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Analysis of Characteristics of Toddlers, Mothers, and Living Environment on the Incidence of Diarrhea in Toddlers in Samarinda City in 2024

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Abstract

Diarrhea is still a challenging health problem for children under five years of age in Indonesia. Diarrhea due to waterborne diseases is still prevalent in Samarinda, and this environmental health problem could trigger outbreaks in multiple regions. The objective of this study was to analyze the effect of the characteristics of child, mother, and environment on the incidence diarrhea in Samarinda. The research method used a case-control design with a sample of 124 (62 cases and 62 controls), and the data was obtained by using a questionnaire. The sampling technique was consecutive sampling. Data analysis was carried out, including univariate and bivariate, by chi-square statistical tests. And multivariate analysis by multiple logistic regression. The results showed that the incidence of diarrhea with nutritional status P = 0.027 (OR = 2.292; 95% CI: 1.092-4.807); history of exclusive breast-feeding P = 0.040 (OR = 2.180; 95% CI: 1.030-4.612); history of immunization status P = 0.014 (OR = 2.860; 95% CI: 1.218-6.716); worker mother P = 0.08 (OR = 0.354; 95% CI: 0.163-0.771); and clean water source P = 0.09 (OR = 2.754; 95% CI: 1.280-5.923); and drinking water management P = 0.017 (OR = 2.444, 95% CI: 1.166-5.127). The factors that did not relate significantly in this research were the child's age (P = 0.402), mother's age (P = 0.467), mother's education (P = 0.534), and family income (P = 0.579). The result from the multivariate shows the variable that had the most significant association with diarrhea was the mother's occupation. The accessibility to clean water sources was an intervening variable that played an important role in diarrhea cases in Samarinda. Health institutions also need to conduct periodic water quality checks and increase community knowledge about water quality and diarrhea prevention. This study could provide valuable input for diarrhea prevention and control programs.

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INTRODUCTION

Diarrhea is the release of soft or liquid stools with frequency ≥ 3 times a day, with or without blood or mucus (WHO, 2017). Global Burden of Disease data in 2016 shows that diarrhea is the fifth cause of death worldwide in children under 5 years of age (70.6 deaths [61.9–79.8] per 100,000). Indonesia is ranked 60th worldwide for diarrhea cases (Behera & Mishra, 2022). The prevalence of diarrhea in children under five in Indonesia is 9.8%, and East Kalimantan province ranks 28th with a prevalence of 6.4% (SSGI, 2021). Based on RISKESDAS data (2018), the age category that suffers from diarrhea the most is toddlers, especially those aged 12-23 months.

Diarrhea is the fourth most common disease in the 10 most common diseases in Samarinda City. Based on BPS data from Samarinda City (2018), the total number of diarrhea sufferers is 10,988 people. Based on a report from the East Kalimantan Health Service (2022), the coverage of diarrhea discovered and treated in 2022 in Samarinda City is 38%. The five sub-districts in Samarinda City with the highest number of diarrhea cases are Sungai Kunjang District (1708 cases), Samarinda Ulu District (1632 cases), Sungai Pinang District (1362 cases), North Samarinda District (1292 cases), and Sidomulyo District (858 cases).

Diarrhea is a form of waterborne disease. According to WHO (2017), diarrhea is an infectious disease that can be transmitted through contaminated water sources from human excretion, waste disposal, septic tanks, and latrines increasing the spread of pathogens such as Escherichia coli. Factors that can directly or indirectly trigger diarrhea consist of agent, host, and environmental factors. Many factors are thought to cause diarrhea, including birth weight, nutritional status, measles immunization status, history of zinc administration, breastfeeding patterns, mother's knowledge, and hand-washing habits (Kurniawati and Martini, 2017).

Environmental factors related to the incidence of diarrhea include limited supply of clean water, water contaminated by feces, lack of hygiene facilities, unhygienic disposal of feces, poor personal and environmental hygiene, as well as improper preparation and storage of food. The most dominant environmental factors are facilities for providing clean water and disposal of feces; these two factors interact with human behavior. If environmental factors are unhealthy due to exposure to diarrhea germs and accumulate with unhealthy human behavior, so diarrhea transmission can easily occur (Dharmayanti & Tjandrarini, 2020).

