

Water Quality is Associated with A Very Strong Correlation between Diarrhea and Childhood Stunting: A Meta-Analysis of Prevalence Data from 34 Provinces in Indonesia

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Abstract:

Background: Today, 36% of children under the age of five in Indonesia are being stunted. Many programs have been applied to solve this problem. But among all, diarrhea seems to have escaped attention as an important factor contributing to stunting rates. Even though nutrition sensitive intervention (diarrhea is one of its contributors) has higher contribution than nutrition specific intervention to stunting. Therefore, this study aims to investigate the correlation between diarrhea and stunting incidence that would be used as reference data for planning future health programs on reducing stunting in Indonesia.

Materials and Methods: This is a descriptive study, by using the data on cases of diarrhea and stunting in Indonesia for two years (2016-2017). The data of diarrhea and stunting were obtained from the Information Center of the Ministry of Health of the Republic of Indonesia. Meanwhile the data of river water conditions in Indonesia was obtained from the Ministry of Environment of the Republic of Indonesia. The t-test was used to measure the correlation between diarrhea cases and stunting.

Results: The result revealed that diarrhea's incidence has an overlapping pattern with stunting rates in Indonesia. Furthermore, the result revealed that majority of stunted children lived in areas with low river water quality index. This study showed a very strong correlation between diarrhea and stunting in Indonesia. This study also found that water quality might contribute to diarrhea cases in Indonesia.

Conclusion: All results emphasize that early prevention and treatment of diarrhea cases should be the first approach to reduce stunting cases especially in Indonesia.

Key Word: Stunting; Diarrhea, Water Quality Index

Date of Submission: 14-01-2020

Date of acceptance: 01-02-2020

I. Introduction

Indonesia is on the fifth rank for stunting number in the world. World Bank released the data that 37% of Indonesian children under 5 years of age were stunted in 2013. Previous reports showed that growth failure in the first 2 years of life associated with stunting in adulthood. (Coly et al., 2006; Stein et al., 2010) Moreover for women, stunting of mothers is known to be a consistent risk factor for perinatal and neonatal deaths. (Lawn JE1, Cousens S, 2005; Özaltın Emre, Hill Kenneth, 2010) There should be a significant concern and efforts on reducing stunting rate, because besides increasing the risk of death, stunting also gives short-term and long-term effects on human life. Short-term effects of stunting include disorders of cognitive, motor, and language development, while the long-term effects of stunting include general poor health, reduced work capacity and productivity academically or career-wise. On a national scale, the data from the Ministry of Health of the Republic of Indonesia in 2017 revealed that the average incidence of stunting for children under the age of 24 months is around 22% in each province. (K. K. R. Indonesia, 2018) Of all the provinces in Indonesia, West Java is the largest contributor to national stunting number, namely 161,190 from 954,834 children under the age of 24 months, roughly around 17%. This number has increased by 5% compared to the previous year. (K. K. R. Indonesia, 2018)

On the other hand, the Indonesian government has carried out continuing programs to improve this situation. However, these programs have not significantly affected on stunting reduction. The Indonesian Ministry of Health stated that specific nutrition interventions in the health sector could only contribute to 30% of stunting cases, while 70% were attributed by sensitive nutrition intervention involving various sectors, including the availability of clean water and sanitation. For instances in West Java province-the Health Department of

West Java province-has improved the health status of infants and pregnant women for specific nutritional interventions. This program succeeded in improving the nutritional status of children in West Java above the national average. In addition, the local government has brought the West Java province to be in the high category indicated by its Human Development Index (HDI) on other health supports, such as in personal level. At the household level, as indicated by the sanitation indicator number of 64%, West Java settled the national average, although there remained a challenge to improve it. Likewise, the health services in West Java was increasing and was already above the national average.(Barat, 2017)These data above showed that there were other factors that could influence the high number of stunting cases. Unfortunately, specific nutritional intervention has not integrated yet in whole program on stunting reduction.

