stunting recovery efforts beyond childhood can still be achieved, i.e. improving the living standards, food intake, and water and sanitation infrastructure programs. Correspondingly, a longitudinal study conducted by Aryastami (2015) found that stunted children may grow normally if optimal child growth can be pursued at the age of 4-5 years, through improved nutrition supported by a general economic improvement. However, according to Martorell, et.al., (1994); Dornan and Georgiadis, (2015) although nutritional improvements in childhood (1-12 years) may affect height in adulthood, it is preferable to do the nutritional improvements early in life until the age of 5 years.

Souganidis (2012) found that stunting continues to cause significant morbidity and mortality worldwide. Prendergast and Humphrey (2014) said that stunting in early life is associated with increased morbidity and mortality, reduced physical capacity, neurodevelopment and increased risk of degenerative diseases in elderhood. Correspondingly, Victora, et.al. (2008) also mentioned that height at the age of 24 months can be used to predict height in adulthood and is associated with a lack of cognitive ability, lack of education, and potential income which all contribute to reducing human capital in developing countries.

Stunting often results in delays in mental development, poor school performance and reduced intellectual capacity which in turn will affect economic productivity at the national level in the future (WHO, 1995). Also, stunting may cause severe anaemia, dysentery, and delayed puberty (Unicef, 1998). Meanwhile, Achadi (2014) said that for someone who is exposed to stunting, other processes in the body are also inhibited, such as brain growth which affects intelligence. Children who experience stunting and rapid gain of weight after the age of 2 years will have higher risk of being overweight or obese in the future. Meanwhile, weight was also associated with a higher risk of coronary heart disease, stroke, hypertension and type 2 diabetes (Black, et.al., 2013 in WHO, 2014). Mukkudem and Kruger (2004) found that stunting resulted in fat deposits in women in South Africa.

Meanwhile, Georgiadis (2014) argued that stunting has severe consequences for child survival, health, and skill development throughout life, dramatically undermines individual economic productivity and economic prosperity nationally and makes it difficult for people in low-income countries to escape poverty. The consequences of stunting children in the future are less optimal work capacity which in turn impacts economic productivity (De Onis and Blossner, 1997; Ezzati, et. al., 2004).

The importance of safe drinking water, sanitation, and hygienic behaviour has long been recognized in public health, the health of infants and children in particular (Jones, 1923 in Cumming and Cairncross, 2016). Safe drinking water and sanitation are vital determinants of human health and well-being. Less safe drinking water is one of the leading causes of illness and death, as a result of viral infections, chemical pollution, and poor hygiene (BPS, 2015). Lack of access to clean drinking water and sanitation, coupled with the absence of good hygiene practices is one of the causes of malnutrition (Adair & Guilkey, 1997).

According to Pruss-Ustun, et.al. (2008), about 50 percent of all malnutrition cases are associated with recurrent diarrhoea or intestinal helminth infections as a direct result of unsafe water, inadequate sanitation, and poor hygiene behaviour. Meanwhile, Pruss Ustun, et.al. (2014) asserted that the provision of clean water, safe sanitation, and clean life practices are essential to protect health. His findings showed the importantance of Water, Sanitation, and Hygiene (WASH) is due to the addition to preventing diarrhoea as well as other diseases and according to WHO (2011), babies and children are individuals at high risk of unhealthy waterborne diseases.

Bartram & Cairncross (2010) mentioned that proper sanitation could prevent endemic diarrhoea, giardiasis, schistosomiasis, trachoma, and many other infectious diseases. Meanwhile reliable safe water at home prevents not only diarrhoea, but also guinea worm which is transmitted through water and can prevent transmission of epidemic diseases, such as typhus, and cholera. Correspondingly, Hotez, et.al. (2006) said that the transmission of worms could be through human waste containing worm eggs. In addition, King (2010) conducted research to analyze the direction of the causal effect between poverty and schistosomiasis, a disease caused by a worm-parasite. His research showed the connection between schistosomiasis and poverty now appears evident, though causation is likely to be bidirectional. Therefore, worms are closely related to poverty, poor sanitation, and lack of clean water. So the provision of safe drinking water and not disposing of waste in the open are essential to overcome worm infection. However, according to Mara, et.al. (2010), most countries focus more on medicines than on sanitation improvements.

