THE CORRELATION BETWEEN HEALTHY HOUSES AND ACCESS TO SAFE DRINKING WATER WITH THE INCIDENCE OF DIARRHEA IN EAST JAVA IN 2016

Siti Fera Irawati[1], Arief Wibowo[1]
[1]Department of Biostatistics and Population,
Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia
Correspondence Address: Siti Fera Irawati
Email: irawatifera@yahoo.com

ABSTRACT
Diarrhea is a common endemic disease in Indonesia. In developing countries, the high prevalence of diarrhea can be attributed to the lack of clean water and proper sanitation. This study determined a correlation between access to safe drinking water and healthy houses with the incidence of diarrhea in East Java in 2016. The study applied a correlation study design. The population consisted of all diarrhea patients treated in East Java in 2016; thus, the population was used also as a sample. The data were obtained from secondary data, namely the 2016 East Java Provincial Health Profile. Pearson correlation test was used in analyzing the data. There was a correlation between healthy homes (p = 0.000) and sustainable access to safe drinking water (p = 0.000) with the incidence of diarrhea. Pearson correlation coefficient for the healthy house variable was 0.798, while the Pearson correlation coefficient for sustainable access to safe drinking water was 0.722. It can be concluded that the relationship between healthy homes and access to safe drinking water with the incidence of diarrhea in the Province of East Java in 2016 was strong enough.

Keywords: diarrhea, healthy houses, access to safe drinking water.

INTRODUCTION

Diarrhea is the dominant cause of pain and death among children (Yu, Lougee, and Murno, 2017). Globally about 1.7 billion children suffer from diarrhea; as many as 525,000 of them die every year. On average, children under three years old experience diarrhea three times a year in low-income countries. This condition might lead to malnourishment due to nutrients loss required for children growth. Children who are malnourished are at a higher risk of experiencing diarrhea (WHO, 2017).

Diarrhea is a common endemic disease in Indonesia (Indonesian Ministry of Health of Republic of Indonesia, 2016). The prevalence of diarrhea increased during the period from 2000 to 2010 in Indonesia. The Incidence Rate (IR) of diarrhea was 301 per 1,000 population in 2000 and reached 411 per 1,000 population in 2010 (Indonesian Ministry of Health of Republic of Indonesia, 2011). In 2016, reports showed three diarrhea outbreaks with high Case Fatality Rate (CFR)

(3.04%) (Ministry of Health of Republic of Indonesia, 2016). In East Java, the number of diarrhea cases was 865,249 in 2016 which was lower than the number in 2015 (887,184 cases) (East Java Provincial Health Office, 2016).

In diarrhea, the person experiences bowel movement with a liquid consistency at least three times a day. Rotavirus is the most well-known agent of diarrhea, causing up to 50% of acute diarrhea incidents. There are three clinical types of diarrhea; first, acute watery diarrhea, including cholera, which lasts several hours or days and can cause dehydration; second, acute bloody diarrhea or dysentery, which causes intestinal damage, sepsis, malnutrition, and dehydration; and third, persistent diarrhea (Yu, Lougee, and Murno, 2017). Body fluid loss and severe dehydration are the leading causes of death from diarrhea. Furthermore, other factors such as septic bacterial infection may promote death from diarrhea among children (WHO, 2017).

Preventive measures of diarrhea may include providing safe drinking water,

managing suitable sanitation facilities, and washing hands with soap. Diarrhea can be treated with ORS, which is a solution of water, salt, and white sugar. Additionally, intake of zinc tablets (20 mg) for 10 to14 days can reduce the sickness span (WHO, 2017).

The high prevalence of diarrhea in developing countries may be inferred to lack of both clean water and proper sanitation (Cairncross *et al.*, 2010). Although the global efforts over the past decade to achieve the MDG targets related to clean water coverage, sanitation prevails is still a big challenge and the coverage percentage is still below the target (77%). In 2015, about 2.4 billion people did not have access to proper sanitation facilities and around 1 billion of them were practicing open defecation (Cha *et al.*, 2017).