Research in 20 countries in the world revealed that a higher cumulative burden of diarrhea increases the risk of stunting.(Checkley et al., 2008) On the contrary, other studies showed that the effects of diarrhea seemed to be temporary, because the children were able to recover from their growth deficits.(Desmond & Casale, 2017)These data suggested that children in developing countries experienced malnutrition due to low food intake and not because of the high pressure of diarrhea. A new study is needed to see which one of the aforementioned features applied to Indonesia, especially in West Java province.

The effect of diarrhea on stunting at least is divided into three categories. First, diarrhea affects nutritional status, especially in stunted children. Second, diarrhea is a risk factor. Third, proper food intake therapy for patients during and after infection. (Brown, 2003) Therefore, controlling disease through reducing the burden of malnutrition in children in developing countries is at the heart of this controversy. For this reason, a better understanding of the relationship between diarrhea and stunting will help shaping the future disease control programs on stunting prevention.(Checkley et al., 2008) A good and fitting programs will give better hope for stunting reduction in Indonesia. Therefore, this study aims to investigate the correlation between diarrhea and stunting cases in Indonesia and other factors that influencing it. The result of this study could be a starting reference to be used in planning further investigations and creating preventive health program on stunting.

II. Material And Methods

Study Design:The study used stunting datasets from 34 provinces in Indonesia. These two years data of stunting is the only available data. The data is displayed in stunting percentages on children aged 0-23 month in each province. Then, the data was processed so that it can display on the number of stunting cases per province. By using the number of babies born in 2016 and 2017 in each province, the number of childhood stunting cases in each province is obtained. Then, the number of stunting cases were analyzed to show the trends across the years and for different provinces. After that, we analyze the pattern similarity of stunting and diarrhea incidence per province in the same year. Analysis of pattern similarity was also carried out in the incidence of diarrhea and water quality index in each province.

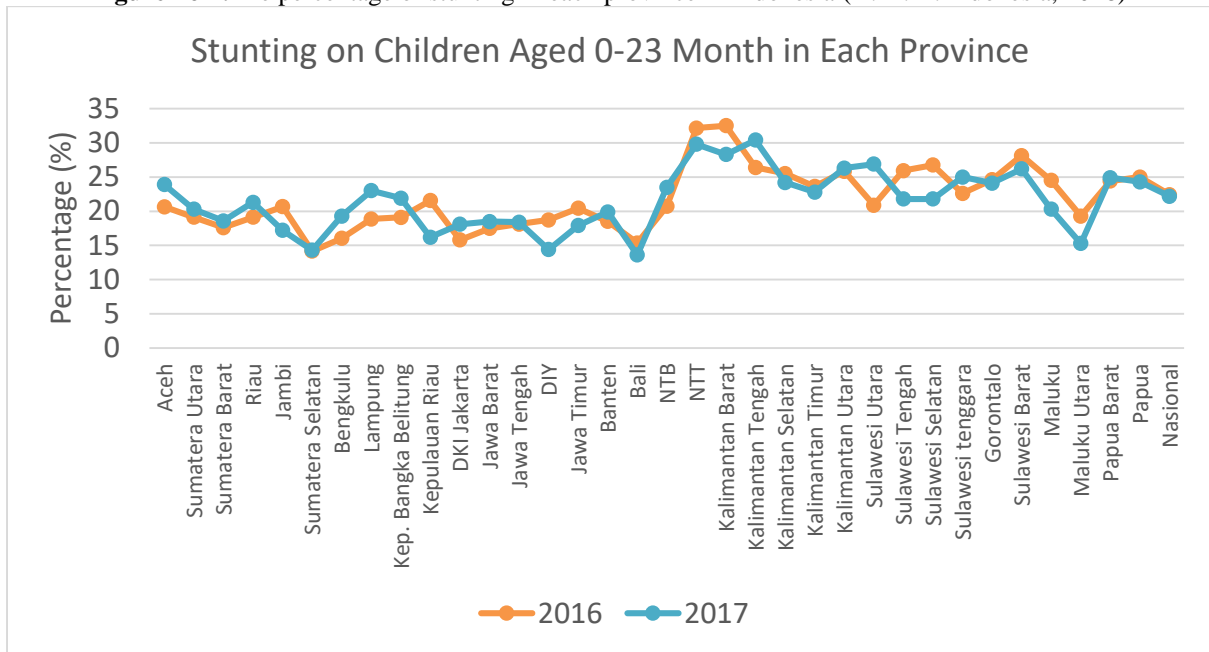
Data Sources:The only available data on stunting cases was from the Information center of the Ministry of Health of the Republic of Indonesia, from 2016 to 2017.(K. K. R. Indonesia, 2017, 2018) Stunting data was published by the Indonesian Ministry of Health in the form of a percentage of children below 24 month per province. The data of diarrhea incidence was also obtained from the Information center of the Ministry of Health of the Republic of Indonesia (2016-2017).(K. K. R. Indonesia, 2017, 2018) Meanwhile, data on river water conditions in Indonesia was obtained from the Ministry of Environment. (K. L. H. & K. R. Indonesia, 2017)