Boiling water is also one way to improve water quality. Drinking water treatment at the household level becomes one of the means to get safe drinking water to overcome the difficulties to meet clean water sources. Blake, et.al. (1993) stated that boiling water is a protective effort against diarrhoea attacks. Sodha, et.al. (2011) also found that water that is not boiled has a greater likelihood of containing E. Choli bacteria than boiled water.

Method

This is quantitative research with cross-sectional data collection type. The data used are secondary data sourced from Indonesia Family Life Survey (IFLS) 5. The dependent variable in this research is stunting status in children aged 0-59 months. The primary independent variables are sanitation status, drinking water sources, and drinking water treatment status, while the control variables are sex, birth weight, maternal employment status, maternal education level, and household economic status. The unit of analysis used in the study was 3,834 individuals aged 0-59 months who lived with their biological mother. The operational definition of the variables utilized in this study is presented in Table 2 below.

Table 2. Definition of Variables in Model

No	Variable	Name	Definition	Source	Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1.	The prevalence of stunting	stunting	Length/Height-for-age. Stunting if less than -2 SD-Z (stunting consists of stunting dan severe stunting).	book us; bus_us; us04	0= Normal* 1= Stunting
2.	Sanitation Status	ssts	The presence of a toilet facility	b2_kr; kr20	1= Proper 0= Poor*
3.	Drinking water sources	sami	Primary sources of drinking water for the households	b2_kr; kr13	1=Piped water 0=Others*
4.	Drinking water treatment status	stssami	Drinking water treatment status before being consumed	b2_kr; kr13,kr13a	1=Mineral water 2=Boiled non-mineral water 3=Non-boiled non-mineral water*

5.	The sex of children	jks	The sex of children under five	bkar1; ar07	1=Male* 0=Female
6.	Birth weight	bb	Birth weight of children under five	b4ch1; ch24	1= LBW 0= Normal*
7.	Maternal employment status	kerja	Status of mother's work a week ago	bk_ar1; tk24b	1= Not working* 2= Informal worker 3=Formal worker
8.	Highest maternal education level	didik	The mothers' highest education level	bk_ar1; ar16,ar17	1=Low 2=Middle 3=High*
9.	The economic status of households	stsekon	Quintile of households' expenditure	bk 1, konsumsi	1=Quintile 1* 2=Quintile 2 3=Quintile 3 4=Quintile 4 5=Quintile 5

Note: *) Reference category

The method of analysis used in this study is descriptive analysis (univariate and bivariate) and inferential analysis (multivariate). Both methods are used to achieve the objectives to be attained from this research. This research uses SPSS 23 and Stata 13 software. This study uses binary logistic regression analysis because the dependent variable is categorical data with two categories.

The research hypothesis is that sanitation, water sources, and water treatment affect the incidence of stunting in children under five. At this stage, the primary independent variable and the birth weight variable will be put into the model concurrently (**Model 1**). The objective is to determine the effect of birth weight to the prevalence of stunting. The next step is to exclude the weight variable to determine the effect of primary independent variable to stunting status (**Model 2**). In addition, the final stage will be adjusted for other independent variables, such as gender of toddler, birth weight, mother's employment status, mother's highest level of education, and household income (**Model 3**).

The model design is as follows.

