



Determinants of Diarrhea in Toddlers at Post-Declaration Open-Defecation-Free Area

Arum Siwiendrayanti[✉], Inda Zumalat Dawil Maulidah

Environmental Health Division, Public Health Department, Universitas Negeri Semarang, Indonesia

Article Info

Article History:

Submitted April 2022

Accepted June 2022

Published July 2022

Keywords:

Diarrhea, toddler, ODF

DOI

<https://doi.org/10.15294/kemas.v18i1.36250>

Abstract

Kudus District Health Office in 2020 reported that diarrhea was still the main cause of post-neonatal and toddler mortality even though Kudus District had become an Open Defecation Free (ODF) District in 2019. The highest case finding was in the working area of the Gondosari Health Center at 22.9% in 2020 and an increase of 20.8% compared to the previous year. Aim: to find out the determinants of the incidence diarrhea in toddler after ODF declaration in the work area of the Gondosari Health Center, Kudus Regency. Method: this type of research is an analytic observational study with a cross-sectional design and was obtained in December 2021. The number of samples was 71 samples with the purposive sampling technique. The research instrument used a questionnaire sheet and an observation sheet. Data analysis used Chi-Square and Fisher tests. Result: the results showed the quality of latrine facilities (RP=1.9 and p=0.112), PAMRT (RP=1.0 and p=1,000), PLCRT (RP=3.1 and p=0.001), drinking water sources (RP= 1.1 and p=0.986, water microbiological quality (RP=4.0 and p=0.026). Conclusion: there is a relationship between PLCRT and water microbiological quality with the incidence of diarrhea in children under five after the ODF declaration in the Gondosari Health Center working area. It is hoped that the government will seek a better water source development program for the community and regular monitoring of ODF areas.

Introduction

Diarrhea ranks eighth globally as the leading cause of death for all ages and accounts for approximately 1.65 million annually worldwide. In children under five, diarrhea kills more than 440,000 children annually, making it the major cause of death in children under five (GBD 2016, 2018). About 78% of children dying from diarrhea live in Africa and Southeast Asia (Mernie, Kloos and Adane, 2022). One of the risk factors for diarrhea that is often studied is the environmental factor of the settlement or community residence, which includes clean water facilities, environment sanitation, family latrines, and home conditions.

On December 2, 2019, Kudus Regency was declared 100% Open Defecation Free (ODF) and became the 14th district in Central Java to achieve ODF Regency. With this declaration, it is hoped that it will prevent the

spread of environmental-based diseases, one of which is diarrhea. Nevertheless, the rate of finding cases of diarrhea is still increasing from 2019 to 2020. The Incident Rate (IR) of diarrhea for all ages in the Kudus Regency is from 18.5% to 31.3% (Dinas Kesehatan Kabupaten Kudus, 2020b), exceeding the 10% predetermined target of the estimated number of people with diarrhea of all ages. When IR diarrhea in children under five in Kudus Regency is 8% of the estimated diarrhea in health facilities. It has decreased by 3.5% from 2019. Yet it is still the major cause of post-neonatal death and death in children under five, so it is still a concern and priority in its prevention. The highest finding of diarrhea cases in the Kudus Regency was in the working area of the Gondosari Health Center, which was 22.9%. This figure has increased by 20.8% compared to 2019. Based on data as of August 2021, there were findings of 45 cases of

[✉] Correspondence Address:

Environmental Health Division, Public Health Department, Universitas Negeri Semarang, Indonesia.

Email : a_shiwi@mail.unnes.ac.id

diarrhea served at the UPTD of the Gondosari Health Center (Puskesmas Gondosari, 2021).

