ASSOCIATION BETWEEN HOUSEHOLD ENVIRONMENTAL SANITATION AND DIARRHEAL INCIDENCE AMONG TODDLERS IN MEDAN CITY: A CROSS-SECTIONAL STUDY

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ABSTRACT

Diarrhea remains a major public health problem among children under five in urban areas, despite the increasing coverage of basic household sanitation over time. This condition indicates that improvements in sanitation facilities have not yet produced an optimal impact on reducing the incidence of diarrhea. This study aims to analyze the relationship between household environmental sanitation conditions and the incidence of diarrhea among children under five in Medan City. This research employed a quantitative design with a cross-sectional approach, involving mothers with children aged 24–59 months. Data were collected through structured interviews and direct observation of household environmental sanitation facilities, including sources of clean water, latrine ownership, solid waste management, and wastewater disposal facilities. The collected data were analyzed using bivariate analysis with the chi-square test. The results showed that there was no statistically significant association between all environmental sanitation variables and the incidence of diarrhea among children under five. These findings suggest that the mere physical availability of adequate sanitation facilities does not necessarily contribute directly to reducing diarrhea incidence without being supported by consistent household hygiene practices. Therefore, diarrhea prevention efforts among children under five should be carried out comprehensively by integrating improvements in environmental sanitation with the strengthening of clean and healthy living behaviors at the household level.

Keywords : *First Keyword, Second Keyword, Third Keyword, Fourth Keyword, And Fifth Keyword*

INTRODUCTION

Diarrhea remains a major public health problem, particularly among children under five, as it contributes substantially to morbidity and mortality in developing countries. Globally, diarrhea is the second leading cause of death among children under five after Pneumonia, with an estimated hundreds of thousands of deaths each year (Ministry of Health of the Republic of Indonesia, 2022). Annually, diarrhea contributes to mortality among approximately two billion children worldwide, with more than 525,000 deaths occurring in children under five. The first two years of life represent the period with the highest incidence of diarrheal cases, which then gradually declines as children grow older (World Health Organization, 2023).

In line with Sustainable Development Goals Goal 6, access to safe drinking water, sanitation, and hygiene is essential for human health and well-being. Consumption of unsafe water can adversely affect health through diseases such as Diarrhea. More than 700 children under the age of five die every day from diarrheal diseases attributable to inadequate water, sanitation, and hygiene (WASH). Nevertheless, approximately 2.2 billion people worldwide still lack access to safely managed drinking water. More than half of the global population does not have access to safely managed sanitation services, around three billion people lack access to basic handwashing facilities with soap, and approximately 673 million people still practice open defecation (UNICEF, 2022).

Diarrhea is an environmentally based disease that is closely associated with sanitation conditions and hygiene practices. Environmental factors such as the quality of clean water, ownership and proper use of improved latrines, household solid waste management, and wastewater disposal systems play a critical role in the transmission of diarrheal pathogens. Inadequate sanitation increases the risk of contamination by pathogenic microorganisms, particularly through water and food media (World Health Organization, 2023).

Evidence from Bangladesh indicates that children aged 6–11 months are more likely to experience diarrhea compared to older children, particularly in households lacking access to safe drinking water and where mothers have limited knowledge regarding child health and hygiene practices (Kamal, 2022). Another study conducted across five Southeast Asian countries—Indonesia, Cambodia, Myanmar, the Philippines, and Timor-Leste—identified fecal disposal practices, breastfeeding status, and child feeding history as significant risk factors for diarrhea among children under five (Arifin, 2022). Similarly, research conducted by Agustina (2021) in Kupang Tengah found that inadequate latrine facilities, poor solid waste management, and lack of handwashing facilities with soap were significant risk factors for diarrheal incidence.