Model 1

$$\log\left(\frac{p_1}{p_0}\right) = \beta_0 + \beta_1 \text{ssts} + \beta_2 \text{sami} + \beta_3 \text{stssami}_1 + \beta_6 \text{bbl} + e$$

Model 2

$$\log\left(\frac{p_1}{p_0}\right) = \beta_0 + \beta_1 \text{ssts} + \beta_2 \text{sami} + \beta_3 \text{stssami}_1 + e$$

Model 3

$$\log\left(\frac{p_1}{p_0}\right) = \beta_0 + \beta_1 \text{ssts} + \beta_2 \text{sami} + \beta_3 \text{stssami}_1 + \beta_4 \text{stssami}_2 + \beta_5 \text{jk} + \beta_6 \text{bbl} +$$
$$\beta_7 \text{didik}_1 + \beta_8 \text{didik}_2 + \beta_9 \text{kerja}_1 + \beta_9 \text{kerja}_2 + \beta_{10} \text{kepro}_1 + \beta_{10} \text{kepro}_2 + e$$

Discussion

The results showed that the prevalence of stunting in Indonesia in 2014 reached 29.5 percent. Referring to the WHO's Provision (1995), stunting case in Indonesia is still at a near-high prevalence. Compared to stunting events in 2013 which reached 37.2 percent, this figure is quite optimistic, although steps must be taken to keep it down to a lower level. In detail, the distribution of the percentage of under-fives according to the independent variables used is presented in Table 3.

Table 3. Distribution of Number and Percentage of Children Under-Fives Based on Individual Characteristics, Underlying Determinant, and Basic Determinant, Indonesia, 2014

Variable	n	Percentage
(1)	(2)	(3)
1. Sex		
Male	1,994	52.00
Female	1,840	48.00
Total	3,834	100.00
2. Birth Weight		
LBW	229	7.80
Normal	3,535	92.20
Total	3,834	100.00
3. Sanitation Status		
Proper	2,875	75.00
Poor	959	25.00
Total	3,834	100.00
4. Drinking Water Sources		
Piped water	645	16.80
Others	3,189	83.20
Total	3,834	100.00
5. Drinking Water Treatment Status		
Bottled water	1.463	38,2
Boiled non-bottled water	2.115	55,1
Non-boiled non-bottled water	256	6,7
Total	3.834	100,00
6. Highest Maternal Education Level		
Low	927	24,2
Middle	2.353	61,4
High	554	14,4
Total	3.834	100,00

7. Maternal Employment Status		
Not working	1.843	48,1
Informal worker	1.161	30,3
Formal worker	830	21,6
Total	3.834	100,00
8. Economic Status of Households		
Quintile 1	781	20,4
Quintile 2	817	21,3
Quintile 3	816	21,3
Quintile 4	776	20,2
Quintile 5	644	16,8
Total	3.834	100,00

Source: IFLS5

Table 3 above shows that based on IFLS5 results, the largest proportion of children under five is male (52.0%). The percentage of LBW under-fives was 7.8 percent (low prevalence). Meanwhile, Riskesdas 2013 showed children under age five who experienced LBW were recorded at 11.1 percent (moderate prevalence). The majority of children under five years old live in households with proper sanitation facilities (75%). Meanwhile, only about 16.8 percent of children under the age of five live in households which use piped water for their drinking water needs. Meanwhile, the results also show that 6.7 percent of households still consume non-boiled water.

Regarding education, by 2014 the majority of those under-five have mothers with secondary schools (junior and senior high and equivalent) with a percentage of more than 50 percent, while those with a high education rate of about 14 percent. Based on the economic status of households, it appears that under-fives are mostly living in households with expenditure categories in quintiles 2 and 3. Under-fives living in households with the highest expenditure group is only 16.8 percent. It indicates that the majority of under-fives in Indonesia live in households with middle to lower economic levels.

Based on Table 4 it can be seen that the occurrence of stunting in under-fives is significant for the category of households that do not have proper sanitation where the percentage reaches 36.9 percent.