In Indonesia, 18% of households drink water that comes from surface sources, with high exposure to contamination, such as springs, rivers, ponds, and lakes (Central Body of Statistics, 2014), and merely 11% of households have access to piped water in their homes (Surjadi, 2003). However, the water quality usually does not meet the minimum requirements for drinking water, containing fluctuating discharges and frequent disruptions. Moreover, piped water is vulnerable to contamination with fecal bacteria and dangerous for consumption without treatment (Komarulzaman, Smits, and Jong, 2017).

In Indonesia, many households still depend on drinking water sources that are unsafe and easily contaminated with bacteria, such as rivers. The contamination can also occur during the collection, transportation, storage, and presentation of water due to fecal contaminated hands and tools (Shaheed *et al.*, 2014).

Moreover, globally Indonesia has the second-highest population practicing open defecation (54 million). Young children's stools are considered less dangerous than adults' due to their diminutive size and mild odor. However, according to Gil et al. (2004), children's stools are more infective than adults. Formative studies in Eastern Indonesia found that 80% of respondents agreed or strongly agreed with the statement "Baby droppings can spread disease" which reflected the high knowledge level about the health hazard of children's stools. However, knowledge is not always enough and should be followed by practice. Unfortunately, 48% of Indonesian households do not practice safe disposal for the stools of their children under five years old. However, the safe disposal level in Indonesia (52%) is lower than the safe disposal level in East Java (66%). Another study from 3 districts in Indonesia; Java, NTT, and Papua, found only 43.4% of households practicing safe disposal of the children's stools (Cronin et al., 2016). This situation increases the possible risk of environmental and water pollution. As a result of the poor water quality and sanitation, the prevalence of diarrhea is still high in Indonesia, responsible for 31% of postnatal deaths and 25% of children deaths (Komarulzaman, Smits and Jong, 2017).

This study aimed to determine the correlation between access to safe drinking water and healthy houses with the incidence of diarrhea in East Java in 2016. The study results could be used for planning programs or formulating policies related to diarrhea control and as material for other studies related to risk factors of diarrhea.

METHODS

This study applied a correlational study design. All diarrhea patients in East Java who were treated in 2016 were involved in the population. Thus, the population also acted as the study sample. The independent variables were the number of people who have sustainable access to safe drinking water and the number of healthy houses, while the

dependent variable was the number of diarrhea cases. Residents with sustainable access to safe drinking water referred to individuals who got their water from piped networks (PDAM, BPSPAM) or not piped networks (protected dug wells, pumped dug wells, pumps with pump wells, water terminals, protected springs, and collected rainwater tanks). Healthy houses referred to residential buildings that met health requirements including the housing components, sanitation, and household facilities such as healthy latrines, landfills, clean water facilities, wastewater disposal facilities, proper ventilation, suitable residential density, and houses with non-clayed floors. The diarrhea cases were the reported and treated cases in East Java Province in 2016.

The data source was the secondary data from the East Java Provincial Health Profile in 2016. Data were analyzed using univariate and bivariate analyses. Bivariate analysis was performed using the Pearson's Correlation Coefficient. Before data analysis, the Kolmogorov Smirnov test was conducted to test the data normality. Ethical approval for the research protocols was obtained from the Research Ethics Committee of Faculty of Dental Medicine UniversitasAirlangga on 23rd August 2019 with a certificate number of 578/HRECC.FODM/VIII/2019.