Community-Based Total Sanitation (Sanitasi Total Berbasis Masyarakat/STBM) is a health program launched by the government through Kepmenkes No.852/Menkes/SK/IX/2008, then strengthened by the issuance of Minister of Health Regulation No. 3 of 2014 concerning Community-Based Total Sanitation. The outcome indicator of the STBM National Strategy is a decrease in the incidence of diarrheal diseases and other diseases related to sanitation and hygiene behavior. STBM consists of five pillars, namely: stopping open defecation, washing hands with soap (Cuci Tangan Pakai Sabun/CTPS), managing drinking water, and household food, securing household waste, and securing household liquid waste. Children who live in families that do not apply STBM have a 1.63 times higher chance of experiencing diarrhea compared to children who live in families that implement STBM, as well as the use of clean water and good quality latrines, will experience a 20% less risk of diarrhea (Soboksa et al., 2019). In addition, improved hygiene, such as the practice of washing hands with soap at critical times can reduce the incidence of diarrhea in children by 35% (Hashi, Kumie and Gasana, 2017).

In the working area of the Kudus District Health Center, families with access to proper sanitation facilities (healthy latrines) account for 95.6% of the total population (Dinas Kesehatan Kabupaten Kudus, 2020b). Based on the Environmental Health Risk Assessment (EHRA) study report in 2020, 78.73% of the 132 villages/sub-districts in Kudus Regency did not do CTPS at five critical times, did not do waste sorting, and did not segregate waste by 92.39%. The waste canal (Saluran Pembuangan Air Limbah/SPAL) at risk of being polluted is 94.7%. Meanwhile, 20% of the drinking water used by households still uses rainwater, and 25% comes from river water (Dinas Kesehatan Kabupaten Kudus, 2020a).

By 2020, around 2 billion people worldwide will not have access to safely managed drinking water, and 3.6 billion will not have access to safely managed sanitation services (Wagari, Girma and Geremew, 2022). In Indonesia, nearly 100 million people lack

access to proper sanitation, and 33 million live without proper drinking water (Cameron et al., 2021). Drinking water from protected sources does not mean it is safe because it still allows contamination with pathogens during transportation and storage. The estimation is that 10% of good drinking water sources have been contaminated with fecal material containing at least 100 *Escherichia coli* or thermotolerant coliform bacteria per 100 ml (Bain et al., 2014). Meanwhile, the water in the packaging has a small risk of contamination with feces (Wolf et al., 2018).

Based on a preliminary survey conducted in October 2021, out of ten respondents, four of them did not wash their hands with soap in five critical times of CTPS, six had open trash cans, seven had open SPAL and were not airtight, and seven still used drinking water from unprotected sources

In Kudus Regency, the findings of diarrhea cases still occur in areas with ODF, especially in the work area of the Gondosari Health Center, Gebog District. This study aims to determine the determinants of the incidence of diarrhea in children under five in areas that have been declared ODF, including the quality of latrine facilities, household drinking water management, household liquid waste management, drinking water sources, and water microbiological quality. The results of this study are expected to provide a more comprehensive picture as a basis for policy-making in preventing diarrhea.

Method

This type of research uses analytic observational with a cross-sectional research design. It took time from December 2021 until February 2022 in the working area of the Gondosari Health Center, Kudus Regency. The independent variables in this study were the quality of latrine facilities, Household Drinking Water Management (Pengelolaan Air Minum Rumah Tangga/PAMRT), Household Liquid Waste Management (Pengelolaan Limbah Cair Rumah Tangga/PLCRT), drinking water sources, and microbiological quality of water. The dependent variable in this study is the incidence of diarrhea in children under five. It used instruments of questionnaire sheets,

observation sheets, and compact dry to measure the microbiological quality of water.

The sampling technique used is purposive sampling by the inclusion and exclusion criteria. Obtained 71 samples that meet the inclusion and exclusion criteria. The inclusion criteria in this study were that the respondent was a mother of a toddler who was willing to be the subject, and in the house, some toddlers lived in the working area of the Gondosari Health Center. The exclusion criteria were mothers of children under five who were not at home at the time of the study. The primary data collection technique was direct observation of the research location. Secondary data collection techniques were from the Kudus Regency Health Office and Gondosari Health Center.

The analysis used was cross-tabulation to determine the relationship between the independent and dependent variables. The statistical test used is the Chi-Square test if the cells have an expected value of less than five and a maximum of 20%, and Fisher's test if the Chi-Square test conditions do not meet.

