

8-1-2017

The Association Between Sanitation, Hygiene, and Stunting in Children Under Two-Years (An Analysis of Indonesia's Basic Health Research, 2013)

Lulu'ul Badriyah

Department of Public Health Nutrition, Faculty of Public Health, Universitas Indonesia, Depok 16424, Indonesia, luluulb@gmail.com

Ahmad Syafiq

Department of Public Health Nutrition, Faculty of Public Health, Universitas Indonesia, Depok 16424, Indonesia

Follow this and additional works at: <https://scholarhub.ui.ac.id/mjhr>

Recommended Citation

Badriyah L, Syafiq A. The Association Between Sanitation, Hygiene, and Stunting in Children Under Two-Years (An Analysis of Indonesia's Basic Health Research, 2013). Makara J Health Res. 2017;21.

The Association Between Sanitation, Hygiene, and Stunting in Children Under Two-Years (An Analysis of Indonesia's Basic Health Research, 2013)

Lulu'ul Badriyah*, Ahmad Syafiq

Department of Public Health Nutrition, Faculty of Public Health, Universitas Indonesia, Depok 16424, Indonesia

*E-mail: luluulb@gmail.com

Abstract

Background: This study aims to identify the relationship between sanitation, hygiene, and stunting in children under two-years in Indonesia. **Methods:** This was a cross-sectional study that examined 9,688 children under the age of two. We obtained data from Indonesia's Basic Health Research paper that was released in 2013 and applied multiple logistic regression analysis. The prevalence of stunting amongst children under two-years in 2013 was 33.3%. **Results:** Our analysis showed that stunting is closely related to low birth weight, age, gender, exclusive breastfeeding, socioeconomic status, garbage removal, and waste management. Appropriate sanitation and hygiene had a significant impact on stunting amongst children under two-years in Indonesia, with waste management and low birth weight being the most important indicators. **Conclusions:** Nutrition, socioeconomic status, and a healthy environment are key to ensure children under two-years meet the recommended growth standards.

Keywords: children under two-years, hygiene, sanitation, stunting

Introduction

Childhood stunting is one of the most significant impediments to human development.¹ Stunting is caused by inadequate nutritional intake over an extended period of time from conception until 24 months of age. This period from pregnancy to the child's second birthday is known as 'the 1000 day window of opportunity'.² Stunting can lead to long term implications including diminished cognitive and physical development, lower test performances, lower household expenditure per capita, an increased likelihood of living in poverty, an increased risk of obstructed labour and asphyxia when giving birth, and an increased risk of degenerative diseases such as obesity, diabetes mellitus, heart disease, stroke, hypertension, and cancer.^{1,3,4}

Globally the prevalence of stunting of children under the age of five is very high. In 2015 there were 159 million stunted children under five. It is projected that in 2025 there will be 127 million stunted children under the age of five.⁵ The 2013 Indonesian Basic Health Research reported that the prevalence of stunting was 37.2%, a figure that had increased from 2010 (35.6%) and 2007 (36.8%). There were 14 provinces identified to have a high prevalence of stunting and a further 15 provinces with a very high prevalence.⁶

Whilst inadequate intake of nutrients is a large factor, stunting is also caused by poor hygiene and a lack of

sanitation. Poor hygiene and a lack of sanitation can cause environmental enteropathy, which can increase the permeability of the small intestine to pathogens, and reduce the absorption of nutrients even without manifestations of diarrhoea.⁷ It is predicted that up to 50% of malnutrition is related to repeated diarrhoea or intestinal infection due to a combination of water, sanitation, and hygiene.^{8,9} Research has shown that interventions that focus on changing sanitation and hygiene habits can reduce stunting. Studies have found that sanitation and hygiene interventions that reach 99% of the population can reduce diarrhoea symptoms by 30%, thus lowering the prevalence of stunting by 2-4%.¹⁰

Sanitation and environmental hygiene in Indonesia is an area that requires urgent attention. The 2013 Indonesian Basic Health Research reported that only 59.8% of families had improved sanitation, 12.9% of families did not have appropriate lavatories, and 66.8% of families did not have access to potable water.⁶ This study aims to identify the relationship between sanitation, hygiene, and stunting amongst children under two-years in Indonesia.