According to the Provincial Health Office of North Sumatra, the neonatal mortality rate (AKN) was 2.9 per 1,000 live births, the under-five mortality rate (AKABA) was 0.3 per 1,000 live births, and the infant mortality rate (AKB) was 2.9 per 1,000 live births. Among causes of death in children aged 12–59 months, diarrhea ranked as the third leading cause. The number of reported diarrhea cases among children under five in North Sumatra reached 70,243 cases, representing 27.74% of those receiving health services. Diarrhea was also the leading cause of post-neonatal mortality (29 days–11 months), accounting for 22 cases. In November, an outbreak (KLB) of diarrhea affected three villages with an attack rate of 3.33%, involving 50 cases, including 15 cases among children under five. In 2020, the neonatal mortality rate was recorded

at 2.3 per 1,000 live births, the infant mortality rate at 2.7 per 1,000 live births, and the under-five mortality rate at 0.2 per 1,000 live births. Diarrhea was the second leading cause of death among children aged 12–59 months, with a morbidity rate of 843 per 1,000 population (North Sumatra Provincial Health Office, 2020).

The number of diarrheal cases in Medan City in 2021 reached 18,588 cases among children under five, with the five highest-burden sub-districts being Medan Perjuangan, Medan Belawan, Medan Deli, Medan Labuhan, and Medan Amplas (Medan City Health Office, 2023). A study conducted by Nurlaila in 2022 reported that environmental sanitation factors—such as housing conditions, excreta disposal, and access to clean water—as well as maternal personal hygiene, particularly handwashing with soap, were significantly associated with the incidence of diarrhea among children under five.

As one of the largest cities in Indonesia, Medan is characterized by high population density and socioeconomic heterogeneity, both of which may influence household environmental sanitation conditions. Although access to basic sanitation services in urban areas tends to be better than in rural settings, cases of diarrhea among children under five continue to be reported annually. This situation suggests that the risk of diarrhea is not solely determined by physical environmental factors but is also influenced by household-level behaviors and health practices (Medan City Health Office, 2023).

Based on this background, it is essential to comprehensively examine the relationship between environmental sanitation and the incidence of diarrhea among children under five. Such an approach is expected to provide a more holistic understanding of the determinants of diarrheal disease, thereby informing the development of more effective and evidence-based environmental health interventions in Medan City.

METHOD

This study employed an analytical survey design using a cross-sectional approach. It was designed to examine the relationship between environmental sanitation and diarrhea among children under five, with all variables measured simultaneously (Creswell, John W., 2018). The study was conducted in seven sub-districts of Medan. The study population consisted of children aged 24–59 months and their mothers residing in the selected sub-districts. The sample was determined using a purposive sampling method based on inclusion criteria, namely children aged 24–59 months living in Medan Amplas, Medan Perjuangan, Medan Labuhan, Medan Barat, Medan Deli, Medan Belawan, and Medan Denai, and households with access to both piped (PDAM) and non-piped water sources.

This study utilized a structured questionnaire and an observation checklist that had been tested for validity and reliability prior to data collection. Validity testing was conducted using the Pearson Product Moment correlation, in which all items were declared valid (r count > r table; $\alpha = 0.05$). Reliability testing was performed using Cronbach's Alpha, with a value of ≥ 0.70, indicating good internal consistency (Creswell, John W., 2018; Sugiyono, 2019).

Operationally, diarrhea was defined as a condition in which children aged 2–5 years experienced bowel movements ≥3 times per day with loose or watery stools within the past month, categorized as diarrhea or non-diarrhea based on frequency and stool consistency. Environmental

sanitation referred to the fulfillment of household health requirements, including access to clean water, latrine ownership, solid waste management, and wastewater disposal, in accordance with Minister of Health Regulation of the Republic of Indonesia No. 829 of 1999. Clean water sources were classified as piped (PAM) and non-piped, while latrine ownership, solid waste management, and wastewater disposal facilities were assessed through observation and categorized as either meeting or not meeting environmental health standards.

Univariate analysis was conducted to provide a general overview of the variables under study, including factors related to access to basic sanitation facilities—such as sources of drinking water, latrine ownership and fecal disposal facilities, solid waste management, and wastewater disposal systems—as well as the incidence of diarrhea. The results of the univariate analysis were presented in the form of frequency distribution tables to describe the characteristics of each variable (Polit, Denise F. & Beck, Cheryl Tatano, 2021).