This research has obtained ethical clearance from the Health Research Ethics Commission, Semarang State University, with registration number 394/KEPK/EC/2021.

Results and Discussions

Table 1 shows 24 (33.8%) toddlers with diarrhea in the last three months and 47 (66.2%). Respondents with quality latrine facilities do not meet the requirements (18.3%), while respondents having quality latrine facilities meet the requirements (81.7%). Respondents who manage drinking water unsafely are (4.2%), while those with drinking water safely are (95.8%). Respondents who do liquid waste poorly are (31.0%), while those who manage liquid waste well are (69.0%). Respondents with unprotected drinking water sources are (39.4%), while those with protected drinking water sources are (60.6%). Respondents with water microbiological quality do not meet the requirements of (73.2%), while those who have water microbiological quality meet the requirements are (26.8%).

Table 1. Univariate Analysis Results

Variables	Frequency	Percentage(%)
Diarrhea Incident		
Yes	24	33,8
No	47	66,2
Latrine Facility Quality		
Does not meet the requirements	13	18,3
Meet the requirements	58	81,7
Drinking Water Management		
Unsafe	3	4,2
Safe	68	95,8
Domestic Liquid Waste Management		
Poor	22	31,0
Well	49	69,0
Drinking Water Source		
Unprotected	28	39,4
Protected	43	60,6
Water Microbiology Quality		
Does not meet the requirements	52	73,2
Meet the requirements	19	26,8

Source: Primary Data, 2021

Pathogens that cause diarrhea are transmitted mainly by the fecal-oral route. Pathogens from contaminated feces can be transmitted to new hosts through contaminated hands, drinking water, soil, flies, and food (Majorin et al., 2019). The availability of latrines reduces environmental pollution from excreta and can prevent the transmission of disease-causing organisms (Tafere et al., 2020). The quality of latrine facilities that meet the requirements are latrines with waterproof and non-slip floors and are channeled to the Wastewater Treatment System (SPAL). In addition, under the latrine is the septic tank with a distance of >10 meters from the water source. As in the research (Getahun and Adane, 2021) and (Yaya et al., 2018) that the latrines meet the requirements of the waste/sewage is channeled through the sewer system, septic tanks, facilities in the form of pit latrines, ventilated pit latrines, pit latrines with slabs, and compost toilets. The mechanism of diarrheal disease transmission is due to the latrine facility's quality that does not meet the requirements. It transfers disease-causing bacteria in the feces to the host through various media. Such as water, hands, insects, and soil which in turn will contaminate food/drinks (Sidhi et al., 2016). Children from homes with feces around holes/slabs/around latrines are three times more likely to get diarrhea than those with clean latrines (Natnael, Lingerew and Adane, 2021). Based on the analytical test, there is no relationship between the quality of latrine facilities and the incidence of diarrhea in children under five in the working area of the Gondosari Health Center, Kudus Regency, with a value of $p = 0.112$ ($p > 0.05$). This study is in line with research (Tutuanita, 2019), where there is no significant correlation between access to sanitation and the incidence of diarrhea. It is because Kudus Regency has been declared ODF, and based on research from 71 respondents, 81.7% already have quality latrines that meet the requirements.

Safe household drinking water management can break the chain of the spread of pathogens, but based on the results of research using the Chi-square test analysis, the p -value = 1,000 ($p > 0.05$). It shows that there is no relationship between household drinking water management and the incidence of diarrhea in

children under five in the working area of the Gondosari Health Center, Kudus Regency. It is because it is very likely that the route of germs transmission in the study site is not dominated by drinking water. Of the 71 respondents, 95.8% have managed to drink water safely, including boiling it before drinking and storing it in a clean and closed container. Boiling water to a boil can kill some diarrhea-causing pathogens such as *Shigella flexneri* (Moyo et al., 2022). People tend to only know the importance of safe drinking water management but ignore personal hygiene when using the water (Ko and Sakai, 2022). According to (McClelland et al., 2022), storing drinking water in separate special containers and separating drinking water from other water supplies can reduce the risk of diarrhea.