Methods

This research paper used a cross-sectional study design and we obtained secondary data from Indonesia's Basic Health Research carried out in 2013. Our sample population included families with children under the age of two from 33 provinces in Indonesia. Indonesia's

Basic Health Research reported that there were 30,801 children under the age of two in 2013, however only 9,688 had complete data. Data used in this research was scrutinised by using a total sampling method and all respondents were required to have complete data.

Stunting. Stunting is a chronic condition caused by under or malnutrition. The WHO's Child Growth Standards states that if a child's height for their age bracket is <-2 standard deviations away from the median they fall within the stunted category.

Sanitation. A water source is the main source for drinking water and this source is considered improved if it comes as prepackaged water, potable tap water, from reputable water supply companies and pumps, protected ground wells, protected springs, and water reservoirs. If a person's main water source comes from tainted tap water, unprotected ground wells, unprotected springs, rivers, lakes, and irrigation systems then it is known as an unimproved water source. The appearance of water is generally a good indicator of its physical quality. If it is tasteless, foamless, colourless, odourless, and clear the water is usually safe for human consumption. The distance between a water source and a possible source of contamination is an important factor of water safety. If the distance is more than 10 m from a potential source of contamination i.e. a septic tank, then it is considered far or safe, however if it is less than 10m it is near or unsafe. Toilet facilities include the location of the lavatory, the type of lavatory used, and the way human waste is disposed of. If a family has access to a toilet and they use latrines and septic tanks they are considered to have improved facilities, however if they have no access to toilet facilities or use shared lavatories they are unimproved facilities. Sewage management is an onsite building used to collect wastewater from showers, washing facilities, and kitchens etc. Sewage management is considered good if there is a covered shelter in the yard, it is considered poor if the shelter is open or outside the yard, on the ground, or it is directed down the drain or river. Waste management is the way a household collects, stores, and disposes of garbage. If a household's rubbish is collected, compostable, or buried in the ground it is acceptable, if the garbage is burnt, thrown into the river, or street then it is considered unacceptable.

Hygiene. Appropriate hand washing with soap prior to eating and food preparation and after using the bathroom is integral to remove bacteria. If a family is using an open area such as a farm, ditch, garden, yard, or body of water as a toilet it is classified as open defecation.

Children characteristics. Data including their age, gender, birth weight, age of initiation of breastfeeding, exclusive breastfeeding experience, and diarrhoea and

upper respiratory tract infection (URTI) history was collected about each child. Their birth weight was obtained from official birth documents and information about the initiation of breastfeeding and exclusive breastfeeding gathered through interviews with their Mothers. A doctor evaluated past experience of diarrhoea and URTI if they had experienced symptoms in the last month.

Family characteristics. Family characteristics including the mother's height, employment status, and education level were gathered, as well as the number of family members and their socioeconomic status. This study used categories from previous research papers that defined a mother with a height of less than 150cm as short.¹¹

Data analysis. Data used in this research was analysed using a statistic software, SPSS version 16.0. The data analysis was completed using a bivariate analysis and multiple logistic regressions.

Results

Results showed that 33.3% of Indonesian children aged under two-years suffered from some degree of stunting. 9.7% of families studied used unimproved water sources, 5.4% of families used poor quality water, 17.4% had their main water sources close to a potential source of contamination, and only 1.2% of families had their main water source far from a potential source of contamination. Additionally, 33.1% of families no septic tank or were using an unimproved one, 83.5% had poor sewage management, 66.6% had poor waste management, 32.1% used no soap to wash their hands, and 12.9% still practiced open defecation (Table 1).

Based on the analysis of the characteristics of the children, we found that 57.8% of subjects under two-years had some form of stunting, with 51.4% of those children being male. Furthermore, 6.4% of children had a low birth weight, 39.2% did not benefit from early initiation of breastfeeding, and 69.9% children did not experience exclusive breastfeeding. Alarmingly, 11% of children studied experienced diarrhoea and 26.3% experienced URTI's in the last month. Upon further analysis of family characteristics it was found that 30.9% of mothers were classified as short, 7.0% did not have a proper education, 35.8% were working mothers, and 5.5% of families had over 8 members.

