

Factors Influencing the Incidence of Diarrhea in Kepulauan Seribu District, DKI Jakarta

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ABSTRACT

Introduction: Diarrhea cases in the Seribu Islands were recorded in 190 cases in 2021 and in 461 cases in 2022. The factors influencing the incidence of diarrhea are knowledge, attitudes and practices, clean water sources, and clean water quality. The aim of the study was to analyze factors related to the incidence of diarrhea in the Seribu Islands District.

Methods: This study was conducted in the Seribu Islands District from February to August 2024. This study was an observational analysis with a case-control approach design. The respondent criteria include having a history of diarrhea in the South Seribu Islands District, as showed by a doctor's diagnosis and positive laboratory results for diarrhea from January to December 2022, and having resided there for more than six months. The case group was consisted of 37 samples and the control group consisted of 37 samples. The independent variables in this study were the biological, physical, and chemical quality of clean water, clean water sources, knowledge, attitudes, and practice. The collected data were analyzed using the chi-square and logistic regression test using SPSS software.

Results: The variables of physical quality of clean water, clean water sources, knowledge and practices of respondents did not have a significant effect on the incidence of diarrhea ($p > 0.05$). Meanwhile, the biological and chemical quality of clean water, and the respondents' attitudes had a significant effect on the incidence of diarrhea ($p < 0.05$). Based on the results of the multivariate analysis, the biological quality of clean water had a significant effect ($p = 0.001$) with an odds ratio of 9.18. The most influential factor on the incidence of diarrhea is the biological quality of the clean water.

Conclusion: The variables of knowledge, attitudes, practices, clean water sources, and physical and chemical quality of water showed no effect on the incidence of diarrhea ($p \text{ value} > 0.05$). The biological quality of the water variable had an effect on the incidence of diarrhea ($p \text{ value} = 0.001$), with an odds ratio of 9.18. Since *E. coli*-contaminated food and water contribute significantly to the spread of diarrheal illnesses in the community, it is crucial to monitor the quality of food and drinking water and to improve sanitation in order to reduce the prevalence of diarrhea, particularly in the Seribu Islands.



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INTRODUCTION

Diarrhea is a food-borne and water-borne disease that is transmitted through the fecal-oral route. Diarrhea remains a global public health problem. Every year, there are 2 billion cases of

diarrhea and approximately 2 million toddlers die from diarrhea worldwide (Cohen et al., 2022). Diarrhea is caused by bacterial infections (*Vibrio* spp., *Escherichia coli*, *Salmonella* sp., *Shigella* sp., *Campylobacter* sp.), viruses (Rotavirus and Adenovirus), and parasites (*Entamoeba histolytica*, *Giardia lamblia*, *Blastocystis hominis*) as well as malabsorption and food factors (Fedor et al., 2019; Chang et al., 2021; Khurana et al., 2021). In Indonesia, diarrhea is a disease that ranks 4th among all the age groups. In DKI Jakarta, diarrhea cases in all age groups tended to fluctuate from 2018 to 2022. In 2020, diarrhea was one of the diseases included in the 10 most common outpatient diseases at Puskesmas of DKI Jakarta. In 2021, there were 123,892 diarrhea cases. Meanwhile, diarrhea cases in the Seribu Islands were recorded as 190 cases in 2021 and 461 cases in 2022 (DKI Jakarta Health Office, 2022).

Factors contributing to the transmission of diarrhea include water, environmental hygiene, and sanitation. The incidence of diarrhea is also closely related to human knowledge, attitudes, and practices, clean water sources, wastewater disposal facilities and environmental health (Lo Vecchio et al., 2021; Abidin et al., 2022). Inadequate waste management and feces disposal are also related to diarrhea cases that appear in the community. Water quality is characterized by the fulfillment of physical, chemical and biological requirements (Paramastri et al., 2021). Biological indicators of water quality are characterized by negative values in the examination of *Escherichia coli* and total coliforms in water. The presence of *E. coli* in the water indicates that the water was contaminated with feces. In addition, the physical and chemical qualities must also meet standard standards so they can be consumed or utilized by the community (Alizade et al., 2019).

