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THE DETERMINANTS OF DIARRHEA DISEASE INCIDENCE IN DENSELY POPULATED AREA OF WEST NUSA TENGGARA, INDONESIA

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Abstract

Introduction: *Diarrhoea due to water borne diseases is still prevalent in Indonesia and this environmental health problem could triggered outbreaks in multiple regions.* ***Objectives:*** *The aim of this study was to determine the correlation of environmental factors, behavior and quality of water to the incidence of diarrhea in densely populated settlements in Rasanae Barat District, Bima City.* ***Method:*** *This study used cross sectional design and the data was obtained by survey and interview using questionnaire. The population in the study was all residents who lived permanently in the Rasanae Barat District of Bima City. The sample size is 192 which determined by formula for testing the proportion of a single population. Variables of this study were environmental factors (distance of clean water facilities with latrines (septic tanks) and waste bins facilities), behavioral factors (knowledge, and attitude) and water quality (total coliform). Data analysis was carried out includes univariate, bivariate by chi-square statistical test. and multivariate analysis by multiple logistic regression.* ***Results and Discussion:*** *Based on the results of the study, it showed that the variables associated with the incidence of diarrhea were water quality (total coliform) (p=0,000), and knowledge (p= 0.003).* ***Conclusion:*** *Since the variables that have significant association to diarrhea were water quality and knowledge, so it is important for community to build septic tank with requirement standard to overcome the land limitation. Health institution also need to conduct periodic water quality checks and also increase community knowledge about water quality and diarrhea prevention. This study could provide valuable input for diarrhea prevention and control program.*

INTRODUCTION

The ongoing occurrence of waterborne diseases such as diarrhea is one of impacts of environmental health problems. Diarrhea is a fecal discharge disease whose consistency is mushy to liquid with a fecal discharge frequency 3 or more times a day (1). Diarrhea transmission mode is typically by fecal-oral means through enteropathogens such as *Escherichia coli* infected food or drinks (2). Diarrhea is usually a symptom of a gastrointestinal infection that can be caused by numbers of bacterial, viral and parasitic organisms. As a result of poor hygiene, infection is spread through contaminated food or drinking water or from person to person (3). According to the World Health Organization, diarrheal disease is the second leading cause of death in children under age of 5 years. Every year, there are almost 1,7 billion cases of childhood diarrhea (4). The incidence of diarrheal disease in Indonesia is still high, outbreak event of diarrhoea frequently leads to mortality in various regions. In 2015, there were 18 outbreaks of diarrhea with a total of 1.213 cases and 30 deaths with a Case Fatality Rate (CFR) of 2,47%. One of areas with high cases of diarrhea occurred in Bima, West Nusa Tenggara. In 2015, there were 18 outbreaks of diarrhea with a total of 1.213 new cases and 30 deaths with a Case Fatality Rate (CFR) of 2,47%, while in 2017, the number of diarrhea in Bima was 7.320 cases (5).

Diarrheal disease can have a negative impact in both physical fitness and mental development. Diarrhea is also a major cause of malnutrition in the childhood. Diarrhea caused electrolyte imbalances, kidney impairment, dehydration, and defective responses to the immune system (6). rhea in various regions, so the risk factors are important to be identified in order to prevent and reduce the incidence of diarrheal diseases. Factors involved in the emergence of diarrhea are complex, and the relative contribution of each factor varies as a function of socio-economic, environmental, and behavioral variables interaction. Previous studies stated that environmental factors such as clean water facilities, latrines and household floor condition are associated with the incidence of diarrhea (7-9). Safe water should be in accordance with the requirements such as physical, bacteriological and chemical conditions. The bacteriological requirement for safe drinking water is the water must be free from bacteria, particularly pathogenic bacteria. Escherichia coli (EC) and or thermo-tolerant fecal coliform (FC) recommended as indicator of the potential presence of fecal contamination and waterborne pathogens (10). Almost half the world's population household water sources are unsafe due to contamination during collection, storage, and domestic use. In addition, environmental factors such as waste management and improper handling of domestic waste can also increase the risk of diarrhea. Poor waste management allows for increased risk of diarrhea. Since waste that is not properly managed can cause the presence of bacteria that may contaminate food and drink that can be spread by flies landing on the garbage (11).