Data Analysis: The study employed descriptive analysis to explore the patterns of stunting and diarrhea cases in 2 years (2016-2017). The same analysis was also applied to diarrhea incidence and water quality index in each provinces. The t-test was used to see the correlation between diarrhea cases and stunting.

III. Result

The Indonesian Ministry of Health displayed stunting data in a percentage of stunting per province (Figure 1). This figure was not enough to reveal important factors that affect stunting cases. The result only encourages efforts to carry out specific nutrition interventions, which directly targeted nutritional intake for mothers and children rather than targeting the sensitive nutrition intervention which in reality has 70% contribution for stunting. However, we have processed the data employing the number of childhoods stunting per province in 2016 and 2017. This way, the relationship between stunting and sensitive nutritional factors can be revealed.

Figure no 1:The percentage of stunting in each province in Indonesia (K. K. R. Indonesia, 2018)



The results showed a striking similar pattern of diarrhea's incidence and stunting cases in 2016 and 2017 (Figure 2 and Figure 3), where the high number of diarrhea cases was found to be in accordance with the high number of stunting cases. Vice versa, the low number of diarrhea cases was found in accordance with low number of stunting cases.

Figure no2:The pattern of diarrhea and stunting cases in Indonesia on 2016

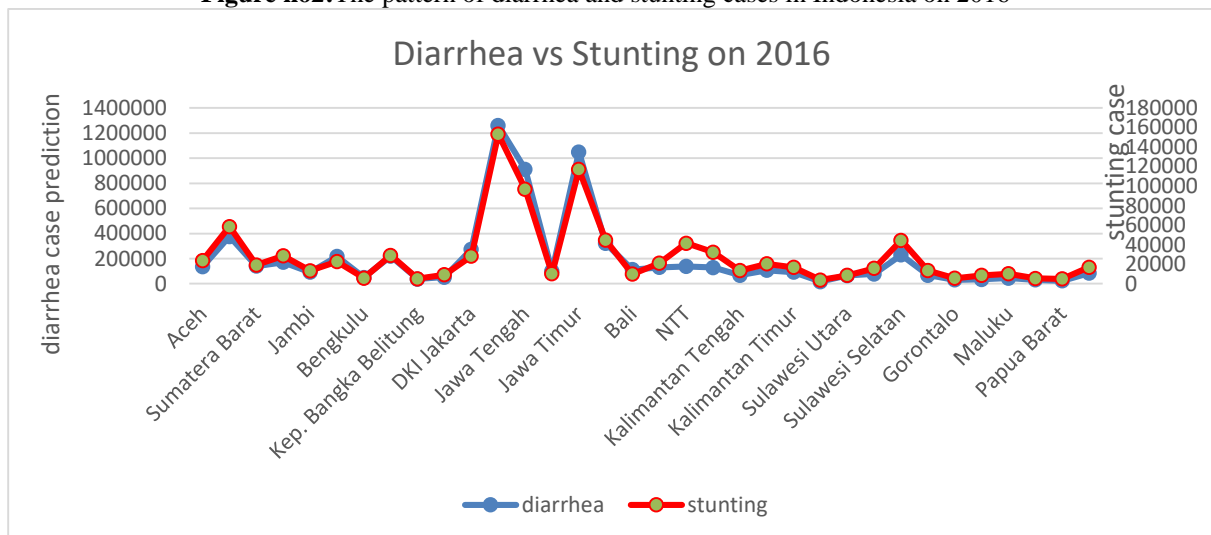
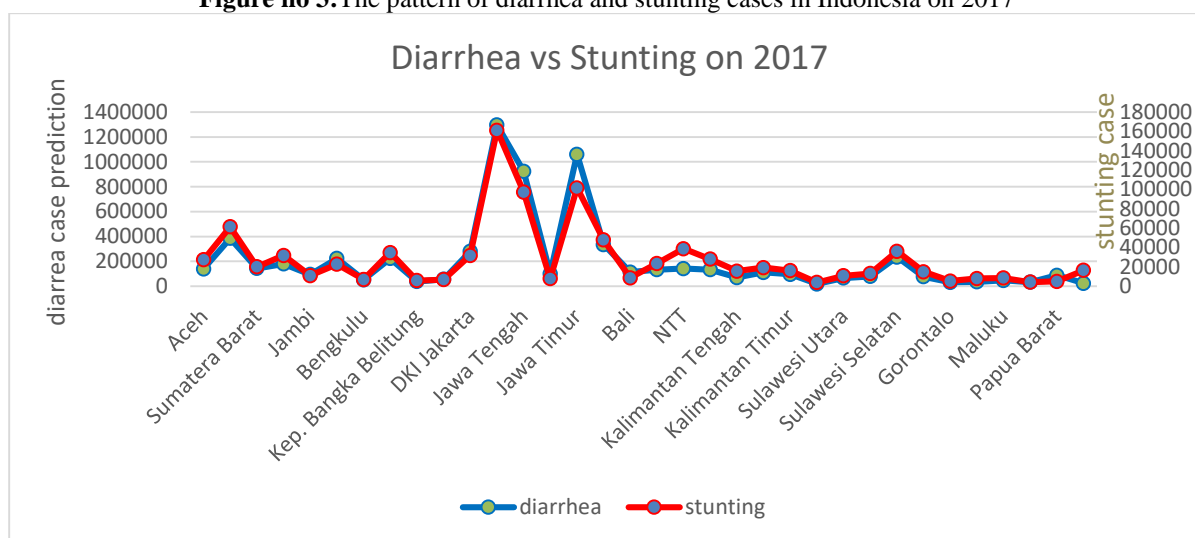


Figure no 3:The pattern of diarrhea and stunting cases in Indonesia on 2017



Further analysis revealed that there was a strong positive correlation between stunting and diarrhea cases (Table 1). This result indicated that diarrhea cases had a strong influence on stunting cases in Indonesia, at least in year 2016 and 2017. This confirmed other studies showing that diarrhea associated with stunting in children.(Checkley et al., 2008; Vonaesch et al., 2017) Our result also reinforced WHO recommendations about infectious diseases (in this case diarrhea) as a part of focus for reducing stunting rates.(WHO, 2018) It is well-known that the infectious diseases interfere with nutritional status, such as the loss of appetite, impaired intestinal absorption, and shifting energy used from growth to immune responses. Moreover, malnutrition increases the risk of infection due to its negative impact on the epithelial barrier function and loss of the immune response.(Scrimshaw N.S., 1968; Solomons, 2007)

Table no1: t-test result of diarrhea and stunting cases in 2016-2017

Year	2016	2017
Number of provinces	34	34
Pearson Correlation	0,98	0,97
t count	3,93	3,97
P	0,0002	0,00019
t table	1,69	1,69