The bivariate analysis showed that there was a significant association between water source, toilet use, and sewage and waste management with childhood stunting. The odds ratio (OR) between stunting and improved water sources was 1.18 (95% CI, 1.02-1.36), and the OR between stunting and unimproved water sources was 1.33 (95% CI, 1.22-1.45). Furthermore, the OR between stunting and poor sewage management was 1.15 (95% CI, 1.02-1.30), and between stunting and bad waste

Table 1. Univariate Analysis Result

Variable	Sum (n = 9688)	Percentage (%)	Variable	Sum (n = 9688)	Percentage (%)
Nutritional Status			URTI		
Stunting	3229	33.3	Yes	2552	26.3
Normal	6459	66.7	No	7137	73.7
Water Source			Height of Mother		
Unimproved	944	9.7	Short	2997	30.9
Improved	8744	90.3	Tall	6691	69.1
Physical Quality of Water			Mother's Level of Education		
Bad	9168	94.6	No school	679	7.0
Good	520	5.4	Primary school	2147	22.2
Distance to Source of Contamination			Junior high school	2184	22.5
Near	1689	17.4	Senior high school	3343	34.5
Far	7999	82.6	University	1335	13.8
Distance to Water Source			Employment Status of Mother		
Far	112	1.2	Employed	3464	35.8
Near	9576	98.8	Unemployed	6224	64.2
Toilet Facilities			Socioeconomic Status		
None/Unimproved	3209	33.1	Quintile 5	2562	24.6
Improved	6479	66.9	Quintile 4	2463	25.4
Sewage Management			Quintile 3	1995	20.6
Bad	8090	83.5	Quintile 2	1607	16.6
Good	1598	16.5	Quintile 1	1061	11.0
Waste Management			Number of Family Members		
Bad	6448	66.6	≥8 members	535	5.5
Good	3240	33.4	5-7 members	4530	46.8
Handwashing			2-4 members	4623	47.7
No	3110	32.1			
Yes	6578	67.9			
Open Defecation					
Yes	1248	12.9			
No	8440	87.1			
Age					
12-23 months	5598	57.8			
6-11 months	2661	27.5			
0-5 months	1429	14.8			
Gender					
Female	4713	48.6			
Male	4975	51.4			
Birth Weight					
Low birth weight	616	6.4			
Normal	9072	93.6			
Early Initiation of Breastfeeding					
No	3793	39.2			
Yes	5895	60.8			
Exclusive Breastfeeding					
No	6771	69.9			
Yes	2917	30.1			
Diarrhoea					
Yes	1068	11.0			
No	8620	89.0			

management it was 1.33 (95% CI, 1.22-1.46). Additionally, there was a significant association between stunting and handwashing using soap with an odds ratio of 1.11 (95% CI, 1.01-1.21), and between stunting and open defecation, with an odds ratio 1.40 (95% CI, 1.23-1.57) (Table 2).

Bivariate analysis showed that children who were more likely to suffer from stunting were those aged under two-years (OR 1.63, 95% CI, 1.44-1.86), male (OR 1.18, 95% CI, 1.09-1.29), had a low birth weight (OR 2.10, 95% CI, 1.71-2.38), were exclusively breastfed (OR 0.82, 95% CI, 0.75-0.90), had a mother of short stature (OR 1.44, 95% CI, 1.31-1.57), or a mother with a low level of education (OR 1.51, 95% CI, 1.24-1.83), and those whose family was in quintile 1 (OR 1.78, 95% CI, 1.53-2.06) (Table 2).

Results from the multivariate analysis clearly identified that families who practiced poor waste management (i.e. burnt, disposed of in a ditch or the river) were at a higher risk of having a stunted child (OR 1.17, 95% CI, 1.05-1.29), when compared with families who managed their waste well (i.e. removed by a cleaning service, composted or buried). Additionally, results show that there are many factors that affect childhood stunting such as age, gender, exclusive breastfeeding, birth weight, mother's height, and socioeconomic status.