The research on household liquid waste management variables with diarrhea in toddlers obtained a p -value = 0.000 ($p < 0.05$). It shows a relationship between household wastewater management and the incidence of diarrhea in children under five in the working area of the Gondosari Health Center, Kudus Regency. Domestic or domestic liquid waste includes water used for bathing, used for washing clothes, used for washing furniture, food ingredients, and others. In this study, the household liquid waste management meet the requirements when it does not stagnate, the sewer is watertight and closed, and connected to infiltration wells or communal Wastewater Treatment Plants (IPAL). Disposal of liquid waste that does not meet the requirements can cause contamination of groundwater surfaces and water sources. According to (Barrantes et al., 2022), rotavirus, enterovirus, and norovirus are pathogens that are often transmitted through water. They pollute water through human activities such as leakage of sewers and septic systems, agricultural and urban runoff, and unsafe disposal of wastewater. Reducing the risk of water-borne diarrhea is critical to achieving the 6th sustainable development goal of ensuring people have access to clean water and sanitation (Meki, Ncube and Vayi, 2022). The waste needs proper management to prevent contamination so that liquid waste does not become a breeding ground for disease germs such as flies, does not contaminate water sources,

and soil, and does not cause odors. Puddles of water around the house due to unqualified sewerage can trigger the emergence of disease vectors such as cockroaches and cause diarrhea (Sembiring, Wulan S.R., Annida H., 2022). The results are in line with research (Mebrahtom, Worku and Gage, 2022), stating households that manage wastewater inappropriately are closely related to the diarrhea incidence and are three times more likely to die from diarrhea in infants than households that manage their waste liquid properly.

The research on the source of drinking water with the incidence of diarrhea in toddlers obtained a value of $p = 0.784$ ($p > 0.05$), which means that there is no relationship between drinking water sources and the incidence of diarrhea in children under five in the work area of the Gondosari Health Center, Kudus Regency. According to Grady et al., (2015), the criteria for protected drinking water sources include water sources from plumbing/companies, drilled wells/pumps, protected dug wells and protected springs, rainwater storage, and bottled water (if the water source is for other household needs are protected). The results are in line with research (Magdalena et al., 2019) which states that there is no relationship between drinking water sources and the incidence of diarrhea in toddlers, with a p-value of 1,000. According to research (Bhar et al., 2017), on the use of safe drinking water and slum household sanitation facilities in Siliguri, West Bengal said that the use of drinking water sources by the community is increasing or high. But the piping connections and toilet sanitation used are still low. So the incidence of diarrhea is influenced by water sources contaminated with feces. Changes in surface water and groundwater conditions that are contaminated due to climate change also contribute to the transmission of diarrheal diseases (Dimitrova et al., 2022).

The study obtained a p-value = 0.026 ($p < 0.05$), indicating a relationship between the microbiological quality of water and the incidence of diarrhea in children under five in the Gondosari Health Center working area, Kudus Regency. The cause of microbiological contamination of clean water could be pipe leaks, water source conditions, and water reservoir conditions. When boiled water, it could be recontamination. Especially during storage and transfer, include boil with incorrect temperature/time (Wani, Smeets and Shrivastava, 2022). Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010 concerning Drinking Water Quality Requirements, namely water that meets physical, microbiological, chemical, and radioactive requirements contained in mandatory and additional parameters (Peraturan Menteri Kesehatan RI, 2010). Raw water for drinking water that meets biological requirements must not contain pathogenic microorganisms that can cause disease. The pathogenic bacteria determination presence can be done by testing the presence of *Escherichia coli*, an indicator bacteria of water pollution, and total coliform, showing coliform bacteria from feces, soil, or other natural sources (Rakesh et al., 2022). The microbiological parameters in the drinking water quality requirements meet the requirements if the total coliform bacteria is 0 CFU/100 ml of water sample and the permissible level of *E. coli* is 0 CFU/100 ml. Lack of access to clean water, poor sanitation, and inadequate personal hygiene account for 90% of the incidence of diarrhea (Ayalew et al., 2018).

The results are in line with research Mengistie et al., (2022), which states that the presence of *E. coli* in water is associated with an increase in the incidence of diarrhea.