Clean water facilities in the Seribu Islands District from groundwater, collected rainwater, water treatment installations with Brackish Water Reverse Osmosis technology (BWRO), and water treatment installations with Sea Water Reverse Osmosis technology (SWRO). Also, Seribu Islands District has several risk factors for diarrhea such as poor sanitation, low water quality and water sources that only rely on a few sources as mentioned previously. The results of the initial examination of the bacteriological quality of SWRO and BWRO water in the South Seribu Islands Sub-District at 13 locations showed that the results did not meet the standards by 75% and met the requirements by 25% (total coliform exceeded the threshold) (Dinas Kesehatan DKI Jakarta, 2022).

The physical and chemical properties of water are clear, colorless, tasteless, and odorless. Drinking water sources affect diarrhea ($p = 0.003$) with OR (95% CI) = 1.9 (1.26-2.89) which means that people who use unsafe drinking water sources are almost two times more at risk than people who use safe drinking water sources. Salinity, total dissolved solids (TDS), and *E. coli* factors in clean water sources are correlated with diarrhea cases (Dwipayanti, 2020). Other factors that influence the incidence of diarrhea are knowledge, attitudes, and practice. According to (Dwipayanti, 2020), the incidence of diarrhea in Banjaringan District, Klungkung Regency, is determined by factors such as the standard of toilet sanitation, hand washing with soap, and the practice of hand washing with soap at five crucial periods. Furthermore, in Kalideres, West Jakarta, environmental sanitation and hand washing practices are risk factors for diarrhea (Aryawan & Setiawati, 2022). Diarrhea is spread by the use of goose-neck toilets without septic tanks that discharge waste—both urine and feces—directly onto open spaces and unwaterproof floors (Fitriani et al., 2021).

Currently, studies on the factors influencing the incidence of diarrhea in the Seribu Islands District are limited. Therefore, research was conducted on the factors that influence the incidence of diarrhea in the Seribu Islands District.

METHODS

This study was an observational analysis with a case-control approach design. Two groups were compared: diarrhea group and control group. This study was conducted from February to August 2024 in the South Seribu Islands Sub-District, Seribu Islands District, and DKI Jakarta. The population of the diarrhea group comprises all people diagnosed with diarrhea in the working area of the South Seribu Islands Sub-District Health Center in 2022-2023, while the population of the control group comprises all people living in the South Seribu Islands District who do not suffer from diarrhea.

The sample size in the study was obtained from the calculation of the odds ratio (OR) hypothesis test formula with P1, P2, and OR values from previous studies using the minimum sample size formula below (Lemeshow & Hosmer, 2009): 37 samples from the diarrhea group and 37 samples from the control group.

$$n = \frac{\{Z_{1-\alpha/2}\sqrt{2P(1-P)} + Z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

n	= minimum sample size
$Z_{1-\alpha/2}$	= confidence level 95% (1,96)
$Z_{1-\beta}$	= test power = 80% (0,84)
P	= P average from (P1 + P2)/2
P1	= OR with diarrhea incidence from previous study
P2	= OR control group

The independent variables in this study were biological quality, physical quality, chemical quality of clean water, clean water sources, knowledge, attitudes, and practices. The dependent variable in this study was the incidence of diarrhea in the working area of the South Seribu Islands sub-district Health Center.

Water biological quality test was performed using MPN method (presumptive, confirmed, completed test) with lactose broth triple and brilliant green lactose bile broth growth medium. Briefly, water samples are grown on the growth medium. Positive indicators are marked by the growth of *E. coli* on the growth medium, then the data is entered into the MPN table. Good biological quality of water were total coliform and the presence of *E. coli* was zero per 100 ml.

Water chemical quality include odor, taste, color, and turbidity. Observations are made visually and organoleptically. pH measurement with a pH meter. Hardness is done by the EDTA titration method, chloride test using the argentometry method (silver nitrate titration). Measurement of nitrate and nitrite by spectrophotometry or colorimetry methods. Good water chemical parameters are the minimum content of arsenic, fluoride, total chromium, cadmium, nitrite, nitrate, pH in the water 0,01 mg/l, 1,5 mg/l, 0,05 mg/l, 0,003 mg/l, 3 mg/l, 50 mg/l, 0,1 mg/l, 0,9 mg/l, 7, respectively. Data collection was carried out by conducting interviews, questionnaires, and the confidentiality of respondent data was ensured to be saved by researchers. The collected data were then analyzed using the chi-square test and logistic regression test using SPSS software. The study was approved by the Ethics Committee of Faculty of Public Health, Diponegoro University No:100/EA/KEPK-FKM/2024.