Table 2. Bivariate and Multivariate Analysis Results

Variable	Crude Odds Ratio	95% CI	Adjusted Odds Ratio	95% CI
Water Source				
Unimproved	1.18*	1.02-1.35	0.96	0.83-1.12
Improved	1		1	1
Physical Quality of Water				
Bad	1.01	0.84-1.22	1.16	0.96-1.41
Good	1		1	1
Distance to Source of Contamination				
Near	1.02	0.92-1.14	0.97	0.87-1.08
Far	1		1	1
Distance to Water Source				
Far	1.11	0.75-1.64	1.00	0.67-1.49
Near	1		1	1
Toilet Facilities				
None/Unimproved	1.33*	1.22-1.45	1.05	0.67-1.49
Improved	1		1	1
Sewage Management				
Bad	1.15*	1.02-1.30	1.01	0.92-1.19
Good	1		1	1
Waste Management				
Bad	1.34 *	1.22-1.46	1.17*	1.05-1.29
Good	1		1	1
Hand Washing				
No	1.11 *	1.01-1.21	1.03	0.94-1.13
Yes	1		1	1
Open Defecation				
Yes	1.39*	1.23-1.57	1.02	0.86-1.19
No	1		1	1
Age				
12-23 months	1.63*	1.43-1.86	1.55*	1.35-1.77
6-11 months	1.06*	0.92-1.22	0.99	0.86-1.16
0-5 months	1		1	1
Gender				
Male	1.18*	1.09-1.29	1.22*	1.12-1.33
Female	1		1	1
Birth Weight				
Low birth weight	2.01*	1.71-2.38	2.03*	1.72-2.41
Normal	1		1	1
Early Initiation of Breastfeeding				
No	0.99	0.90-1.07	0.98	0.89-1.08
Yes	1		1	1
Exclusive Breastfeeding				
No	0.82*	0.75-0.90	0.87*	0.79-0.96
Yes	1		1	1
Diarrhoea				
Yes	1.10	0.97-1.27	1.02	0.89-1.17
No	1		1	1
URTI				
Yes	1.08	0.98-1.190	1.03	0.93-1.14
No	1		1	1

Table 2. Bivariate and Multivariate Analysis Results (continued)

Variable	Crude Odds Ratio	95% CI	Adjusted Odds Ratio	95% CI
Height of Mother				
Short	1.44*	1.31-1.57	1.36*	1.24-1.49
Tall	1		1	1
Employment Status of Mother				
Employed	1.00	0.96-1.14	1.09	0.99-1.19
Unemployed	1		1	1
Mother's Level of Education				
No school	1.51*	1.24-1.84	1.17	0.95-1.45
Primary school	1.15*	1.27-1.70	1.19	1.00-1.41
Junior high school	1.30*	1.13-1.51	1.14	0.96-1.34
Senior high school	1.08	0.94-1.24	1.03	0.88-1.19
University	1		1	1
Socioeconomic Status				
Quintile 1	1.78*	1.53-2.06	1.37*	1.09-1.71
Quintile 2	1.50*	1.31-1.71	1.22*	1.03-1.45
Quintile 3	1.28*	1.13-1.14	1.12	0.96-1.34
Quintile 4	1.19*	1.05-1.34	1.12	0.88-1.19
Quintile 5	1		1	1
Number of Family Members				
≥ 8 members	1.096	0.91-1.32	1.06	0.87-1.28
5-7 members	1.086	0.99-1.19	1.08	0.98-1.18
2-4 members	1		1	1

* $p < 0.05$ p -values

Children under two-years had a higher risk of stunting (OR 1.55, 95% CI, 1.35-1.77) when compared with children aged under five months and males were more likely to be affected by stunting (OR 1.22, 95% CI, 1.72-2.41). Children under two-years who had a low birth weight were more prone to stunting with an OR of 2.03 (95% CI, 1.72-2.41). The OR of mother's of short stature with stunted children was 1.36 (95% CI, 1.24-1.49), and 1.37 (95% CI, 1.09-1.71) for families in quintile 1 for socioeconomic status. Interestingly, results found that children who were not exclusively breastfed were less likely to suffer from stunting (adjusted OR 0.87, 95% CI, 0.79-0.96).

Discussion

Results from this study found that the prevalence of stunting in the sample population was 33.3%. This result is consistent with data from The Indonesian Basic Health Research Report in 2013 that found the prevalence was 32.9%, however other research conducted in three other provinces of Indonesia place the figure at 28.4%.^{6,12}

After adjusting for variables, we found that sanitation, waste management, and hygiene had a direct relation with stunting prevalence. Families with poor waste management were 1.17 times more likely to have children who suffer

from stunting (95% CI, 1.05-1.29) when compared with families who practiced safe waste management. These findings are consistent with research carried out in Brazil that found that children who had little access to waste collection services in their villages had a higher stunting prevalence. The Brazilian study found that children with limited access to waste collection were 2.55 times more likely to suffer from stunting and 2.74 times more likely to be underweight when compared with children with good access to waste collection services.¹⁵ Poor waste management can increase bacteria and vermin levels which can lead to environmental enteropathy. Other sanitation and hygiene factors such as water source, water quality, distance of water potential contamination, distance to water source, toilet use, sewage management, handwashing with soap, and open defecation were not categorised as factors that trigger stunting, a result that is different to previous research.¹⁴⁻¹⁸