RESULTS

Overview of the Number of Treated Diarrhea Patients in East Java in 2014-2016 according to Gender

The number of diarrhea cases was decreasing in (2014-2016). The number was 1,051,910 cases in 2014; 887,164 cases in 2015; and 865,249 cases in 2016 (Figure 1).
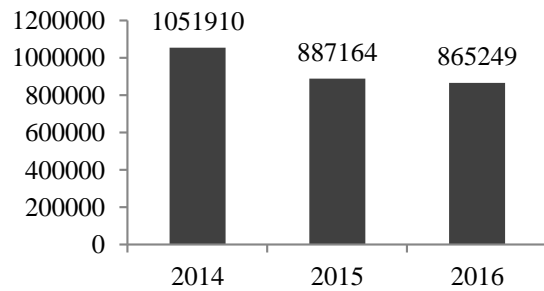
Source: East Java Provincial Health Profile (2014-2016)

Figure 1. Total Number of Cases of Diarrhea in East Java (2014-2016)

Based on gender, diarrhea prevalence was more in women than men. The number of women who suffered from diarrhea was 546,424 in 2014, decreased to 465,767 in 2015, and declined to 452,517 in 2016. While in men, the number was 499,006 in 2014, lowered to 421,427 in 2015, and reduced again to 412,732 in 2016 (Figure 2).
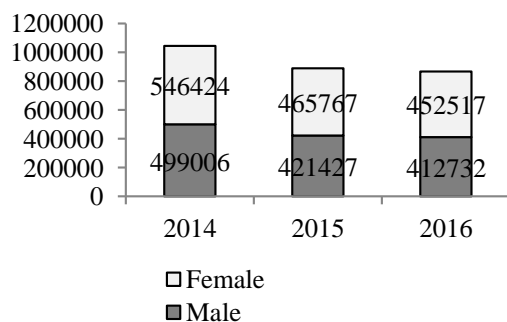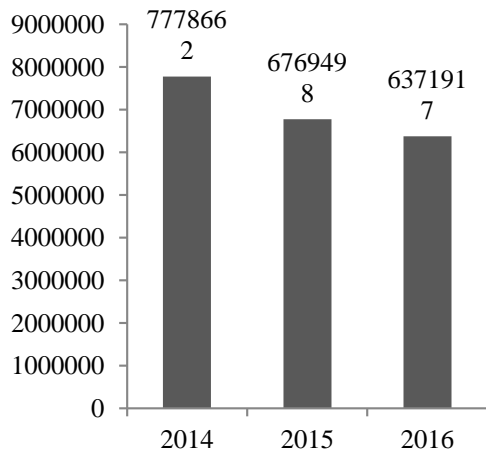

Source: East Java Provincial Health Profile (2014-2016)

Figure 2. Total Number of Cases of Diarrhea based on Gender in East Java (2014-2016)

Overview of Number of Healthy Houses and Number of Population with Sustainable Access to Safe Drinking Water in East Java in (2014-2016)

The number of healthy houses in East Java was decreasing (2014-2016), starting from 7,778,662 healthy homes in

2014, followed by 6,769,498 in 2015, and dropped to 6,371,917 in 2016 (Figure 3).

Source: East Java Provincial Health Profile (2014-2016)

Figure 3. Total Number of Healthy Houses in East Java in (2014-2016)

The number of people with sustainable access to safe drinking was increasing in (2014-2016), started with 11,955,541 residents in 2014, raised to 22,871,640 in 2015, and increased again to 69,513,264 in 2016 (Figure 4).
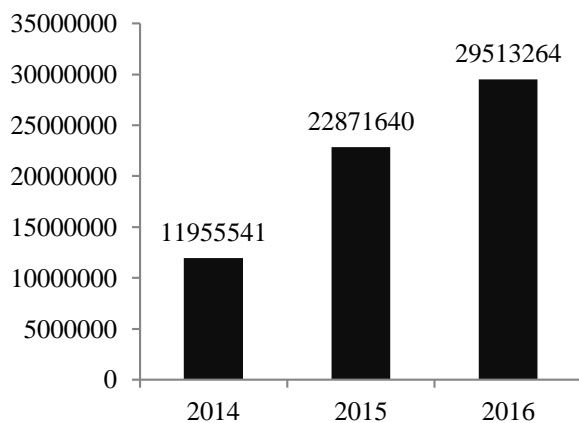
Source: East Java Provincial Health Profile (2014-2016)

Figure 4. Total Number of Population with Sustainable Access to Safe Drinking Water in East Java (2014-2016)

Analysis of Correlation Between Healthy House and Sustainable Access to Safe Drinking Water with the Incidence of Diarrhea in East Java

The normality test showed that a p-value was 0.439 for incidence of diarrhea, 0.741 for healthy houses, and 0.526 for sustainable access to safe drinking water (Table 1). Thus, the three variables had regular distribution, and thus Pearson's correlation coefficient could be used to estimate their correlation strength.