RESULTS

Characteristics of Respondent

The distribution of the frequency of diarrhea incidence, respondent characteristics, knowledge, attitudes, respondent practices, sources of clean water, and the results of biological, physical, and chemical quality examinations of clean water from laboratory tests are presented in Table 1.

Table 1. Frequency Distribution of Diarrhea Incidents, Respondent Characteristics, Respondent Knowledge, Attitudes and Practice, Clean Water Sources, and Biological, Chemical and Physical Quality of Consumption Water

Variables	n	%
Diarrhea Incidence		
Diarrhea	37	50.0
No Diarrhea	37	50.0
Sex		
Male	20	27.0
Female	54	73.0

Variables	n	%
Education	4	6.0
Pre-school		
Elementary school	5	7.0
Junior high school	20	27.0
Senior high school	28	37.0
Diploma	11	15.0
Higher education	6	8.0
Occupation		
Civil servant / Troops	7	9.0
Entrepreneur	6	8.0
Laborer	4	6.0
No occupation	35	47.0
Others	22	29.0
Salary		
> UMR Jakarta	27	36.0
> UMR Jakarta	47	64.0
Knowledge		
Good	35	47.0
Poor	39	53.0
Practice		
Good	53	71.0
Poor	21	29.0
Attitude		
Good	39	53.0
Poor	35	47.0
Water Source		
Good	44	59.0
Poor	30	41.0
Biologic properties		
Good	34	46.0
Poor	40	54.0
Physical properties		
Good	50	67.0
Poor	24	33.0
Chemical properties		
Good	22	29.0
Poor	52	71.0

The frequency distribution of females was 54 (73%), and 20 (27%) were males. Respondent education shows 4 (6%) had not graduated from elementary school or pre-school, five (7%) had elementary school, 20 (27%) had junior high school, 28 (37%) had senior high school, and 17 (23%) had higher education. The frequency distribution of poor and good practices was 35 (47%) and 39 (53%), respectively. The frequency distribution of good respondent knowledge was 35 (47%) and poor knowledge was 39 (53%). The frequency distribution of poor respondent attitudes was 21 (29%), and that of good attitudes was 53 (71%). Good clean water sources were found in 44 (59%) and poor sources in 30 (41%). The frequency distribution of the biological quality examination of clean water showed that 40 (54%) were positive for *E. coli* and 34 (46%) were negative. Table 2 showed questions to determine respondents' knowledge, behavior, and practices related to diarrhea.

Table 2. Question Items from Knowledge, Attitudes, and Behavior

Questions	Correct Answer	
	n	%
Knowledge		
What is meant by diarrhea?	33	45.0
Can diarrhea be prevented?	32	44.0
Is diarrhea an infectious disease?	25	34.0
What are the methods to prevent diarrhea?	28	38.0
Does dirty and raw water cause diarrhea?	40	54.0
Does poor sanitation cause diarrhea?	52	70.0
What is the organism cause diarrhea?	21	28.0
Does contaminated food cause diarrhea?	42	57.0
Attitude		
Do you wash your hands before eating?	44	59.0
Do you wash your hands with soap?	50	68.0
Do you wash your hands using soap before preparing food?	53	72.0
Do you wash your hands using soap after defecating?	47	63.0
Do you wash your hands with soap after cleaning your child?	38	51.0
Do you wash your hands with soap after handling poultry/animals?	42	57.0
Practice	40	54.0
Do you boil the water you use for drinking until it boils?		
Do you eat food that is cooked thoroughly?	32	43.0
Is the food served covered?	21	28.0
How do you wash eating and drinking utensils?	25	34.0
Where does this family get clean water for drinking?	31	42.0
Where does this family get clean water to prepare food?	23	31.0

Analysis of the Influence of Risk Factors on the Incidence of Diarrhea

The analysis of the influence of risk factors (knowledge, attitudes and practice of respondents, clean water sources, biological, chemical, and physical quality of clean water) on the incidence of diarrhea is shown in table 3.