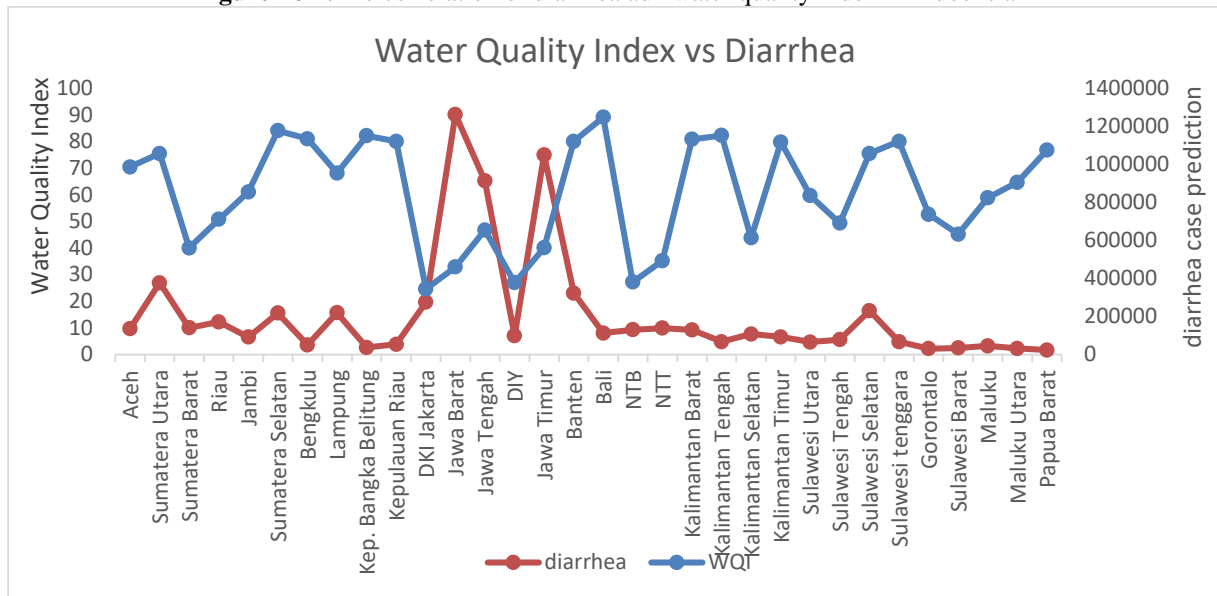
After showing a correlation between stunting and diarrhea cases, the next question was what kind of sensitive nutrition interventions that contributed to increasing stunted growth or diarrhea incidence. It is known that various sectors involved in sensitive nutrition interventions, including the access to clean water and sanitation. Environmental factors that have a large role in the availability of clean water and sanitation are river water quality. Therefore, further analysis was carried out to find whether and how far river water conditions could contribute to diarrhea cases in Indonesia. River water conditions were represented by Water Quality Index (WQI), where its determination employed the river water pollution index method. The river water pollution index provides information on the water body quality and their suitability using Total Suspended Solid (TSS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total of Phosphate, Fecal Coli, and Coliform parameters.(K. L. H. & K. R. Indonesia, 2017) Water quality criteria was obtained from guidelines for determining water quality status which was released by the ministry of Environment and Forestry of Indonesia in 2003 and 2017, is illustrated in table 2.(K. L. H. & K. R. Indonesia, 2017; T. M. of E. of Indonesia, 2003)

Table no 2: Water Quality Criteria

WQI	Water Pollution Index (Pli)	Description
100	$0 \leq Pli \leq 1$	Meet the requirements of water quality
80	$1 \leq Pli \leq 4.67$	Mild pollutant
60	$4.67 \leq Pli \leq 6.32$	Mild to moderate pollutant
40	$6.32 \leq Pli \leq 6.88$	Moderate pollutant
20	$Pli > 6.88$	Moderate to high pollutant

The result showed that the highest number of sufferers lived in the areas with high levels of river water pollution (Figure 4). Three provinces in Indonesia with the highest estimated cases of diarrhea (West Java, Central Java, and East Java) resided in the areas with low water quality levels, with an average of index number 39.89 (Figure 4). Meanwhile, other provinces with lower cases of diarrhea are in areas with higher water quality levels with an average of 58 for the index number (Figure 4). This result showed that a province's river water quality seemed to be an important contributor to its high stunting cases in Indonesia. This was in line with recent study suggesting that poor water quality gave significant effect on child growth.(Cumming & Cairncross, 2016)