Samarinda is a city that flows by the Mahakam River. There is Karang Mumus River which divides right in the middle of Samarinda City and is one of the sources of life and activities for the people who live around the area. According to a water quality study with E. coli parameters, the water quality of the Karang Mumus River is not suitable for use as a water source for hygiene and sanitation. This is because many people still have very little awareness of healthy living behavior and environmental health awareness, such as defecating, throwing away waste, and throwing rubbish in rivers (Daramusseng & Syamsir, 2021). Therefore, this study aims to determine the prevalence and relationship between toddlers, mothers, and environmental factors with the incidence of diarrhea in toddlers in Samarinda City.

METHOD

This research was conducted at 5 community health centers in Samarinda City, which have the highest prevalence rates of diarrhea. This research uses a case-control study which conducted during the rainy season (1 January – 1 March 2024). We focused on 5 community health centers consisting of Temindung Health Center, Air Putih Health Center, Loa Bakung Health Center, Sidomulyo Health Center, and Bengkuring Health Center because they are considered to represent Samarinda City geographically and socio-demographically. The sample population was toddlers aged 10 - 59 months who diarrhea and visited the community health centers in Samarinda City.

The dependent variable in this study is diarrhea in toddlers. The independent variables in this study include toddlers characteristics (age, nutritional status, exclusive breastfeeding,

immunization status), mothers characteristics (age, education, employment, family income), and environmental characteristics (type of clean water source, water management). The sample size was calculated using a formula referring to previous research by (Kurniawati and Martini, 2017). From these variables, the risk factor variable was taken, considering the smallest OR with a significant P value. Following this formula, the minimum sample size required is 62 respondents for each case and control group. The data collection technique is guided interviews with questionnaires with respondents directly at the Community Health Center to reduce bias.

Data analysis included univariate; bivariate with the chi-square statistical test; and multivariate analysis with multiple logistic regression. Binary logistic regression was performed to analyze the relationship between diarrhea and its factors. We present adjusted odds ratios (OR) with 95% CI, and a P value < 0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

The results of the study are shown in Table 1, where the characteristics of children aged > 24 months (52.4%) with an average age of 23.46 months are higher than the characteristics of children aged ≤ 24 months (47.6%) with an average age of 42.13 months. The characteristics of good nutritional status (61.3%) are higher than those of poor nutrition (38.7%). The characteristics of a history of exclusive breastfeeding (63.7%) are higher than those of not giving exclusive breastfeeding (36.3%). The characteristics of a complete history of immunization (74.2%) were higher than a complete history of immunization (25.8%).

The characteristics of mothers in Table 1 show that those of productive age (58.1%) have an average age of 30.28 years, higher than those of non-productive age (41.9%) who have an average age of 39.27 years. The characteristics of higher education (75%) are higher than low education (25%). In this study, 11 respondents (8.87%) had an elementary school education, 20 respondents had a junior high school education, 88 respondents had a high school education (70.97%), and 5 respondents had a bachelor's education (4.03%). The characteristics of working mothers (66.1%) are higher than those of non-working mothers (33.9%). The majority of mothers have jobs, namely private employees, 60 respondents (48.39%), entrepreneurs, 21 respondents (16.93%), civil servants, 3 respondents (2.42%), and housewives, 40 respondents (32.26%). The characteristics of high-income communities (62.1%) are greater than those of low-income communities (37.9%).

Table 1. Characteristics sample

Variable	N	%
Child's age		
≤ 24 month	30	47.6
> 24 month	94	52.4
Nutritional status		
Low	48	38.7
Good	76	61.3
Exclusive breast-feeding		
No	45	36.3
Yes	79	63.7
Immunization status		
Incomplete	32	25.8
Complete	92	74.2
Mother's age		
Not Productive	52	41.9
Productive	72	58.1
Mother's education		
Low	31	25
High	93	75
Worker mother		
Yes	82	66.1
No	42	33.9
Family income		
Low	47	37.9
High	77	62.1
Clean water source		
Not protected	44	35.5
Protected	80	64.5
Drinking water management		
No	49	39.5
Yes	75	60.5

The environment characteristics in Table 1 show that there are show more protected clean water sources (64.5%) than unprotected clean

water sources (35.5%). In this study, it was found that the majority of respondents used clean water sources, namely PDAM, 80 respondents (64.52%), and electric pump water, 44 respondents (35.48%). Residential environmental characteristics based on drinking water management that manage drinking water (60.5%) are higher than those that do not manage drinking water (39.5%). Most respondents managed to drink water by boiling drinking water 75 respondents (60.48%) and 49 respondents (39.52%) did not manage it because they used refilled gallons of drinking water.