Table 1. Normality Test Results for the Variables of Incidence of Diarrhea, Healthy Houses, and Sustainable Access to Safe Drinking Water

Category	Results
Incidence of Diarrhea	
Kolmogorov-Smirnov Z	0.868
Asymp. Sig. (2-tailed)	0.439
N	38
Healthy Houses	
Kolmogorov-Smirnov Z	0.682
Asymp. Sig. (2-tailed)	0.741
N	38
Sustainable Access to Safe Drinking Water	
Kolmogorov-Smirnov Z	0.811
Asymp. Sig. (2-tailed)	0.526
N	38

The p-value of the healthy houses was 0.000. Thus, there was a correlation between healthy houses and the occurrence of diarrhea with a correlation coefficient score equal to 0.798. This result reflected that the relationship between these variables was stable enough as the

correlation coefficient was close to 1 (Table 2).

The p-value for sustainable access to safe drinking water was 0.000. Thus, there was a correlation between sustainable access to safe drinking water and the incidence of diarrhea. The correlation coefficient score was 0.722. This result indicated that the relationship between these variables was relatively stable since the correlation coefficient was close to 1 (Table 2).

Table 2. Pearson's Correlation Results between Healthy House, Sustainable Access to Safe Drinking Water, and the Incidence of Diarrhea in East Java 2016

Incidence of Diarrhea	Healthy House	Sustainable Access to Safe Drinking Water
Sig. (2-tailed)	0.000	0.000
Pearson Correlation	0.798	0.722
N	38	38

DISCUSSION
Analysis of Correlation between Healthy Houses and Sustainable Access to Safe Drinking Water with the Incidence of Diarrhea in East Java

Healthy houses are houses with adequate ventilation and a smoke-free and CO-free environment, clean water accessibility, and adequate sanitation facilities. Healthy houses should be clear from pollution, humidity, and noise and featured by non-clayed grounds (CDC, 2017).

This study showed a correlation between healthy houses with the incidence of diarrhea. These results are confirmed by Setiyaningsih and Sulistyaningsih (2016) showing that infants had a 20.8 higher risk of diarrhea in unhealthy houses than others in healthy homes.

Saleh and Rachim (2014) presented that the provision of both clean water (p = -) and rubbish bins (p = 0.947) were not risk factors for diarrhea, while latrines use (p = 0.000) and sewerage (p = 0.000) were risk factors for diarrhea. Human waste also was categorized as a significant factor. Therefore, it is a priority to provide proper disposal facilities for stools. Stools are high infectious sources of diarrhea (Saleh and Rachim, 2014). Littering also can contaminate both water and soil. The children's stools may be considered as a low-risk infectious factor compared to adults due to their small size and mild odor; however, according to Gil et al. (2004), children's stools were more infective than adults.

A study in Ethiopia revealed that open dumping around houses could be a risk factor for diarrhea. Moreover, domestic wastewater discharge from households to public roads was another diarrhea risk factor. Solid waste disposal and wastewater evacuation on public roads might become a breeding site for insects spreading diarrheal pathogens from open waste to drinking water or food (Thiam et al., 2017). Since diarrhea is caused mainly by contaminated water sources, water sources should be protected to reduce the direct contact or the formation of vector breeding sites. Safe drinking water supply and wastewater treatment are the main solutions to avoid diarrhea (Naik and Stenstrom, 2012).