Previous studies mostly examined diarrhea in the general population. However, there is limited information about the risk factor of diarrheal disease in densely populated settlements. Dense population settlements can have problems such as difficulty making the appropriate distance between water facilities and septic tanks according to required standard. The minimum recommended distance between water source and septic tank is 10 meters. However, in the area with dense population this requirement could be the limitation (12). In addition, areas with high population density are also likely to facilitate person to person transmission of diarrhea that occurs through oral-fecal (13). The increasing population and failure to improve sanitation conditions could lead to the occurrence of water-borne diseases and other diseases (14).

One of areas with high cases of diarrhea occurred in Rasanae Barat District, Bima. West Nusa Tenggara Province. Out of the six villages, namely Nae, Pane, Sarae, Tanjung, Paruga, and Dara, there are two villages that have a population density of over 16.006 people per km^2, namely Sarae and Nae. Nae Urban Village has the highest population density, reaching 17.171 people per km^2 with an area of only 0,31 km^2. This district is a densely populated settlement that may have diarrhea-related environmental health problems. Dense settlements in the population may facilitate transmission of oral-fecal diarrhea. This study interested in analyzing the influence of environmental factors, behavior and water quality with the incidence of diarrhea in densely populated settlements in the district of Rasanae Barat, Bima.

METHOD

This type of research is analytic observational with cross-sectional approach. This research was conducted on Februari-June 2018 in Rasanae Barat District, Bima, West Nusa Tenggara . This area is one of the Subdistricts in the City of Bima, West Nusa Tenggara Province with a geographical position between 118 ° 41 '- 118 ° 48' east longitude and 8 ° 30 '- 8 ° 20' south latitude. Rasanae Barat Subdistrict consists of 6 (six) areas, namely Paruga, Sarae, Tanjung, Dara, Pane, and Nae, where the sub-district capital is located in Paruga. Climatic conditions

in Rasanae Barat Subdistrict are generally the same as those of other regions in Indonesia, namely a tropical climate with two seasons, the rainy season and the dry season. The maximum temperature in the City of Bima reaches 35°C and the minimum temperature reaches 20°C. The average rainfall reaches 1.437 mm with 65 rainy days annually.

The population in the study was all residents who lived permanently in the Rasanae Barat District of Bima City. The sample size is determined by formula for testing the proportion of a single population. 192 samples were included in this study. Independent variables of this study were environmental factors (distance of clean water facilities with latrines (septic tanks) and waste bins facilities), behavioral factors (knowledge, and attitude) and water microbiological quality (total coliform). While dependents variables of this research was the occurrence of diarrhoea. Data collection was performed using structured questionnaire instruments, observations, and measurements. The validity and reliability test of the questionnaire was carried out on 30 respondents in Asakota District because it has the same characteristics as the District of West Rasanae. Water sampling was carried out at each sample house selected in this study. While examination of total coliforms in water samples is carried out in the laboratory by multiple tube method. The criteria for requirements refers to the Minister of Health Regulation No. 492/ Menkes/Per/IV/2010 regarding the standards and quality of clean water and drinking water and Permenkes/736/Menkes/PER/VI/2010 regarding drinking water quality monitoring procedure (15-16).

Data analysis in this study consisted of univariate analysis, bivariate analysis, and multivariate analysis. The characteristics of respondents were identified by descriptive frequency distribution. Univariate analysis was carried out to assess the environmental factors, behavior and water quality in densely populated settlements in Rasanae Barat District. Bivariate analysis was carried out to analyze the influence of environmental, behavioral and water quality factors on the incidence of diarrhea in densely populated settlements in Rasanae Barat District using a chi-square statistical test. Determination of the risk factors that most influence the incidence of diarrhoea was analyzed using multivariate analysis to determine the effect of the independent variable with the dependent variable and which of the independent variables had the greatest effect on the dependent variable using multiple logistic regression statistical tests. The data analysis using SPSS (Statistical Package for the Social Sciences) software. This study has obtained permission from the ethics committee of the Faculty of Medicine, Jenderal Soedirman University, Purwokerto, with number Ref. 1123 / KEPK / III / 2019.