Table 4. Distribution of Number and Percentage of Stunting Status in Children Aged 0-59 Months Based on Each Independent Variables, Indonesia, 2014

Variable/Category	Stunting Status		
	Stunting n (%)	Normal n (%)	Total n (%)
(1)	(2)	(3)	(4)
1. Sex			
Female	517 (28.1)	1,323 (71.9)	1,840 (100)
Male	613 (30.7)	1,381 (69.3)	1,994 (100)
2. Birth Weight			
LBW	140 (46.8)	159 (53.2)	199 (100)
Normal	990 (28.0)	2,545 (72.0)	3,535 (100)
3. Sanitasi Status			
Poor	354 (36.9)	605 (63.1)	959 (100)
Proper	776 (27.0)	2,099 (73.0)	2,875 (100)
4. Drinking Water Sources			
Piped water	170 (26.4)	475 (73.6)	645 (100)
Others	960 (30.1)	2,229 (69.9)	3,189 (100)
5. Drinking Water Treatment Status			
Non-boiled non-bottled water	111 (43.4)	145 (56.6)	256 (100)
Boiled non-bottled water	620 (29.3)	1,495 (70.7)	2,115 (100)
Bottled water	399 (27.3)	1,064 (72.7)	1,463 (100)
6. Highest Maternal Education Level			
Low	346 (37.3)	581 (62.7)	927 (100)
Middle	661 (28.1)	1,692 (71.9)	2,353 (100)
High	123 (22.2)	431 (77.8)	554 (100)
7. Maternal Employment Status			
Not working	556 (30.2)	1,287 (69.8)	1,843 (100)
Informal worker	369 (31.0)	792 (68.2)	1,161 (100)
Formal worker	205 (24.7)	625 (75.3)	830 (100)
8. Economic Status of Households			
Quintile 1	260 (33.3)	521 (66.7)	781 (100)
Quintile 2	264 (32.3)	553 (67.7)	817 (100)
Quintile 3	249 (30.5)	567 (69.5)	816 (100)
Quintile 4	211 (27.2)	565 (72.8)	776 (100)
Quintile 5	146 (22.7)	498 (77.3)	644 (100)

Source: IFLS5

Meanwhile, under-fives who come from households with piped water drinking water sources have a smaller proportion of stunting which is 26.3 percent compared to the other drinking water sources which reached 30.1 percent. In addition to drinking water, other things related to water is water treatment before consumption. Based on Table 4, it shows that households consuming non-boiled water have the greatest proportion of stunting which is 43.4 percent. It is an early proof that boiling water is essential to avoid stunted growth in children.

Based on the sex of children under age five, it shows that males have the largest proportion of stunting which is 30.8 percent. The high occurrence of stunting among male children can not be separated from their vulnerability to infection and disease because the immune system is weaker, plus mobility is greater than in female children (Anker and WHO, 2007). Table 4 also shows that under-fives who experience low birth weight have a huge proportion experiencing stunting, reaching 46.8 percent, while those of normal birth is 28 percent. Based on maternal education level, the highest prevalence of stunting is in the group of mothers with low educational attainment which is 37.3 percent. Table 6 shows that the higher a mother's education level, the less prevalence of stunting in children.

Based on maternal employment status, the mothers who are informal workers are the highest to have stunted children. The difference with the group of mothers who are not working is minimal. But when compared with the category of mothers who work in the formal sector, it is clearly apparent that the difference in the proportion of stunted children in the other two groups is enormous. This result was inconsistent with the research from the research Agede and Chane (2015) and Urke, et.al. (2011). Both researches concluded that working mothers had stunted children more than non-working mothers. Furthermore, regarding the economic status of households, Table 4 indicates that the higher level of household per capita expenditure, then the less the proportion of occurrence of stunting. This result is in line with research by Sari (2012) in Sumatera which found that the proportion of stunted children under the age of five is found in households with low economic status compared with high.

The logistic regression results as presented in Table 5 show that sanitation is a strong predictor of the occurrence of stunting in under five. It is indicated by the significant variable that affects the occurrence of stunting both before and after being controlled with other variables. Model 1 is the regression result that includes all the primary independent variables plus the birth weight variable. Then in model 2, the birth weight variable is removed from the model. Model 3 is a complete model involving all independent variables. The results show that sanitation status, drinking water sources, and drinking water treatment status are reliable predictors of the occurrence of stunting in children under age five.