Bivariate analysis was performed using the chi-square statistical test to examine the association between independent variables and the dependent variable. This analysis aimed to determine whether there was a statistically significant relationship between environmental sanitation factors and the incidence of diarrhea among children under five (Creswell, John W., 2018).

RESULTS AND DISCUSSIONS

Table 1. Distribution of Respondents' Characteristics in Medan

Variable	n=120	%
Age		
Late teenager (>25 tahun)	25	20,8
Early adulthood (25-35 tahun)	72	60
Late Adulthood (36-45 tahun)	20	16.7
Early elderly (>46 tahun)	3	2.5
Education		
Junior High School	11	9.2
Senior High School	68	56.7
University	41	34.2
Occupation		
Employed	31	25.8
Housewife	89	74.2
Child's age		
2 years	63	52.5
3 years	21	17.5
4 years	20	16.7
5 years	16	13.3
Drinking water source		
Refilled water	81	67.5
Boiled water	39	32.5
Diarrhea incidence		

Diarrhea	61	50.8
No Diarrhea	59	49.2

Based on Table 1, the distribution of respondents' characteristics in Medan shows that the majority of respondents were in the early adulthood category, with 72 respondents (60%). Regarding educational background, most respondents had completed senior high school, accounting for 68 respondents (56.7%). In terms of occupation, the majority were housewives, totaling 89 respondents (74.2%). Based on drinking water sources, most respondents used refiled water, with 81 respondents (67.5%). Furthermore, the incidence of diarrhea among children under five indicated that 61 respondents (50.8%) reported their children had experienced diarrhea in the past month.

Table 2. Distribution of Latrine Ownership, Solid Waste Management, and Wastewater Disposal Facilities in Medan

Environmental Sanitation	**Yes**		**No**	
	n	**%**	**n**	**%**
Latrine Ownership				
Availability of a latrine	120	100		
Availability of septic tank	109	90.8	11	9.2
The containment pit does not contaminate drinking water sources	103	85.8	17	14.2
No odor and feces are not accessible to insects or rodents	68	56.7	52	43.3
Adequate size and a floor sloping toward the squat hole with a watertight surface	120	100		
Easy to clean and safe to use	120	100		
Equipped with walls and a roof, with sufficient lighting and ventilation	120	100		
All household members use the latrine (if not, specify alternative defecation practices)	120	100		
Cleaned at least once a week	119	99.2	1	0.8
Availability of water and cleaning tools	119	99.2	1	0.8
Solid Waste Management				
Availability of temporary waste storage both inside and outside the house	120	100		
Waste containers are durable/strong	86	71.7	34	28.3
Waste containers have lids, are easy to open, and easy to empty	45	37.5	75	62.5
Easy to be carried/transported by one person	120	100		
Distance of waste container ≤ 5 meters from the house	120	100		
Waste container does not produce odor and does not become a breeding site for vectors	78	65	42	35
Waste is sorted before disposal	120	100		
Recycling practices for plastic cups or glass bottles	38	31.7	82	68.3
Knowledge of the 3R concept (reuse, reduce, recycle)	65	54,2	55	45.8
Regular practice or application of the 3R concept	38	31.7	82	68.3
Wastewater Disposal Facilities (SPAL)				

Availability of a household wastewater drainage system (SPAL)	120	100		
SPAL is constructed from watertight materials and is covered	120	100		
Wastewater is discharged into an open drainage channel	82	68.3	38	31.7
Open drainage is odorous and has stagnant water	48	40	72	60
SPAL is clean and free from leaves or debris that may cause blockage	104	86.7	16	13.3
SPAL is cleaned at least once a week	98	81.7	22	18.3
Does not serve as a breeding site for vectors	101	84.2	19	15.8
Separation between bathroom/kitchen wastewater and toilet waste	80	66.7	40	33.3
Treatment of bathroom and kitchen wastewater before discharge	1	0.8	119	99.2
Toilet waste is discharged into open drainage	116	96.7	4	3.3