Table 2. Bivariate Analysis Results

Independent Variables	Diarrhea		Not Diarrhea		RP (95%CI)	p
	f	%	f	%		
Latrine Facility Quality						
Does not meet the requirements	7	53,8	6	46,2	1,9 (0,96-3,49)	0,112
Meet the requirements	17	29,3	41	70,7		
Drinking Water Management						
Unsafe	1	33,3	2	66,7	1,0 (0,19-5,05)	1,000
Safe	23	33,8	45	66,2		
Domestic Liquid Waste Management						
Poor	14	63,6	8	36,4	3,1 (1,64-5,89)	0,001
Well	10	20,4	39	79,6		
Drinking Water Source						
Unprotected	10	35,7	18	64,3	1,1 (0,56-2,11)	0,986
Protected	14	32,6	29	67,4		
Water Microbiology Quality						
Does not meet the requirements	22	42,3	30	57,7	4,0 (1,04-15,48)	0,026
Meet the requirements	2	10,5	17	89,5		

Source: Primary Data, 2021

Conclusions

There is a relationship between Domestic Liquid Waste Management/PLCRT and water microbiological quality with the incidence of diarrhea in children under five after the ODF declaration in the Gondosari Health Center work area. There is no relationship between the quality of latrine facilities, Drinking Water Management/PAMRT, and drinking water sources with the incidence of diarrhea in toddlers after the ODF declaration in the Gondosari Health Center work area. Health agencies are expected to give special attention to the community, especially parents of toddlers who live far from health facilities, while still providing health education. In addition, regular monitoring for ODF areas with collaboration between communities, government organizations, and community associations as a strategy for preventing diarrhea in children under five, as well as developing better water sources.

References

- Ayalew, A.M., Mekonnen, W.T., Abaya, S.W., & Mekonnen, Z.A., 2018. Assessment of Diarrhea and Its Associated Factors in Under-Five Children Among Open Defecation and Open Defecation-Free Rural Settings of Dangla District, Northwest Ethiopia. *Journal of Environmental and Public Health*, 2018, pp.1-8.
- Bain, R., Cronk, R., Hossain, R., Bonjour, S., Onda, K., Wright, J., Yang, H., Slaymaker, T., Hunter, P., Pruss-Ustun, A., & Bartram, J., 2014. Global Assessment of Exposure to Faecal Contamination Through Drinking Water Based on a Systematic Review. *Tropical Medicine and International Health*, 19(8), pp.917-927.
- Barrantes, K., Chacon, L., Morales, E., Rivera-Montero, L., Pino, M., Jimenez, A.G., Mora, D.C., Jimenez, P.S., Silva, B., & Romero-Esquivel, L.G., 2022. Occurrence of Pathogenic Microorganisms in Small Drinking-Water Systems in Costa Rica. *Journal of Water and Health*, 20(2), pp.344-355.
- Bhar, D., Bhattacharjee, S., Mukherjee, A., Sarkar, T.K., & Dasgupta, S., 2017. Utilization of Safe Drinking Water and Sanitary Facilities in Slum Households of Siliguri, West Bengal. *Indian Journal of Public Health*, 61(4), pp.248-253.
- Cameron, L., Chase, C., Haque, S., Joseph, G., Pinto, R., & Wang, Q., 2021. Childhood Stunting and Cognitive Effects of Water and Sanitation in Indonesia. *Economics and Human Biology*, 40, pp.100944.
- Dimitrova, A., McElroy, S., Levy, M., Gershunov, A., & Benmarhnia, T., 2022. Precipitation Variability and Risk of Infectious Disease in Children Under 5 Years for 32 Countries: A Global Analysis Using Demographic and Health Survey Data. *The Lancet Planetary Health*, 6(2), pp.e147-e155.