Rego, Moraes, and Dourado (2005) stated that garbage disposal had an influential relationship with diarrhea incidence, with a prevalence ratio (PR) of 2.74 (95% CI 1.28-5.87). The Presence of toilets and applying of garbage disposal techniques inside houses decreased

diarrhea incidence but with a insignificant confidence interval (95%).

According to Curtis et al. (2000), the four transmission routes of diarrhea are first through human-to-human via the environment, second through human-to-human multiplying in the environment, third human-to-animal-to-human via the environment, and finally through animal-to-human via the environment.

Sewage, liquid, and solid waste management are the elements of environmental sanitation that involve several stages: collection, transportation, treatment, and disposal. Organic waste facilitates the proliferation of diarrheal vectors, such as flies. However, the proximity of houses to landfills can play a role in the increase of insects number. This increase could, in turn, facilitate disease transmission among the residents near landfills (Rego, Moraes, and Dourado, 2005). A study conducted in Pakistan has stated that flies control was enough to reduce 23% of diarrhea prevalence among children.cha

Moreover, the proximity of dumps to houses increases children's exposure to pathogens, both directly (through personal contact with garbage or waste), and indirectly (through the contamination around households). Young children were mainly exposed to pathogens directly due to playing near the dumps (Rego, Moraes, and Dourado, 2005). Indirect exposure of children to pathogens might happen due to the presence of human waste in household waste. Households contamination may occur through clothing or direct contact of hands with the surrounding garbage or solid waste, followed by direct pathogens transmission to young children (route 1 or route 2). Garbage also tends to attract animals (dogs, chickens, and pigs), whose droppings act as pathogenic vectors of diarrhea (route 3) (Curtis, Cairncross, and Yonli, 2000). Guinea-Bissau, found that children were more vulnerable to diarrhea caused by Cryptosporidium in households with pigs (2.5 times) in addition to households with dogs (2.1 times). Several studies showed an association between animal waste and diarrhea, particularly related to cross infections in developing countries (Curtis, Cairncross, and Yonli, 2000). Additionally, stools are likely to attract flies, which carry enteric pathogens to food. The Salvador City Animal Disease Control Center, which is responsible for controlling animals around landfills, often reports about the animals' proximity to waste consequences (Rego, Moraes, and Dourado, 2005).

The results showed that there was a correlation between sustainable access to safe drinking water and the incidence of diarrhea. Showed that children under five whose families utilized water from unsafe sources had a 1.21 times greater risk of diarrhea than others whose families utilize water from protected sources.

Piped water contamination is not common due to the constructive characteristics of the piped water system that protect it from external interferes. Moreover, households with piped water tend to maintain health due to the high availability of clean water. However, many households in deprived areas suffer from water unavailability. Consequently, many households store water at home enhancing the vulnerability to contamination (Shaheed et al., 2014).

Water treatment by boiling, chlorination, filtering or others is crucial, especially in poor-quality water supplies. Water treatment enhances water safety before drinking by killing the bacteria and reducing the risk of diarrhea, especially in developing countries. However, the water treatment only is not always enough since the cleanliness preservation is not often maintained accurately during storage and presentation. For instance, water can be contaminated by hands during container placement or removal, reducing the treatment efficiency (Sodha et al., 2011).

In addition to clean water, proper sanitation facilities can prevent diarrhea transmission by reducing the fecal

contamination risk. Those facilities separate human from direct contact with human waste and ensure the safe disposal of stools. However, a recent cluster-randomized trial study in rural Odisha, India, demonstrated that adequate household sanitation facilities did not always improve health. Suitable facilities at home are not enough if the community is still exposed to fecal contamination (Clasen *et al.*, 2014).

However, a more positive impact can be noticed if households allow access to clean water for their neighbors who do not have such access enhancing a healthier environment for their children. Thus, the sanitation at the community level may also be a determinant of the influence scope (Alderman, Hentschel, and Sabates, 2003).