Based on Table 2, all respondents (100%) reported having a latrine. Most had septic tanks (90.8%) and latrines that did not contaminate drinking water sources (85.8%). However, only 56.7% had odor-free latrines that were protected from insects and rodents. Nearly all respondents reported adequate latrine conditions in terms of size, floor structure, ease of cleaning, safety, and availability of water, cleaning tools, ventilation, and lighting (≥99%). In terms of solid waste management, all respondents (100%) had temporary waste storage facilities outside the house, and these were generally accessible and located within 5 meters. However, only 71.7% had durable waste containers, and 62.5% lacked proper lids. While all respondents reported sorting waste before disposal, most did not practice recycling (68.3%), were unaware of the 3R concept (54.2%), and did not apply it regularly (68.3%). Regarding wastewater disposal, all households (100%) had SPAL systems made of watertight and covered materials. However, 68.3% discharged wastewater into open drains, although 60% reported that their drainage systems were not open, odorless, and free of stagnant water. Most respondents maintained clean SPAL systems (86.7%), cleaned them weekly (81.7%), and ensured they did not serve as vector breeding sites (84.2%). Nevertheless, only 66.7% had separated wastewater channels, while the majority did not treat domestic wastewater before disposal (99.2%), and most discharged toilet waste directly into drains (96.7%).

Table 3. Frequency Distribution of Environmental Sanitation in Medan

Variable	n=120	%
Clean water source		
Piped water (PAM)	60	50
Non piped water	60	50
Latrine Ownership		
Non Health Standards	3	2.5
Health Standards	117	97.5
Solid Waste Management		
Non Health Standards	37	30.8
Health Standards	83	89.2
Wastewater Disposal Facilities		
Non Health Standards	60	50

Health Standards	60	50

Based on Table 3, half of the respondents (50%) used piped water (PAM) as their source of clean water. In terms of latrine ownership, the majority of households (97.5%) met the required health standards. Regarding solid waste management, most respondents (89.2%) had practices that met the criteria. However, only 50% of respondents had wastewater disposal facilities that met the required standards.

Table 4. Association between Clean Water Source and Diarrhea Incidence among Toddlers in Medan

	Diarrhea		Non Diarrhea		Total		p.value
	n	%	n	%	n	%	
Clean water source							
Non piped water	28	46.7	32	53.3	60	100	0.456
Piped water (PAM)	33	55	27	45	60	100	
Total	60	50	60	50	120	100	

Based on Table 4, among respondents using non-piped water sources, 46.7% of children experienced diarrhea, while 53.3% did not. In contrast, among those using piped water (PAM), 55% of children experienced diarrhea and 45% did not. The chi-square test showed a p-value of 0.456 ($p > 0.05$), indicating no significant relationship between clean water source and diarrhea incidence among toddlers in Medan.

Table 5. Association between Latrine Ownership and Diarrhea Incidence among Toddlers in Medan

	Diarrhea		Non Diaarhea		Total		p.value
	n	%	n	%	n	%	
Latrine Ownership							
Non Health Standards	2	66.7	1	33.3	3	100	1.000
Health Standards	59	50.4	58	49.6	117	100	
Total	61	50.8	59	49.2	120	100	

Based on Table 5, among respondents with latrines not meeting health standards, 66.7% of toddlers experienced diarrhea, while 33.3% did not. Among those with latrines meeting health standards, 50.4% of toddlers experienced diarrhea and 49.6% did not. The chi-square test yielded a p-value of 1.000 ($p > 0.05$), indicating no significant relationship between latrine ownership and diarrhea incidence among toddlers in Medan.