Table 5. Logistic Regression of Stunting Status

Variables	Model 1		Model 2		Model 3	
	OR	SE	OR	SE	OR	SE
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Birth weight						
Normal (ref)						
LBW	2.216** (0.000)	0.123			2.189** (0.000)	0.124
2. Sanitation Status						
Poor (ref)						
Proper	0.666** (0.000)	0.081	0.669** (0.000)	0.081	0.755** (0.001)	0.085
3. Drinking Water Sources						
Others (ref)						
Piped water	0.785** (0.021)	0.105	0.771** (0.012)	0.104	0.810** (0.046)	0.105
4. Drinking Water Treatment Status						
Non-boiled non-bottled water (ref)						
Boiled non-bottled water	0.584** (0.000)	0.137	0.576** (0.000)	0.136	0.596** (0.000)	0.139
Bottled water	0.527** (0.000)	0.145	0.509** (0.000)	0.144	0.598** (0.001)	0.149
5. Sex						
Male (ref)						
Female					0.875 (0.066)	0.073
6. Highest Maternal Education Level						
Low (ref)						
Middle					0.762** (0.002)	0.086
High					0.664** (0.004)	0.141
7. Maternal Employment Status						
Not working (ref)						
Informal worker					1.074 (0.387)	0.083
Formal worker					0.902 (0.318)	0.104

8. Economic Status of Households		
Quintile 1 (ref)		
Quintile 2	0.979 (0.848)	0.109
Quintile 3	0.932 (0.528)	0.111
Quintile 4	0.854 (0.179)	0.117
Quintile 5	0.740** (0.024)	0.133
Constant		**0.157**

Note: ** = p<0,05, number of p-value are in parentheses

Source: Refined from IFLS5

Model 1 shows that the primary independent variables still have a significant effect on the tendency to become stunted at α = 0.05 with the OR value smaller than 1. Model 2 shows the model after the removal of the birth weight variable. The result is also consistent with the result in model 1 in which the three primary independent variables remain significant. At a given value of other independent variables, the estimated odds that a household with piped water source had stunting children is 0.785 times the estimated odds for a household with non piped water source. Similarly, the estimated odds that a household with boiled non-bottled water treatment had stunting children is 0.584 times the estimated odds for a household with non-boiled non-bottled water treatment. Meanwhile, the estimated odds that a household with bottled water treatment is 0.527 times the estimated odds of non-bottled non-boiled water treatment. It can be implied as an indication that poor drinking water sources and the consumption of non-boiled water can worsen the occurrence of stunting in children born with LBW. The next model is the complete model (Model 3), in which all independent variables are incorporated into the model. In this model, in general, the primary independent variables remain significant at α = 0.05.

Table 5 shows that under-five children living in households with proper sanitation facilities have less risk of stunting than those living with poor sanitation. In addition to sanitation, drinking water sources are also a major factor affecting the occurrence of stunting in Indonesia. From Model 1, at a given value of other independent variables, the estimated odds that a household with piped water source had stunting children is 0.785 times the estimated odds for a household with non piped water source. The regression results show that this variable has a statistically significant effect on stunting status with an OR value smaller than 1, which means that under-five children living in a household with piped water drinking water sources have a lower risk of stunting than under-five children with other sources of drinking water. This is consistent with a study conducted in India in by Parekh and Pillai (2016), which discovered that households without access to piped water had a higher rate of stunting. According to their findings, children with access to piped water are 20% less likely to be stunted than children without such access.