RESULT

192 samples were participated in this study to determine the risk factors of diarrhea in densely populated area. The characteristic of samples/respondents in the West Rasanae District of Bima City could be seen in Table 1.

Table 1. Characteristics of Respondents Based on Gender, Age, Education, Occupation and Income

Characteristics	n	Percentage (%)
Gender		
Male	19	9,9
Female	173	90,1
Age groups		
17-25 yearsold	14	7,3
26-35 yearsold	75	39,1
>36 yearsold	103	53,6
Education		
Uneducated	16	8,3
Elementary school	22	11,5
Junior high school	36	18,8
Senior high school	108	56,2
Higher education	10	5,2
Occupation		
Civil servants	3	1,5
Private employees	9	4,7
Merchant	19	9,9
Others	161	83,9
Income		
< district minimum wage (1.850.000 IDR)	142	74
≥ district minimum wage (1.850.000 IDR)	50	26

Based on Table 1, the majority of respondents were female (90,1%), have the age of > 36 years and most of them graduated from high school (56,2%). For occupation, most of them have other jobs such as housewives, tailor (83,9%) and most of them have income under district minimum wage (1.850.000 IDR).

We also observed the environment and behavioural variables of the respondents, and the results could be seen in Table 2.

Table 2. Univariate Analysis of Environmental and Behavior Variables

Variables	Diarrhea Status			
	Diarrhea		Not diarrhea	
	f	%	f	%
Distance between clean water facilities and latrines				
Unqualified	88	54,7	73	45,3
Qualified	8	25,8	23	74,2
Waste management				
Unqualified	92	50,5	90	49,5
Qualified	4	40,0	6	60,0

Variables	Diarrhea Status			
	Diarrhea		Not diarrhea	
	f	%	f	%
Knowledge				
Poor	82	55,8	65	44,2
Good				
Attitude				
Not supportive	89	54,6	74	45,4
Supportive	7	24,1	22	75,9
Total of Coliform				
Unqualified	83	58,5	59	41,5
Qualified	13	26,0	37	74,0

Based on Table 2, 54,7 % of respondents who suffered from diarrhoea have a distance of clean water facilities with a toilet (septic tank) does not meet the requirements, twice as large as the proportion of respondents who have a distance of clean water facilities with a latrine (septic tank) fulfilling the requirements (25,0%). In the group of respondents who suffered from diarrhoea, the proportion of respondents who owned substandard rubbish bins was (50,5%), slightly larger than the proportion of respondents who have qualified rubbish bins (40,5%). For the total of coliform, in the group of respondents who suffered from diarrhoea, the proportion of respondents with substandard water quality (total coliform) was (58,5%), twice as large as the proportion of respondents who have water quality (total coliform) meets the requirements (26,0%). Bivariate analysis was carried out to analyze the correlation between the dependent variables with the occurrence of diarrhoea (Table 2).

Table 3. Bivariate Analysis

Variables	*p-value*
Distance of Clean Water Facilities with Latrine (Septic Tank)	
Qualified	0,006
Unqualified	
Trash can	
Qualified	0,745
Unqualified	
Knowledge	
Good	0,006
Poor	
Attitude	
Supportive	0,005
Not supportive	
Water quality (Total Coliform)	
Meet the requirement	0,000
Do not meet the requirement	

Based on Table 3, The selected variables for multivariate analysis logistic regression tests were the distance of clean water facilities with septic tanks, knowledge, attitudes and water microbiological quality (total coliform).

Table 4. The Most Influential Risk Factors to Incidence of Diarrhea in Dense Populations in the West Rasanae District of Bima City