The results of Table 2 show that there is a relationship between diarrhea in toddlers and nutritional status (P = 0.043) with the chance of diarrhea in toddlers with low nutritional status being 2.292 times higher compared to toddlers with good nutritional status (OR = 2.292; 95% CI: 1.092- 4.807). There is a relationship between diarrhea in toddlers who have a history of exclusive breastfeeding (P = 0.062) and the incidence of diarrhea in toddlers who are not exclusively breastfed is 2.180 times higher than in toddlers who are exclusively breastfed (OR = 2.180; 95% CI: 1.030-4.612). There is a relationship between diarrhea in toddlers who have a history of immunization status (P = 0.024) and the incidence of diarrhea in toddlers who do not have a history of immunization status is 2.860 times higher than in toddlers who have a history of immunization status (OR = 2.860; 95% CI: 1.218-6.716). There is a relationship between diarrhea in toddlers with working mothers (P = 0.014) and the incidence of diarrhea in toddlers who have working mothers is 0.354 times higher than in toddlers who have housewives (OR = 0.354; 95% CI: 0.163-0.771).

There is a relationship between diarrhea in toddlers who have a clean water source (P = 0.015) and the incidence of diarrhea in toddlers who do not have a clean water source is 2.754 times higher than in toddlers who have a clean water source (OR = 2.754; 95% CI: 1.280-5.923). There is a relationship between diarrhea in toddlers who receive drinking water management (P = 0.028) and the incidence of diarrhea in toddlers who do not receive drinking water management is 2.444 times higher than in toddlers who receive drinking water management (OR = 2.444, 95% CI: 1.166-5.127). There was no relationship between diarrhea in toddlers and the child's age (P = 0.529). There was no relationship between diarrhea in toddlers with maternal age (P = 0.585), maternal education (P = 0.678), and family income (P = 0.711).

Analyzing the dominant factors that influence the risk of diarrhea in toddlers in Samarinda City, multivariable analysis was carried out by looking for the relationship between the independent variables and the dependent variable. The first step is to select candidate variables to be included in the multivariable analysis. Candidate variables can be selected from the results of bivariable analysis with the simple logistic regression test which has a P value < 0.25. The recapitulation results of the simple logistic regression analysis of the incidence of acute diarrhea in toddlers can be seen in Table 3. The results of the simple logistic regression analysis in Table 3 show that those who meet the requirements to enter multivariable modeling with P<0.25 are nutritional status, exclusive breastfeeding, immunization history, mother's occupation, type of clean water source, and drinking water management. Meanwhile, variables that are not included in multivariable modeling are toddler age, mother's age, mother's education, and family income.

The results of the multiple logistic regression analysis process have two stages. The first step in Table 3 shows that the nutritional status variable has a P value > 0.05, and this value is the largest among the other variables, so this variable was excluded. The second step of analysis in Table 4 shows that the exclusive breastfeeding variable has a P value > 0.05 but is still included in the analysis as a confounding factor, if this factor is excluded, there will be a change in the OR of more than 10%. The dominant variable is seen from the OR value of the most significant variable.

Demissie et al. (2021) reported an increased risk of developing diarrhea in children aged 12-23 years compared to children aged 0-11 months. This may happen because babies aged between 12 and 23 months start to crawl and move around the house, making it easy to swallow dirty or contaminated objects. The incre-

Table 2. Bivariable analysis

Variable	Diarrhea		Not Diarrhea		P	OR	CI 95%
	N	%	N	%			
Child's age							
≤ 24 month	17	56.7	13	43.3	0.529	1.424	0.622-3.258
> 24 month	25	33.7	49	66.3			
Nutritional status							
Low	30	62.5	18	37.5	0.043*	2.292	1.092-4.807
Good	32	42.1	44	57.9			
Exclusive breast-feeding							
No	28	62.2	17	37.8	0.062*	2.18	1.030-4.612
Yes	34	43.1	45	56.9			
Immunization status							
Incomplete	22	68.7	10	31.3	0.024*	2.86	1.218-6.716
Complete	40	43.5	52	56.5			
Mother's age							
Not Productive	28	53.8	24	46.2	0.585	1.304	0.638-2.666
Productive	34	47.2	38	52.8			
Mother's education							
Low	17	54.8	14	45.1	0.678	1.295	0.573-2.929
High	45	48.3	48	51.7			
Worker mother							
Yes	34	41.4	48	58.6	0.014*	0.354	0.163-0.771
No	28	66.7	14	33.3			
Family income							
Low	25	53.2	22	46.8	0.711	1.229	0.594-2.541
High	37	72.5	14	27.5			
Clean water source							
Not protected	29	65.9	15	34.1	0.015*	2.754	1.280-5.923
Protected	33	41.2	47	58.8			
Drinking water management							
No	31	63.2	18	36.7	0.028*	2.444	1.166-5.127
Yes	31	41.3	44	58.6			