Table 3. Results of Influence of Risk Factors on the Incidence of Diarrhea

Variables	Diarrhea						P Value
	Control group		Case group		Total		
	n	%	n	%	n	%	
Biologic quality							
Poor	10	13.5	30	40.5	40	54.1	0.001
Good	27	36.5	7	9.5	34	45.9	Significant
Physical quality							
Poor	12	16.2	12	16.2	24	32.4	1.000
Good	25	33.8	25	33.8	50	67.6	Not Significant
Chemical quality							
Poor	5	6.8	17	23.0	22	29.7	0.002
Good	32	43.2	20	27.0	52	70.3	Significant
Water sources							
Poor	13	17.6	17	23.0	30	40.5	0.344
Good	24	32.4	20	27.0	44	59.5	Not Significant
Knowledge							
Poor	17	23.0	22	29.7	39	52.7	0.244
Good	20	27.0	15	20.3	35	47.3	Not Significant
Practice							
Poor	6	8.1	15	20.3	21	28.4	0.020
Good	31	41.9	22	29.7	53	71.6	Significant
Attitude							
Poor	15	20.3	20	27.0	35	47.3	0.244
Good	22	29.7	17	23.0	39	52.7	Not Significant

The physical quality of water, clean water sources, respondent knowledge, and practice did not significant effect on the incidence of diarrhea ($p > 0.05$), and the biological quality of water had a significant effect on the incidence of diarrhea ($p < 0.05$) and the odds ratio (OR) value = 11.571, indicating that respondents with poor hygiene tended to have a risk of diarrhea 11.5 times compared to respondents with good hygiene. The biological quality of water was a risk factor against the incidence of diarrhea.

The chemical quality of water had a significant relationship with the incidence of diarrhea ($p < 0.05$) and the OR value= 5,44, indicating that respondents with poor chemical quality of water tended to have a risk of diarrhea 5,44 times compared to respondents with good chemical quality of water. Respondents' attitudes had a significant effect on the incidence of diarrhea ($p < 0.05$), with an OR value of 3.52, which indicates that respondents with poor attitude tend to have a risk of diarrhea of 3.52 times compared to respondents with good attitude.

Multivariate Analysis of Risk Factors with Diarrhea Incidence

In the analysis of risk factors that are most related to diarrhea, a multivariate analysis of the logistic regression type with the "enter" method was used. Variables that can be used as candidates are variables with a p value < 0.25 . The results of the logistic regression analysis can be seen in Table 4.

Table 4. Multivariate Logistic Regression Analysis Model Stage 1

Variables	B	S.E.	Wald	Df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Biological quality	2.217	0.639	12.034	1	0.001	9.180	2.623	32.124
Chemical quality	0.942	0.708	1.773	1	0.183	2.566	0.641	10.271
Knowledge	0.011	0.615	0.000	1	0.986	1.011	0.303	3.376
Attitude	1.226	0.687	3.186	1	0.074	3.407	0.887	13.094
Practice	0.751	0.602	1.557	1	0.212	2.119	0.651	6.892
Constant	-2.997	0.966	9.630	1	0.002	0.050		

Based on the results of the regression coefficient significance test in the table above, the chemical quality of water, knowledge, attitude, and practice variables have no significant effect on the incidence of diarrhea ($p\text{-value} > 0.05$). The biological quality of drinking water has a significance value of 0.001 ($p\text{-value} < 0.05$). Based on these results, there is a significant relationship to the incidence of diarrhea with an OR value of 9.180 at a 95% confidence interval (2.623 - 32.124). This means that respondents who have water sources with poor biological indicators have a 9.18 times risk of getting diarrhea compared to respondents who have water sources with good biological indicators.

DISCUSSION

Knowledge, Attitude, and Practice Factors

The results of the statistical test showed that there was no significant relationship between the respondents' knowledge and the incidence of diarrhea. This result seems to be the result of a high degree of public knowledge of diarrhea. The results of this study are not the same as the findings of [Shewangizaw et al. \(2023\)](#), that a person's education and knowledge are related to the incidence of diarrhea. The higher the level of knowledge and education of a mother, the better her understanding and ability to receive messages or information, including in the health sector, will be better. Because mothers have a greater role in caring for toddlers, mothers with higher education tend to have sufficient insight to maintain their children's health so that they can prevent diarrhea. The percentage of respondents with higher education was lower than that of those with lower education. Education is not a direct factor causing diarrhea. In addition, education is related to knowledge and behavior ([Abate et al., 2024](#)).