	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I.	
							Lower	Upper
Step 1[a]								
Distance (1)	0,635	0,498	1,627	1	0,202	1,887	0,711	5,007
Knowledge(1)	0,882	0,407	4,689	1	0,030	2,415	1,087	5,364
Attitude (1)	0,694	0,521	1,773	1	0,183	2,001	0,721	5,558
Coliform(1)	1,153	0,409	7,950	1	0,005	3,168	1,421	7,062
Constant	-2,696	0,655	16,956	1	0,000	0,067		
Step 2[a]								
Knowledge(1)	0,905	0,405	4,991	1	0,025	2,473	1,118	5,471
Attitude (1)	0,681	0,518	1,731	1	0,188	1,976	0,716	5,448
Coliform(1)	1,361	0,379	12,863	1	0,000	3,900	1,854	8,206
Constant	-2,317	0,565	16,819	1	0,000	0,099		
Step 3[a]								
Knowledge(1)	1,101	0,377	8,555	1	0,003	3,009	1,438	6,294
Coliform(1)	1,442	0,373	14,946	1	0,000	4,227	2,035	8,779
Constant	-1,938	0,460	17,740	1	0,000	0,144		

a. Variabel(s) entered on step 1: distance, knowlegde, attitude, coliform
B : beta coefficient, S.E : standard error; Wald : wald test; df = degree of freedom Sig : significance value
Exp (B) = exponentiation of the B coefficient, CI = confidence interval

Based on multivariate analysis on Table 4, the variables that significantly influence the incidence of diarrhea were water quality (total coliform) and knowledge. Respondents with substandard water quality (total coliform) have a risk of infected with diarrhea by 4,2 times higher compared to respondents with water quality (total coliform) meeting the requirements. Respondents with poor knowledge have a risk of diarrhea 3,0 times higher compared to respondents with sufficient health knowledge.

DISCUSSION

Based on the results of the multivariate logistic regression, the variables that have significant association on the incidence of diarrhea in densely populated settlements in Rasanae Barat Subdistrict of Bima City were the water quality (total coliform) and knowledge. Based current guidelines from WHO, it is advised that *Escherichia coli* (EC) or thermotolerant coliform (FC) be used as sources of fecal contamination of drinking water (17). However, based on reviews from various studies support the use of EC as a fecal indicator for drinking water in households (18). The results of this study is also in accordance with previous report which stated that diarrheal disease is one of the world's leading causes of child mortality and morbidity, mostly from contaminated sources of food and water. 780 million population world widely have lack access to improved drinking water and 2,5 billion have lack improved sanitation.

Infection-related diarrhea is common in developing countries (4). Previous review also showed that the presence of EC in household drinking water is significantly associated with diarrhea. Diarrheagenic *E. coli* (DEC) are among the most popular etiologic agents of diarrhea from water origin. Based on their virulence and phenotypic traits, *E.coli* bacteria are classified into enterotoxigenic E Coli (ETEC), enteropathogenic *E coli* (EPEC), Vero toxin/Shiga toxin-producing *E coli* (VTEC/STEC) or enterohaemorrhagic *E coli* (EHEC), enteroinvasive E coli (EIEC), diffusely adherent E Coli (DAEC) and enteroaggregative *E coli* (EAEC)(19). This agents are transmitted primarily through the fecal-oral route, either through direct person-to-person contact or through infected food or water; hygiene. It is therefore, good hand washing and hygienic measures, could avoid the spread the diarrhea incidence (20). Unfortunately, the identification of coli bacteria species present in water samples were not carried out in this study.

The total coliform found in the water was high that is most likely influenced by the location of the water sources are too close with septic tanks. Based on observations, the proportion of respondents who suffered from diarrhea had substandard/ insufficient water facilities 83,6% twice as large as the proportion of respondents who have water facilities to meet the requirements of 29,0%. The ideal distance between the septic tank and the well/water resources is 10 meters so that the water is not contaminated by pathogenic bacteria (21). However, the ideal distance of 10 meters between the water source and the septic tank seems difficult to apply in areas with high population density due to insufficient land. Several attempts can be made to overcome land limitations. One of them is by knowing the direction of groundwater flow in order to put the septic tank so that the flow direction does not lead to wells or water sources.

In addition, the direction of groundwater flow when making a septic tank should be identified. It is important to note that the groundwater flow velocity in each region is different, giving rise to an ideal distance that varies between wells and septic tanks. It also depends on the rock formations and geographical conditions in each of these areas (22). Each toilet also needs to be equipped with a septic tank. The septic tank is a watertight tube that functions as a place to collect human waste (feces and urine). A solid part of human waste will be left in the septic tank. While the liquid part comes out of the septic tank and is absorbed through fields or infiltration wells (23). Installation of clean water installation with a septic tank at a distance of less than 10 meters must be waterproof at least meters below the surface of the ground in order to protect clean water from contamination of bacteria causing diarrhea (24).