Figure no 4:The correlation of diarrhea adn water quality index in Indoensia



The Citarumriver, the largest river in West Java, is a good example for further investigation. Over the past 20 years, the water quality of the Citarum River has dropped dramatically; Biological Oxygen Demand (BOD) value is nine times the normal standard, fecal coliform numbers in several locations are more than 5,000 times.(WordBank, 2013) The presence of coliform bacteria is known to cause nausea, vomiting, and bloody diarrhea, especially among infants and those with a compromised immune system.(Joshi & Sati, 2011; Tyagi et al., 2013) Besides bacteria, viruses and parasites also play a role in the spread of waterborne diseases including diarrhea. Dirty water is a source of developing parasites which will increase the risk of infection for people living in the area. This infection will divert the energy for body growth towards fighting infection that in turn could contributes to an increased risk of stunting. As with children below 5 years of age, results indicate that adequate drinking water treatment is the only important predictor of diarrhea in children below 2 years of age.(Sinharoy et al., 2016)

IV. Discussion

The study provided analysis the correlation of stunting, diarrhea incidence, and water quality from 2 year available data from 34 provinces in Indonesia. The insights from the study identified key determinants of stunting reduction among children below 23 month of age in Indonesia. It has also added the knowledge on the importance of infection diseases (in this case: diarrhea) and the quality of river which is corroborated by other studies that the burden of infection diseases and poor water quality can greatly affect to the height of stunting case. (Bukusuba, Kaaya, & Atukwase, 2017; Cumming & Cairncross, 2016; Israul & Hera, 2018; Null et al., 2018) Generally, the finding indicated that childhood diarrhea that might predispose them to get health problems especially stunting.(Danaei et al., 2016; Paudel, Pradhan, & Pahari, 2012) Moderate to high pollutant of river in a population make them vulnerable to get diarrhea.(Cabral, 2010; Garg, Hamilton, Hochard, Plous, & Talbot, 2018; Guzman-otazo et al., 2019; Pandey, Kass, Soupir, Biswas, & Singh, 2014; Wen, Schoups, & Giesen, 2017) Therefore, reducing stunting program which is focus on the reduction of diarrhea and the improvement of water quality index are important. The study concludes that the significant positive association between diarrhea and childhood stunting that could be maximized for policy formulation on stunting reduction. Since majority of diarrhea incidence are in area with lower quality of water, it could imply that the improvement of water quality would help in reducing stunting. The findings from this study could be explored for policy and program to against childhood stunting. It is very crucial to do further investigation related to the agents of diseases that lurk in water sources surrounding the stunted person, such as the river, ground and drinking water. However, this

study is not without some limitations. Available data of this study are not differentiated based on the cause of diarrhea, whether related to specific nutritional interventions or sensitive nutritional interventions. Therefore, further studies on how diarrhea can affect stunting are still needed, including whether diarrhea could directly affect nutritional status of children aged 0-23 month, or whether diarrhea is a risk factor for malnutrition, or whether a problem in food intake therapy for patients during and after infection has happened. Further investigation is also needed to understand whether the effect of stunting is temporary or it settles at the later stage of age.

V. Conclusion

This study revealed a strong correlation between diarrhea and stunting in Indonesia, as shown by similar patterns between stunting rates and diarrhea cases in 2016-2017. In addition this study found that river water quality might contribute to the high incidence of diarrhea in Indonesia. The results of this study emphasize that early prevention and treatment of diarrhea cases should be the first approach to reduce stunting cases, although this yet to be proven. While this study opens new hopes for better stunting prevention programs in Indonesia, new challenges appear on proving the direct correlation between stunting and the history of diarrhea for children aged 0-23 month. Further study of parasitic agents associated with diarrhea at local water sources is strongly needed.

VI. Acknowledgment

The authors would like to humbly acknowledge the Directorate of Research and Community Service of Universitas Padjadjaran and the West Java Provincial Health Office of Indonesia for supporting this research.

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Hesti L. Wiraswati, etal. “Water Quality is Associated with A Very Strong Correlation between Diarrhea and Childhood Stunting: A Meta-Analysis of Prevalence Data from 34 Provinces in Indonesia”. *IOSR Journal of Nursing and Health Science (IOSR-JNHS)*, 9(01), 2020, pp. 10-16.