- Dinas Kesehatan Kabupaten Kudus., 2020a. *Laporan Studi Environmental Health Risk Assessment (EHRA)*. Kudus.
- Dinas Kesehatan Kabupaten Kudus., 2020b. *Profil Kesehatan Kabupaten Kudus 2020*. Kudus.
- GBD 2016., 2018. Estimates of the Global, Regional, and National Morbidity, Mortality, and Aetiologies of Diarrhoea in 195 Countries: A Systematic Analysis for the Global Burden of Disease Study 2016. *The Lancet Infectious Diseases*, 18(11), pp.1211–1228.
- Getahun, W., & Adane, M., 2021. Prevalence of Acute Diarrhea and Water, Sanitation, and Hygiene (WASH) Associated Factors Among Children Under Five in Woldia Town, Amhara Region, Northeastern Ethiopia. *BMC Pediatrics*, 21(1), pp.1–15.
- Grady, C.A., Kipkorir, E.C., Nguyen, K., & Blatchley, E.R., 2015. Microbial Quality of Improved Drinking Water Sources: Evidence from Western Kenya and Southern Vietnam. *Journal of Water and Health*, 13(2), pp.607–612.
- Hashi, A., Kumie, A., & Gasana, J., 2017. Hand Washing with Soap and WASH Educational Intervention Reduces Under-Five Childhood Diarrhoea Incidence in Jigjiga District, Eastern Ethiopia: A Community-Based Cluster Randomized Controlled Trial. *Preventive Medicine Reports*, 6, pp.361–368.
- Ko, S.H., & Sakai, H., 2022. Water Sanitation, Hygiene and the Prevalence of Diarrhea in the Rural Areas of the Delta Region of Myanmar. *Journal of Water and Health*, 20(1), pp.149–156.
- Magdalena, I., Rantetampang, A.L., Pongtiku, A., & Mallongi, A., 2019. The Risk Factors Environment and Behavior Influence Diarrhea Incidence to Child in Abepura Hospital Jayapura City. *International Journal of Science and Healthcare Research*, 4(1), pp.171–180.
- Majorin, F., Torondel, B., Chan, G.K.S.C., & Clasen, T., 2019. Interventions to Improve Disposal of Child Faeces for Preventing Diarrhoea and Soil-Transmitted Helminth Infection. *Cochrane Database of Systematic Reviews*, 2019.
- McClelland, P.H., Kenney, C.T., Palacardo, F., Roberts, N.L.S., Luhende, N., Chua, J., Huang, J., Patel, P., Sanchez, L.A., Kim, W.J., Kwon, J., Christos, P.J., & Finkel, M.L., 2022. Improved Water and Waste Management Practices Reduce Diarrhea Risk in Children under Age Five in Rural Tanzania : A Community-Based , Cross-Sectional Analysis. *International Journal of Environmental Research and Public Health*, 19(4218), pp.1–18.
- Mebrahtom, S., Worku, A., & Gage, D.J., 2022. The Risk of Water, Sanitation and Hygiene on Diarrhea-Related Infant Mortality in Eastern Ethiopia: A Population-Based Nested Case-Control. *BMC Public Health*, 22(1), pp.1–14.
- Meki, C.D., Ncube, E.J., & Vayi, K., 2022. Community-Level Interventions for Mitigating the Risk of Waterborne Diarrheal Diseases: A Systematic Review. *Systematic Reviews*, 11(1), pp.1–12.
- Mengistie, B., Gobena, T., Admassu, D., Assefa, N., Ayele, D.M., Mengistu, D.A., Worku, A., Kumie, A., Terfa, W., Bikila, Z., & Azage, M., 2022. Seasonal Variability Influence on the Prevalence of Diarrhoea among Under-Five-Year-old Children in Kersa District, Eastern Ethiopia: A Community-Based Longitudinal Study. *Environmental Health Insights*, 16, pp.1–11.
- Mernie, G., Kloos, H., & Adane, M., 2022. Prevalence of and Factors Associated with Acute Diarrhea Among Children Under Five in Rural Areas in Ethiopia with and without Implementation of Community-Led Total Sanitation and Hygiene. *BMC Pediatrics*, 22(1), pp.1–16.
- Moyo, T.M., Juru, T.P., Sibanda, E., Marape, G., Gombe, N.T., Govha, E., & Tshimanga, M., 2022. Risk Factors for Contracting Watery Diarrhoea in Mzilikazi, Bulawayo City, Zimbabwe, 2020: a Case Control Study. *Pan African Medical Journal*, 41(145), pp.1–13.
- Natnael, T., Lingerew, M., & Adane, M., 2021. Prevalence of Acute Diarrhea and Associated Factors Among Children Under Five in Semi-Urban Areas of Northeastern Ethiopia. *BMC Pediatrics*, 21(1), pp.1–11.
- Peraturan Menteri Kesehatan RI., 2010. *Peraturan Menteri Kesehatan Republik Indonesia Nomor 492/Menkes/Per/IV/2010 Tentang Persyaratan Kualitas Air Minum*, Kemenkes RI.
- Rakesh, P., Samiksha, K., Harmanpreet, K., Mansi, R., Vijay, K., & Amit, G., 2022. Qualitative and Quantitative Enumeration of Coliform Bacteria in Song River Water in Rural Area of Dehradun. *Journal of Medical Pharmaceutical and Allied Sciences*, 11(2), pp.4534–4538.
- Sembiring, W.S.R., Annida H., & A, R.F., 2022. Diarrhea Incidence in Tanah Bumbu, South Kalimantan, Under A Spatial Approach. *Jurnal Kesehatan Masyarakat*, 17(4), pp.526–534.
- Sidhi, A.N., Raharjo, M., & Dewanti, N.A.Y., 2016.