Several interventions also could be carried out to improve the microbiological quality of water such as physical removal of pathogens by filtration, adsorption or sedimentation. The second could be chemical treatment to deactivate pathogen such as with chlorine. Then, boiling or pasteurization or ultraviolet (UV) radiation also could be carried out (25). Previous research also stated that the condition of clean water facilities is the most influential risk factor for the occurrence of diarrhea (26). The availability of clean water, sanitation and hygiene as important roles for prevention of diarrhea. It is stated that the diarrhea is caused by the consumption of unclean and healthy water, inadequate sanitation and inadequate hygiene. It estimated that 94% of diarrheal events can be prevented by environmental modification including increased availability of clean water, and improved sanitation and hygiene (27). There are two main approaches to primary prevention of diarrhea infection which are improved water and sanitation and vaccination. Improving access to clean water, sanitation facilities, and hygiene behaviors (WASH) are key opportunities to improve child health and well-being by preventing infectious disease spread and improving nutritional status (7). The aims of WASH program is to interrupt fecal-oral transmission pathways, which is often called 5F (fluids, fields, flies, fingers and food) (28). Prevention of diarrhea with a focus on safe water and improved hygiene and sanitation is not only possible but also cost-effective: every $1 invested yields an average return of $ 25,50 (29). This should also be balanced with public education with increased health knowledge through health promotion and education (30).

The second influential variable on the occurrence of diarrhea in the study area is knowledge of respondents related to diarrhea. Previous studies also showed the correlation between knowledge and the occurrence of diarrhea (31-32). Lack of knowledge of respondents regarding diarrhea and factors associated with diarrhea can increase the risk of diarrhea infection. A person's knowledge is usually related to education. Based on education respondents, the highest level of education was senior high school graduates (56,2%) and the least were higher education graduates (5,2%). In addition, knowledge can also be obtained from information from television, poster, social media or from health worker counseling (33). It is necessary to increase the knowledge of the community with various methods to reduce the incidence of diarrhea in the area. Basic preventive approaches for interrupting fecal-oral

transmission routes focus primarily on handwashing, hygiene and access to adequate safe water, which can be enhanced by health promotion and awareness. Such interventions against diarrhea are believed to be capable of reducing death from this disease by up to two thirds (34). In this study, the waste management showed no correlation with the occurrence of diarrhea. Yet according to some references, improper waste management can invite vectors. Garbage collection in the bin exceeds 3 x 24 hours (3 days) can invite vectors especially flies. Vector of flies inside the house due to a pile of rubbish that is not thrown away can carry bacteria making it possible to land on food to be consumed so that it can cause diarrhea (35-36).

The shortcomings of this study was the use of cross-sectional study design so it is less accurate to conclude a causal relationship between the independent variables and the dependent variable. In addition, identification of pathogenic species in water samples was also not carried out in the study. It will provide many benefits if further research is carried out on the identification of pathogenic bacteria in water samples so that species that contaminate water can be identified. The strength of this study is being community-based, analyzing integrated several variables from environmental to behavior factors to reveal risk factors for diarrhea in high-density areas.

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CONCLUSION

This study showed that there were a relationship between water quality (total coliform), the distance of clean water facilities and latrines, knowledge, attitudes to the incidence of diarrhea in densely populated areas. Therefore, the community needs to pay attention to the construction of latrines that are in accordance with the standard even if the land is limited. In addition, the community must also treat their water well before consuming it to avoid diarrhea. than optimal, cleaning the water by boiling, chlorinating, ctive behavioral strategy to reduce the risk of diarrhea. For health authority also need to make efforts to increase community knowledge through various methods such as through health education, dissemination of information, and community discussion to create a positive attitude and practice towards the better diarrhea prevention and management. It is expected that the environmental health inspector to pay more attention to environmental health issues in the community, routinely supervise the quality of clean water by conducting periodic water quality checks and disinfection of clean water facilities by chlorization. For further research, identification of coli bacterial species can be carried out to have more effective diarrhea prevention.

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