Conventional lavatories can improve the cleanliness level of households, however, elimination of feces in the environment cannot be fully achieved if other households do not possess those facilities (Clasen *et al.*, 2014). Those factors affect health indirectly at the community level. Similarly, Alderman, Hentschel, and Sabates (2003) approved that water access only is not enough and should be combined with the lavatories access to get the required positive health effects.

CONCLUSION

It can be concluded that there was a decrease in diarrhea cases in (2014-2016) in East Java. Women experienced diarrhea more frequently than men. The number of healthy houses was decreasing, while the number of people with sustainable access to safe drinking water was increasing in (2014-2016). It can also be inferred that there was a correlation between access to safe drinking water, healthy houses, and diarrhea contamination. The relationship between the three elements was considerably compelling.

To control diarrhea cases in East Java, it is suggested working with community leaders to increase public awareness about the importance of healthy houses (especially healthy latrines and landfills ownership indicators) and sustainable access to safe drinking water. To get the required health impact, it is essential to cover the community needs of both drinking water ownership and lavatories access.

REFERENCES

Alderman, H., Hentschel, J. and Sabates, R. (2003) 'With the Help of One ' s Neighbors : Externalities in the Production of Nutrition in Peru', *Social Science and Medicine*, 56, pp. 2019–2031. doi: 10.1016/s0277-9536(02)00183-1.

Central Bureau of Statistics (2014) *Statistik Indonesia 2014*. Jakarta: Badan Pusat Statistik.

Cairncross, S.,Hunt, Ã., Boisson, S., Bostoen, K., Curtis, V., Fung, I. (2010) 'Water, Sanitation and Hygiene for the Prevention of Diarrhoea', *Interntionl Journal of Epidemiology*, 39, pp. 193–205. doi: 10.1093/ije/dyq035.

CDC (2017) *A Healthy Home for Everryone*. Georgia: CDC.

Cha, S. Lee, J., Seo, D., Park, B., Mannansiangi, P., Bernard, K., Mulakubyazho, G., Famasulu, H. (2017) 'Effects of Improved Sanitation on Diarrheal Reduction for Children Under Five in Idiofa , DR Congo : a Cluster Randomized Trial', *Infectious Disese of Proverty*. Infectious Diseases of Poverty, 6, pp. 1–12. doi: 10.1186/s40249-017-0351-x.

Clasen, T.,Boisson, S., Routray, P., Torondel, B., Bell, M., Cumming, O., Ensink, J., Freeman, M., Jenkins, M. (2014) 'Effectiveness of a Rural Sanitation Programme on Diarrhoea, Soil-Transmitted Helminth Infection , and Child Malnutrition in Odisha , India : a

Cluster-Randomised Trial', *The Lancet Global Health*. Clasen *et al.* Open Access article distributed under the terms of CC BY-NC-ND, 2(11), pp. e645–e653. doi: 10.1016/S2214-109X(14)70307-9.

Cronin, A. A.,Sebayang, S. K., Torlesse, H., Nandy, R. (2016) 'Association of Safe Disposal of Child Feces and Reported Diarrhea in Indonesia : Need for Stronger Focus on a Neglected Risk', *nternational Journal of Environmental Research and Public Health*, 23. doi: 10.3390/ijerph13030310.

Curtis, V., Cairncross, S. and Yonli, R. (2000) 'Domestic Hygiene and Diarrhoea Pinpointing the Problem', *Trop. Med. Int. Health*, 5, pp. 22–32. doi: doi.org/10.1046/j.1365-3156.2000.00512.x.

East Java Provincial Health Office (2014) *Profil Kesehatan Jawa Timur Tahun 2014*. Surabaya: East Java Provincial Health Office.

East Java Provincial Health Office (2015) *Profil Kesehatan Provinsi Jawa Timur Tahun 2015*. Surabaya: East Java Provincial Health Office.

East Java Provincial Health Office (2016) *Profil Kesehatan Provinsi Jawa Timur Tahun 2016*. Surabaya: East Java Provincial Health Office.