Several recent studies of stunting in Indonesia did not include sanitation and hygiene variables however Torlesse *et al.* did analyse these variable to identify possible effects on stunting in children in Sikka, Jayawijaya, and Klaten.^{19,20} Their results showed that handwashing with soap and water source had no relation to stunting in children under two-years, however they did find an interaction between water management and toilet use.

Additionally, families who consumed unboiled water were 3 times more likely to have stunted children than families who used unimproved lavatories.¹²

Interestingly, results from another research project found that children who had easy access to potable water and proper waste management were 1 cm taller than children without access.²¹ Further research in Ethiopia showed that respondents who consumed water from an unimproved source were 3.82 times more likely to suffer from stunting.¹⁴ Similar research in Vietnam also showed that use of an unimproved lavatory resulted in children 3.7 cm shorter than children with improved lavatories.²² Literature also shows that repeated faecal cross-contamination causes environmental enteropathy, that can increase the permeability of the small intestine towards pathogens, and decrease nutritional absorption which can lead to malnutrition and stunting even without diarrhoea.^{7,17}

Personal hygiene has also been cited as a factor in childhood stunting, with one study finding that mothers who did not wash their hands before eating were 1.18 times more likely to have underweight children (95% CI, 1.05-1.32) and also 1.18 times more likely to have stunted children (95% CI, 1.04-1.34).¹⁸ Moreover, improper defecating practices in India have also been noted as a triggering factor of childhood stunting even with variables such as a higher socioeconomic status.¹⁷

This research paper found a connection with age, gender, birth weight, exclusive breastfeeding, mother's height, and socioeconomic status to childhood stunting. These were similar results to other studies that found stunting prevalence increased along with the child's age, was more likely to affect males, and research in Brazil found a correlation between low birth weight and stunting.^{13,15,17} This study found that there was an inverted relationship between exclusive breastfeeding and stunting. This may have occurred because of the quality and quantity of breastfeeding. Mothers who suffer from undernutrition have lower fat stores, which can affect her ability to breastfeed, they also have a lower volume of breast milk and her protein and energy levels will be significantly lower than mothers with proper nutrition.²³ As such the nutritional status of lactating mothers has a critical role toward exclusive breastfeeding success.

Result from this analysis also showed that there was a relationship between the mother's height and potential stunting of her offspring. A study in India reported similar results with mothers who were under 150 cm tall were 2.22 times more likely to have stunted children.²⁴ Additionally, this study found that there was a significant relationship between socioeconomic status and childhood stunting. Other research carried out in Indonesia also found a link between lower socioeconomic status and increased stunting in children.^{12,20}

There were some limitations of this study as there were certain factors that could not be quantified. Firstly, the cross-sectional study design could not explain the causal effect between stunting and other variables. Secondly, because of limited data from the 2013 Indonesian Basic Health Research only some variables could be elaborated on, such as the absence of complimentary foods given to exclusively breastfed children which influenced their nutrition status.³ There was also missing or incomplete data in the 2013 Indonesian Basic Health Research. Thirdly, water quality was not tested thoroughly in a laboratory but rather by sight and smell. Finally, reporting of early initiation of breastfeeding and exclusive breastfeeding may also be viewed as a biased variable due to the respondent's ability to recall the data properly. Despite these limitations, this study was able to show a relationship between multiple factors and child stunting including nutrition, socioeconomic status, education level, waste management, sanitation, and hygiene. However, the major result of this research was the finding of low birth weight being the primary triggering factor of stunting in children under two-years in Indonesia.

Conclusions

Nutrition, socioeconomic status, and a healthy environment are key to ensure children under two-years meet the recommended growth standards. Intervention to reduce childhood stunting needs to be multifactorial and include education about nutrition and a healthy environment regardless of socioeconomic status.

Conflicts of Interest Statement

The authors have no conflicts of interest to declare.