The attitudes were significantly related to the incidence of diarrhea. The incidence of diarrhea has dramatically decreased due to the responders' positive management attitude. The

attitudes in the question included respondents' awareness of the importance of maintaining environmental cleanliness, the habit of washing hands before touching food, and an understanding of the initial treatment of diarrhea. Respondents who had a positive and proactive attitude toward maintaining cleanliness and health tended to have families who experienced diarrhea less often. This shows that the good attitude of respondents toward maintaining cleanliness plays a major role in preventing the disease. Abbasi et al. (2021) stated that families with respondents who take proactive measures to keep their homes clean and healthy are less likely to suffer from diarrheal illnesses. Diarrhea risk can be increased by adverse attitudes, such as ignoring hand washing practices or drinking water hygiene. Therefore, to lower the prevalence of diarrhea in the community, interventions that emphasize influencing respondents' attitudes are required, such as through health education and sanitation awareness campaigns.

There is no significant relationship between behavior and the incidence of diarrhea. Although individual behaviors, such as washing hands, maintaining environmental cleanliness, and hygienic food processing, are known to be important factors in preventing diarrhea, the data obtained did not support an association between these behaviors and the frequency of diarrhea in the community studied. This can be caused by various other external factors that influence the occurrence of diarrhea, such as drinking water quality, sanitation infrastructure, and uncontrolled environmental factors (Boafo et al., 2024). The absence of a significant relationship can also be influenced by socio-economic factors that have not been fully resolved. People living in environments with poor sanitation and limited access to clean water may still be at risk of diarrhea, even though they practice hygienic behavior (Malaeb et al., 2022). Inadequate understanding about appropriate processes or habits that have not been consistently implemented can negatively impact results, even when groups may have behaviors that are considered acceptable in terms of hygiene. As a result, further educational programs are required that emphasize both changing behaviors and the significance of proper hygiene practices in combating diarrhea. Hand washing behavior can stop the transmission of pathogenic organisms into the body and thus prevent diarrhea. Hand washing behavior can reduce the incidence of diarrhea (Bohsas et al., 2023).

Clean Water Source Factor

The results of the statistical test showed no significant difference between clean water sources and the incidence of diarrhea ($p > 0.05$). The Seribu Islands have adequate water treatment, specifically through the application of SWRO technology, hence the study's findings are suspect. Even though the water source is regarded as clean, behaviors like not washing the hands after activities, using contaminated equipment to get water, or storage water in an unsanitary method might raise the risk of contamination and diarrhea. This finding is the same as the results of the study by (Girma et al., 2024); there was no significant relationship between clean water facilities and diarrhea. Access to clean water sources is an important factor in preventing diarrhea. The data obtained did not show an association between the water sources and the frequency of diarrhea. This can be caused by various other factors that influence the occurrence of diarrhea, such as personal hygiene, food processing, and water handling in households, which can affect the overall health of the community. Therefore, a more holistic approach is needed to reduce the incidence of diarrhea, which involves improving sanitation infrastructure, increasing public awareness of hygienic practices, and better environmental management, so that the risk of diarrhea can be suppressed more effectively (Ante-Testard et al., 2024).

Biological, Chemical and Physical Quality of Water Factors

The results of statistical tests showed that there was a relationship between *Escherichia coli* in clean water and the incidence of diarrhea ($p < 0.05$). The bacteriological quality of clean water is a risk factor for diarrhea. The results of this study are similar to those of studies conducted in various countries, where *E. coli* is the cause of diarrhea. According to theory, *E. coli* is the main indicator of fecal contamination and is often found in environments with poor sanitation. In this study, the presence of *E. coli* in water and food samples was strongly correlated with an increase in the incidence of diarrhea in the community. This confirms the important role of *E. coli* bacteria

as one of the main causes of diarrhea infection, especially in areas with limited access to clean water and proper sanitation facilities (Alizade et al., 2019; Haugan et al., 2024)