Under -five children living in households which consume non-boiled non-bottled water have a greater risk of stunting compared to households consuming bottled or boiled non-bottled water. The estimated odds that a household with boiled non bottled water treatment had stunting children is 0.584 times the estimated odds for a household with non-boiled non bottled water treatment. Meanwhile, the estimated odds that a household with bottled water treatment is 0.527 times the estimated odds of non-bottled non-boiled water treatment. These results prove that boiling water is a major factor in reducing the risk of stunting in under-five. This is in line with the research conducted by Harriet Torlesse (2016) which states that drinking water treatment is a strong factor in causing stunting in children aged 0-23 months in Indonesia. Furthermore, there is a strong link between the decrease in stunting in Indonesia and how families treat clean water before drinking it, especially by cooking, filtering, or boiling it to kill the pathogens in water, such as viruses, bacteria, spores, fungi, and protozoa.

The results of the treatment for the three primary independent variables above confirm some of the previous research results which have been conducted in some developing countries and found that poor sanitation, unsafe drinking water sources, and poor drinking water treatment are the contributing factors to growth retardation in children under age five. Some of these are the research of Daniel, et.al. (1991) in Lesotho, Esrey (1996) in Sub Sahara Africa, Saaka and Galaa (2016) in Ghana, Shapiro, et.al. (2005) in Bolivia, and Merchant, et.al. (2003) in Sudan. Also, the results of this study strengthen the results of previous studies in Indonesia, such as Torlesse, et.al. (2016) in three districts/ cities (Sikka, Jayawijaya, and Klaten). They said that water and sanitation are the targets of the program if it is to reduce the occurrence of stunting in Indonesia. It is also in line with study by Aryastami (2015) which finds that poor environmental sanitation is one of the reasons a person becomes short at an early age.

The sex variable has no statistically significant effect on the stunting status. It means that there is no difference in the occurrence of stunting between males and females. Although, based on its tendency, males under five are more at risk of stunting than females. However, this result is an initial assumption that nutritional status under-five no longer sees sex differences. These findings contradict the study by Agedew and Chane (2015) which stated that gender is an important factor influencing the incidence of stunting. They discovered that boys aged 6 to 24 months in Ethiopia had a stunting risk 2.5 times that of females. Similarly, according to research by Fitri (2012) in Sumatera, gender has a substantial effect on the incidence of stunting in toddlers. According to Thompson (2021), sex differences in growth line and immune function beginning in utero may place boys at greater risk of infection and undernutrition.

Low Birth Weight (LBW) is one of the nutritional indicators which affect a child's growth and development in the future. Babies born with LBW are at risk of health problems and growth retardation (Kemenkes, 2016). Along with stunting, LBW is also the focus of nutrition improvement initiated by many countries in the world as outlined in SDGs. The results showed that LBW was one of the strongest predictors of the occurrence of stunting in under five. Based on Table 5, it is knownunder-five children born with LBW have a greater risk of stunting than normal-born children. When comparing the primary independent variables, the influence of LBW is higher against the occurrence of stunting in under five. At the given value of other independent variables, the estimated odds that a household with Low Birth Weight had stunting children is 2.216 times the estimated odds for a household with normal weight. This result is also in line with the findings of

Fitri (2012) on the island of Sumatera, which stated that a baby born with LBW has a risk of 1.7 times become stunting compared to normal-born children. Even the Sakaa and Galaa (2016) from their study in Ghana showed that the risk of underweight children under the age of five to be stunted is much greater than those born with normal weight, with a risk of 2.5 times.

The highest maternal education level has a significant influence on the occurrence of stunting in under five. The secondary education category is significant at α = 0.05, which means there is a difference in the occurrence of stunting in under five whose mothers have low to middle education levels, as well as those under-five whose mothers have middle to high educational attainment. Table 5 shows that the higher the maternal education level, the smaller the risk of stunting. Under-fives whose mothers have middle to high education levels are less likely to be stunted than those with low education levels. At given value of other independent variables, the estimated odds that a household which had higher maternal education had a stunting child is 0.664 times the estimated odds for a household with low maternal education level. This finding is consistent with research conducted by Chen and Li (2009), which discovered that, even after adjusting for income, the number of siblings, environmental health, and other socioeconomic factors, a mother's education was a significant factor in determining a child's height in China. According to Miller and Rodgers' (2009) research in Cambodia, mothers with the least or no education had the highest likelihood of their children being stunted before the age of five.