References

1. World Health Organization. *Global Nutrition Targets 2025: Stunting Policy Brief*. Geneva: World Health Organization, 2014.
2. Bloem MW, de Pee S, Hop LT, Khan NC, Laillou A, Minarto, *et al.* Key strategies to further reduce stunting in Southeast Asia: lessons from the ASEAN countries workshop. *Food Nutr Bull*. 2013;34(2 Suppl):S8-16.
3. Stewart CP, Iannotti L, Dewey KG, Michaelsen KF, Onyango AW. Contextualising complementary feeding in a broader framework for stunting prevention. *Matern Child Nutr*. 2013;9:27-45.
4. Black RE, Victora CG, Walker SP, Bhutta Z, Christian P, de Onis M, *et al.* Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*. 2013;382:427-51.
5. UNICEF-WHO-World Bank. WHO. *Joint child malnutrition estimates-Levels and trends*. New York: UNICEF-WHO-World Bank, 2015.
6. Kemenkes RI. *Riset Kesehatan Dasar*. Jakarta: Kemenkes RI, 2013.

7. Humphrey JH. Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet Lond Engl.* 2009;374:1032-5.
8. Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, Colford JM. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis.* 2005;5:42-52.
9. Prüss-Üstün A, Bos R, Gore F, Bartram J. *Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health.* Geneva: World Health Organization, 2008.
10. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. *Lancet Lond Engl.* 2008;371:417-40.
11. Nadiyah N, Briawan D, Martianto D. Faktor Risiko Stunting Pada Anak Usia 0-23 Bulan Di Provinsi Bali, Jawa Barat, Dan Nusa Tenggara Timur. *Jurnal Gizi dan Pangan.* 2014;9:125-32.
12. Torlesse H, Cronin AA, Sebayang SK, Nandy R. Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health.* 2016;16:669.
13. Horta BL, Santos RV, Welch JR, Cardoso AM, dos Santos JV, Assis AMO, et al. Nutritional status of indigenous children: findings from the First National Survey of Indigenous People's Health and Nutrition in Brazil. *Int J Equity Health.* 2013;12:23.
14. Gebregyorgis T, Tadesse T, Atenafu A. Prevalence of Thinness and Stunting and Associated Factors among Adolescent School Girls in Adwa Town, North Ethiopia. *Int J Food Sci.* 2016;2016
15. Haile D, Azage M, Mola T, Rainey R. Exploring spatial variations and factors associated with childhood stunting in Ethiopia: spatial and multilevel analysis. *BMC Pediatr.* 2016;16:49.
16. Checkley W, Gilman RH, Black RE, Epstein LD, et al. Effect of water and sanitation on childhood health in a poor Peruvian peri-urban community. *The Lancet.* 2004; 363:112-8.
17. Spears D. How Much International Variation in Child Height Can Sanitation Explain? The World Bank; 2013. p. 55.
18. Meshram II, Kodavanti MR, Chitty GR, Manchala R, Kumar S, Kakani SK, et al. Influence of Feeding Practices and Associated Factors on the Nutritional Status of Infants in Rural Areas of Madhya Pradesh State, India. *Asia Pac J Public Health.* 2015;27:NP1345-61.
19. Semba RD, Pee S de, Sun K, Sari M, Akhter N, Bloem MW. Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. *The Lancet.* 2008;371:322-8.
20. Ramli, Agho KE, Inder KJ, Bowe SJ, Jacobs J, Dibley MJ. Prevalence and risk factors for stunting and severe stunting among under-fives in North Maluku province of Indonesia. *BMC Pediatr.* 2009;9:64.
21. Arnold BF, Null C, Luby SP, Unicomb L, Stewart CP, Dewey KG, et al. Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits study design and rationale. *BMJ Open.* 2013;3:e003476.
22. World Bank. *Investing in the next generation children grow taller, and smarter, in rural, mountainous villages of Vietnam where community members use improved sanitation.* WSP - World Bank, 2014.
23. Fikawati S, Syafiq A, Karima K. *Gizi ibu dan bayi.* Jakarta: Raja Grafindo Persada; 2015. (In Indonesian).
24. Rah JH, Cronin AA, Badgaiyan B, Aguayo VM, Coates S, Ahmed S. Household sanitation and personal hygiene practices are associated with child stunting in rural India: a cross-sectional analysis of surveys. *BMJ Open.* 2015;5.