Biological quality of water is one of the significant protective factors for diarrhea. According to research by (Mulu et al., 2024), the presence of *E. coli* in clean water is one indicator that the water is polluted and can potentially cause diarrhea when consumed by the community. The presence of enterotoxigenic *E. coli* in water sources can increase the incidence of diarrhea. *Escherichia coli* is the main indicator of fecal contamination that is often found in environments with poor sanitation. In this study, the presence of *E. coli* in water samples was associated with the incidence of diarrhea in the community. This confirms the important role of *E. coli* bacteria as an indicator of diarrhea infection, especially in areas with limited access to clean water and inadequate sanitation facilities.

The chemical factors of the water significant related to the incidence of diarrhea ($p < 0.05$). Chemical parameters such as pH, chlorine levels, and heavy metal content in water. Although these factors can theoretically affect water quality, the results of this study indicate that these factors are not the main causes of diarrhea in the community (Malebatja & Mokgatle, 2023). Also, this study are consistent with Yu et al. (2024), which found that non-ionized ammonia increased by 0.004 mg/L while dissolved oxygen in the surface water decreased by 0.123 mg/L in the Yangtse River, the population's water source. The prevalence of diarrhea surrounding China's Yangtse River is influenced by these factors. The presence of pathogenic bacteria such as *E. coli* is more likely to cause diarrhea than high levels of heavy metals or changes in water pH. This confirms that although the chemical quality of water is important for health, biological contamination remains a major factor in the incidence of diarrhea (Malebatja & Mokgatle, 2023).

The physical quality of the water, such as clarity, color, odor, taste, and temperature, did not had a significant effect to the incidence of diarrhea in the Seribu Islands Regency. These factors are not concentrated in the water and therefore do not affect the water consumed. This is inconsistent with the study of Palmeira et al. (2019), which states that water quality parameters such as free chlorine residue, pH, color, turbidity, fluoride and nitrate. In total, of the 2,897 water samples analyzed, 545 samples did not meet the threshold for water quality requirements. This is related to the incidence of diarrhea and can increase the risk to public health. Therefore, regular monitoring of water quality is needed to avoid waterborne diseases.

Water with poor physical quality often reflects the presence of suspended particles, sediment, and other contaminants, but also has the potential to be a medium for pathogenic microorganisms. In addition, turbid water due to sediment and organic particles provides protection for pathogens from natural disinfection processes. Contaminated water conditions increase the risk of spreading *E. coli* bacteria, especially if the water is consumed without proper treatment (Cohen et al., 2024). Semenza & Ko, (2023) stated that higher water temperatures in tropical coastal areas also support the proliferation of pathogenic microorganisms. In this condition, water that does not meet physical quality standards is one of the factors that facilitates the transmission of diarrhea, especially in communities that rely on well water or untreated rainwater.

The results of the multivariate analysis showed that, of the five variables, there was one variable that had the most influence on the incidence of diarrhea ($p < 0.05$), namely the biological factor of water. It can be concluded that the priority for intervention is the biological factor of drinking water, after which other variables were included in the logistic regression test. The presence of *E. coli* bacteria is strongly correlated with an increase in cases of diarrhea, because *E. coli* can cause intestinal infections that trigger diarrhea, especially in children and vulnerable groups. This study confirms that water and food contaminated with *E. coli* play an important role in the transmission of diarrhea in the community; therefore, supervision of the cleanliness of drinking water and food, as well as improving sanitation, is very necessary to reduce the incidence of diarrhea, especially in the Seribu Islands Districts.

CONCLUSION

The variables of knowledge, attitude, practices, clean water sources, and physical quality of water showed no significant effect on the incidence of diarrhea ($p > 0.05$). While the biological quality of water had a significant effect on the incidence of diarrhea ($p = 0.001$) with odds ratio of 9.180. The DKI Jakarta Provincial Health Office and the Head of Puskesmas need to have a part in providing counseling on diarrhea and how to prevent it. Mothers and toddlers are the primary targets of advice, which mostly focuses on drinking water sanitation and hygiene. For further research, it is necessary to conduct study about other factors related to diarrhea and use longitudinal methods in other diarrhea endemic areas.

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