**P value < 0.05*

Table 3. The multiple logistic regression test analyzes the factors that influence the incidence of diarrhea

	Variable	B	*P*	OR	CI 95%	
					Lower	*Upper*
Step 1	Nutritional status	-0.252	0.723	0.778	0.194	3.119
	Immunization status	-1.080	0.028	0.340	0.130	0.890
	Exclusive breast-feeding	-0.798	0.068	0.450	0.191	1.061
	Worker mother	1.092	0.014	2.980	1.246	7.126
	Clean water source	-1.432	0.002	0.239	0.097	0.588
	Drinking water management	-0.710	0.318	0.492	0.122	1.984
Step 2	Immunization status	-1.080	0.028	0.339	0.130	0.888
	Exclusive breast-feeding	-0.813	0.062	0.444	0.189	1.042
	Worker mother	1.085	0.015	2.959	1.238	7.070
	Clean water source	-1.441	0.002	0.237	0.096	0.582
	Drinking water management	-0.914	0.030	0.401	0.175	0.916

ased risk of diarrhea in children over 12 months of age may be due to the initiation of complementary feeding (Tareke et al., 2022). In research conducted by Fisseha Asfaha (2018) in Ethiopia, diarrhea was most commonly found in children aged 6–23 months, with the highest peak at the age of 12-23 months before starting to decline at the age of 24 months.

Nutritional status is a risk factor for acute diarrhea in children under five. Poor nutritional status is associated with susceptibility to infection. The study by Shrestha et al. (2020) in Nepal shows there is an influence of nutritional status on the incidence of diarrhea, P = 0.01 (OR = 0.70, CI 95%: 0.43-1.11). Another study by Tickell et al. (2020) in Tanzania shows that children with malnutrition have a risk of developing E. coli infection OR = 2.8 (CI 95%: 1.14-3.79).

Study by Asfaha et al. (2018) in the Zana district of Ethiopia reported that infants who were not exclusively breastfed and those who received complementary foods beyond 6 months of age had a fivefold and twofold greater risk of developing diarrhea, respectively, unlike other infants. Similar research results have been reported in East African countries by Tareke et al. (2022) and in Cameroon by Tambe et al. (2015).

Study by Demissie et al. (2021) to determine the prevalence and variables associated with diarrhea in children under 5 years of age in 34 sub-Saharan African countries shows that children who started breastfeeding within 1 hour after birth had a lower risk of diarrhea. Therefore, mothers should be encouraged to start breastfeeding within an hour so that their babies benefit from the protective effects of breastfeeding against infectious diseases, including diarrhea. Several respondents in this study stated that they did not give breast milk when giving birth because breast milk did not come out at that time. Apart from that, several other respondents also said that babies did not want to be given breast milk, so the respondents gave their babies other foods such as biscuit porridge.

Study by Monalisa et al. (2020) on the island of Sumatra shows that there is an effect of complete immunization, namely having passed measles immunization, on the incidence of diarrhea with a value of P = 0.005 and OR = 1.531 (CI 95%: 1.147-2.043). Measles infection in toddlers is often accompanied by diarrhea, so providing immunity against measles will also reduce the incidence of diarrhea. Diarrhea can occur due to the invasion of the measles virus into the gastrointestinal mucosa, disrupting its normal function, or as a result of decreased endurance in measles sufferers (Arifin et al., 2022). Providing rotavirus immunization to children can provide the best protection against diarrhea (Lamberti et al., 2016). Enane et al. (2016), in their research in Botswana, showed that vaccination coverage of 76%–90% in children under 2 years of age reduced morbidity and mortality caused by diarrhea by 23% and 22%, respectively.

The maternal age factor, which is classified as low risk, is 20–30 years of age, and if we look at the relationship with the incidence of diarrhea in children, maternal age does not have a significant relationship with the incidence of diarrhea. The age range of 20-35 years is the fertile and productive age; it is possible that mothers at this age work outside the home so that mothers give less attention to the condition and health of their children. According to Tareke et al. (2022), children born to younger mothers have a greater risk of developing diarrhea than children born to older mothers (35–49 years).