- Hubungan Kualitas Sanitasi Lingkungan dan Bakteriologis Air Bersih Terhadap Kejadian Diare Pada Balita di Wilayah Kerja Puskesmas Adiwerna kabupaten Tegal. *Jurnal Kesehatan Masyarakat*, 4(3), pp.665–676.
- Soboksa, N.E., Hailu, A.B., Gari, S.R., & Alemu, B.M., 2019. Water Supply, Sanitation and Hygiene Interventions and Childhood Diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: A Comparative Cross-Sectional Study. *Journal of Health, Population and Nutrition*, 38(1), pp.1–14.
- Tafere, Y., Abate, B.A., Enyew, H.D., & Mekonnen, A.B., 2020. Diarrheal Diseases in Under-Five Children and Associated Factors among Farta District Rural Community, Amhara Regional State, North Central Ethiopia: A Comparative Cross-Sectional Study. *Journal of Environmental and Public Health*, 2020, pp.3–9.
- Tutuanita, N.Y.Z., 2019. Sanitation, Open Defecation, and Diarrhea in Tangerang, Banten, Indonesia, in early 2017: A Cross-Sectional Epidemiological Study. *Journal of International Dental and Medical Research*, 12(1), pp.368–371.
- Wagari, S., Girma, H., & Geremew, A., 2022. Water, Sanitation, and Hygiene Service Ladders and Childhood Diarrhea in Haramaya Demographic and Health Surveillance Site, Eastern Ethiopia. *Environmental Health Insights*, 16, pp.1–13.
- Wani, H., Smeets, P., & Shrivastava, S., 2022. Evaluation of WASH Indicators Associated with Diarrhoeal Disease Among Under-Five Children in an Urban Slum Pocket, Mumbai City, India: A Community-Based Repeated Cross-Sectional Study. *Journal of Water Sanitation and Hygiene for Development*, 12(4), pp.359–374.
- Wolf, J., Hunter, P.R., Freeman, M.C., Cumming, O., Clasen, T., Bartram, J., Higgins, J.P.T., Johnston, R., Medlicott, K., Boisson, S., & Prüss-Ustün, A., 2018. Impact of Drinking Water, Sanitation and Handwashing With Soap on Childhood Diarrhoeal Disease: Updated Meta-Analysis and Meta-Regression. *Tropical Medicine and International Health*, 23(5), pp.508–525.
- Yaya, S., Hudani, A., Udenigwe, O., Shah, V., Ekholuenetale, M., & Bishwajit, G., 2018. Improving Water, Sanitation and Hygiene Practices, and Housing Quality to Prevent Diarrhea Among Under-Five Children in Nigeria. *Tropical Medicine and Infectious Disease*, 3(2), pp.1–11.