Gil, A. Lanata, C., Kleinau, E., Penny, M. (2004) 'Children ' s Feces Disposal Practices in Developing Countries and Interventions to Prevent Diarrheal Diseases A Literature Review', *Environmental Health pPoject*.

Indonesian Ministry of Health (2011) *Buletin Diare*. Jakarta: Indonesian Ministry of Health.

Indonesian Ministry of Health (2016) *Profil Kesehatan Indonesia*. Jakarta: Indonesian Ministry of Health

Komarulzaman, A., Smits, J. and Jong, E. De (2017) 'Clean Water, Sanitation and Diarrhoea in Indonesia : Effects of Household and Community Factors', *Global Public Health*. Taylor & Francis, 12, pp. 1141–1155. doi: 10.1080/17441692.2015.1127985.

Molbak, K., Aaby, P., Hojlyng, N., da Silva, A.P.. (1994) 'Risk Factors for Cryptosporidium Diarrhea in Early Childhood: A Case-Control Study From Guinea-Bissau, West Africa', *American Journal of Epidemiology*, 139, pp. 734–740. doi: doi.org/10.1093/oxfordjournals.aje.a117064.

Naik, K. S. and Stenstrom, M. K. (2012) 'Evidence of The Influence of Wastewater Treatment on Improved Public Health', *Water Science and Technology*, 66, pp. 644–652. doi: 10.2166/wst.2012.144.

Rego, R. F., Moraes, L. R. S. and Dourado, I. (2005) 'Diarrhoea and Garbage Disposal in Salvador , Brazil', *Transaction of the Royal Society of Tropical Medicine nd Hygiene*, 99, pp. 48–54. doi: 10.1016/j.trstmh.2004.02.008.

Saleh, M. and Rachim, L. H. (2014) 'Hubungan Kondisi Sanitasi Lingkungan dengan Kejadian Diare pada Anak Balita di Wilayah Kerja Puskesmas Baranti Kabupaten Sidrap Tahun 2013', *Jurnal Kesehatan*, VII(1).

Setiyaningsih, S. and Sulistyaningsih (2016) 'Hubungan Rumah Tidak Sehat dengan Kejadian Diare pada Balita di Baturetno Bangutapan Bantul D.I.Yogyakarta', *Unisa Yogyakarta*.

Shaheed, A., Orgill, J., Montgomery, Maggie , Jeuland, A., Brown, Joe. (2014) 'Why " Improved " Water Sources are Not Always Safe', *Bulletin World Health Organization*, (February 2013), pp. 283–289. doi:

10.2471/BLT.13.119594.

Sodha, S. V., Menon, M., Trivedi, K., Ati, A., Figueroa, M. E., Ainslie, R., Wannemuehler, K., Quick, R.(2011) 'Microbiologic Effectiveness of Boiling and Safe Water Storage in South Sulawesi , Indonesia', *Journal of Water and Health*, pp. 577–585. doi: 10.2166/wh.2011.255.

Surjadi, C. (2003) 'Drinking Water Concessions : a Study for Better Understanding Public-Private Partnerships and Water Provision in Low-Income Settlements [Case Study : Jakarta , Indonesia]', *Loughborough University Institutional Repository*.

Thiam, S.,Diène, A. N., Fuhrimann, S., Winkler, M. S., Sy, I., Ndione, J. A., Schindler, C., Vounatsou, P., Utzinger, J., Faye, O.,Cissé, G. (2017) 'Prevalence of Diarrhoea and Risk Factors Among Children Under Five Years Old in Mbour , Senegal : a Cross-Sectional Study', *Infectious Diseases of Poverty*. Infectious Diseases of Poverty, pp. 1–12. doi: 10.1186/s40249-017-0323-1.

WHO (2017) *Diarrhoeal Disease*.

Yu, C., Lougee, D. and Murno, J. R. (2017) *Diarrhea and Dehydration*.