High education will support a mother's ability to absorb new, positive information in caring for toddlers to prevent diarrhea; it will increase understanding in preventing diarrhea (Ndayisaba et al., 2022). Higher levels of education are more oriented toward preventive action, knowing more about health problems, and having better health status (Khaliq et al., 2022). Research conducted by Connell et al. (2017) in East Africa found that children of mothers or caregivers with higher education tended to have a lower prevalence of diarrhea, regardless of water and sanitation conditions. This is due to a better understanding of good hygiene practices and correct feeding practices.

Toddlers from working mothers are 2 times more likely to develop diarrhea than toddlers from mothers who don't work. This is because mothers who do not work have more free time to care for their children to prevent diarrhea

(Hasan et al. 2021). A study conducted in Rwanda by Hbatu et al. (2017) found that housewives had more correct feeding practices compared to working mothers. This is caused by working mothers who find it difficult to manage time to prepare healthy, nutritious food, thereby increasing children's vulnerability to diarrhea and other infections. Apart from having more free time to care for their children, mothers who do not work tend to provide exclusive breastfeeding for a longer duration and more frequently in one day than working mothers (Mulatu et al., 2021).

Low socioeconomic status causes inadequate sanitation facilities, poor environmental and home sanitation, as well as a lack of personal hygiene for children, thereby increasing the risk of diarrhea (Fagbamigbe et al., 2021). Poverty can reduce parents' capacity to support adequate health care for children; they tend to have poor hygiene, a poor diet, and poor education. Poor families prioritize other needs compared to maintaining the health of family members (Sumampouw et al., 2019). Research in Rwanda by Claudine et al. (2021) confirmed an increased risk of diarrhea in low-income households, where children experience malnutrition, causing reduced immunity and an increased risk of diarrhea.

The prevalence of diarrhea in children is influenced by environmental factors such as drinking water sources, sanitation facilities, and water treatment. Drinking water from an unknown source is strongly associated with a greater risk of diarrhea (Alum et al., 2024). Water sources that are not covered are vulnerable to contamination from runoff, making the water unsafe to drink. Mamboleo et al. (2016), in their study in childcare facilities using rainwater and shallow well water, reported 86.7% of diarrhea cases in Kenya.

Clean water with good quality, from a physical perspective, can be seen through the clarity of the water and that it is colorless, tasteless, and odorless (Hailu et al., 2021). Transmission of diarrhea can occur through water used for daily needs; therefore, water sources that do not meet the requirements will have an adverse impact on health (Mallick et al., 2020). The condition of clean water facilities is closely related to the pollution that can occur in clean water. Therefore, to prevent clean water pollution, the clean water facilities used must meet the requirements (McClelland et al., 2022). Research by Wolf et al. (2022) shows clean drinking water and adequate sanitation facilities reduce the risk of diarrhea by 52% and 24%, respectively, in low-income countries.

Water that is not managed according to household drinking water management standards can cause disease. Management of household drinking water can improve the microbiological quality of drinking water in households with simple and affordable methods and reduce the incidence and death rates caused by water-borne diseases such as diarrhea (Mshida et al., 2018). The process of processing raw water into refillable drinking water is in principle filtration to separate suspended contaminants and disinfection to kill unfiltered microorganisms (Darmawan et al., 2022).

Storage of refill water can also affect the presence of E. coli in the refill water. Research by Yunada et al. (2023) shows that there are differences in the amount of E. coli in refillable drinking water with storage time. Refillable drinking water usually doesn't run out in one use but within a few days. According to Agustina (2021), the longer storage allows the growth of microorganisms, which will develop into pathogenic bacteria and cause levels of organic substances to increase.

Our research has limitations in that our research data cannot be generalized to all urban areas in Indonesia, and the results of questionnaire interviews with respondents may result in recall bias.

CONCLUSION

Diarrhea is a common disease in childhood that can be prevented by maintaining personal health and environmental conditions. Multivariate results show that the variable that has the most significant relationship to diarrhea is maternal employment. Accessibility to clean water sources is an intervening variable that plays an important role in diarrhea cases in Samarinda. The health department also needs to carry out regular water quality checks and increase public

knowledge about water quality and diarrhea prevention. This research can provide valuable input for diarrhea prevention and control programs.

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