Based on the results, the maternal employment status does not significantly affect stunting at α = 0,05, in other words, there is no difference in the occurrence of stunting in children under age five based on their mother's job status. A working mother can have a positive impact on child nutrition when the mother is working to get enough resources which are used to meet her child's nutritional needs. In contrast, working mothers often have to be away from their children so the safe keeping (breastfeeding) is also constrained. At the given value of other independent variables, the estimated odds that a working mother in the formal sector had a stunting child is 0.902 times the estimated odds for a non-working mother. Meanwhile, the odds for the maternal workers who work in the informal sector will tend to have stunting 1.704 times more than non-working maternal workers. Furthermore study by Agedew and Chane (2015) showed no connection between the likelihood of stunting occurring in toddlers whose mothers worked for the government and those whose mothers did not, but they did find that moms who worked regularly had a higher likelihood of stunting than housewives (not working).

The economic status of households is approximated by a quintile of total expenditure per capita which is statistically significant at α = 0.05 for households in quintile 4 (top 20 percent). It means that there is a significant difference in the occurrence of stunting between under-fives living in households with low economic status and high economic status. At the given value of other independent variables, the estimated odds that a household in quintile 4 had stunting children is 0.854 times the estimated odds for a quintile 1 household. It is because the low economic status will cause limitations to obtain the high-quality food sources needed for the growth of the children. This result is in line with the research of Torlesse, et.al. (2016) that found that under five from low-income families tended to be more stunted by their growth than those from richer households.

Conclusion

The result of the tabulation shows stunting percentage in 2014 is in medium prevalence with a value of 29.50 percent. The three determinants of stunting prevalence are poor sanitation facilities, non-piped drinking water sources, and consuming non-boiled non-bottled water. Based on other characteristics, males under-five children, experiencing LBW, have low maternal education levels, informal workers, and live in a household with the lowest economic status.

From the logistic regression result, it is known that sanitation status, drinking water sources drinking water treatment, and maternal education level status have a statistically significant influence on stunting status in children. Under-fives living in households with poor sanitation facilities are at higher risk of stunting than those who live in households with proper sanitation. Compared to under-fives living in households with piped water drinking water sources, under-fives who have no access to piped water are at greater risk of being stunted. Besides, the study also shows that consuming boiling water is one way to reduce the possibility of stunting in under five.

The results emphasizes the evidence of previous research which found that poor sanitation and drinking water facilities are contributing factors to stunted growth in children under age five in developing countries. The study also shows that children born with LBW and living in households with poor sanitation have the highest risk of stunting. It is an indication that poor sanitation has exacerbated the impact of LBW on the occurrence of stunting in children under age five.

The acceleration of the provision of proper sanitation and the high quality of the source of protected drinking water needs to be improved. Based on this study, those factors have a significant influence on the low nutritional status of children under age five. It needs to hold public education for the community to get used to cooking or boiling water before consumption, especially if the source of drinking water comes from an unprotected water source. It also needs to raise the awareness of the public to not defecate in the open area because it can be a medium for the spread of diseases.

There is a need to invite the community to be directly involved in creating a clean environment starting from the households in order for the government programs to accelerate and improve the nutritional status of the community more precisely and quickly, especially children as the next generation of the nation. The steps to reduce the prevalence of stunting in children under age five should not only focus on nutrition improvement but also sanitation improvement programs and access to a proper source of drinking water for the communities should remain a focus on health.

For improving this research, it is recommended to use longitudinal data so that the changes in sanitation, water sources, and water treatment status can be detected. So, it shows the effects in detail for each stage of development of children under age five. For IFLS organizers, it is recommended to include the distance between the septic tank and drinking water sources, which is one of the requirements in determining access to appropriate drinking water sources.

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