Table 6. Association between Solid Waste Management and Diarrhea Incidence among Toddlers in Medan

	Diarrhea		Non Diaarhea		Total		p.value
	n	%	n	%	n	%	
Solid Waste Management							
Non Health Standards	16	43.2	21	56.8	37	100	0.361
Health Standards	45	54.2	38	45.8	83	100	

Total	61	50.8	59	49.2	120	100	

Based on Table 6, among respondents with inadequate solid waste management, 66.7% of toddlers experienced diarrhea, while 56.8% did not. Among those with adequate waste management, 54.2% of toddlers experienced diarrhea and 45.9% did not. The chi-square test showed a p-value of 0.361 (p > 0.05), indicating no significant relationship between solid waste management and diarrhea incidence among toddlers in Medan.

Table 7. Association between Wastewater Disposal Facilities and Diarrhea Incidence among Toddlers in Medan

	Diarrhea		**Non Diaarhea**		**Total**		**p.value**
	n	**%**	**n**	**%**	**n**	**%**	
Wastewater Disposal Facilities							
Non Health Standards	30	50	30	50	60	100	1.000
Health Standards	31	51.7	29	48.3	60	100	
Total	61	50.8	59	49.2	120	100	

Based on Table 7, among respondents with inadequate wastewater disposal facilities, 50% of toddlers experienced diarrhea and 50% did not. Similarly, among those with adequate facilities, 51.7% of toddlers experienced diarrhea and 48.3% did not. The chi-square test yielded a p-value of 1.000 (p > 0.05), indicating no significant relationship between wastewater disposal facilities and diarrhea incidence among toddlers in Medan.

The study found that 61 respondents (50.8%) reported diarrhea among toddlers in the past month, while 59 respondents (49.2%) did not. Among those with diarrhea, 54.1% used piped water (PAM) and 45.9% used well water. In contrast, among those without diarrhea, 45.8% used PAM and 54.2% used well water. This prevalence is relatively high compared to national data in 2020 (28.8%) and local data in Medan for 2020 (12.2%), 2021 (49.8%), and the monthly report (0.46%).

Interviews with health workers indicated that diarrhea data are primarily based on cases reported at community health centers, without active household surveillance. Meanwhile, respondents reported that initial home management, such as giving bananas, is commonly practiced, and medical care is sought only if symptoms persist. Consequently, many mild cases are not recorded in health facility data. Additionally, some respondents prefer seeking treatment from private pediatricians or midwives rather than visiting public health centers, contributing to potential underreporting.

The study findings indicate that most respondents had latrines meeting health standards, accounting for 117 respondents (97.5%). This was reflected by the availability of private latrines with goose-neck designs equipped with septic tanks, although a small proportion still discharged waste directly into nearby drains. In terms of solid waste management, 83 respondents (89.2%) met the required criteria; however, some households still used uncovered waste containers. Meanwhile, only 60 respondents (50%) had adequate wastewater disposal facilities, characterized by relatively clean drainage systems, free from blockages and not serving as vector breeding sites, although some wastewater was still discharged into open channels.

The chi-square test yielded a p-value of 0.456 (p > 0.05), indicating no significant relationship between clean water sources and diarrhea incidence among toddlers in Medan. This

finding may be explained by the fact that the majority of respondents (67.5%) used bottled/refilled water as their primary source of drinking water, while other water sources were mainly used for bathing, washing, and food preparation. This condition may reduce the risk of diarrhea transmission through water. According to the Indonesian Ministry of Health, access to safe and protected water sources is associated with a lower risk of diarrhea, particularly when used for drinking, handwashing, and food preparation (Ministry of Health of the Republic of Indonesia, 2015). Communities can prevent diarrhea transmission by ensuring safe water handling, proper storage, and hygienic practices. These findings are consistent with previous studies, including research by Lubis (2022), which reported no association between clean water facilities and diarrhea among breastfeeding children in post-eruption settlements of Mount Sinabung, Karo. Similarly, a study by Zara and Fitriany (2021) in Aceh also found no significant relationship between water quality and diarrhea incidence among toddlers.

The chi-square test yielded a p-value of 1.000 ($p > 0.05$), indicating no significant relationship between latrine ownership and diarrhea incidence among toddlers in Medan. Most households already had private latrines with goose-neck designs, were used by all family members, and were equipped with cleaning facilities, although some respondents still discharged toilet waste directly into nearby drains due to the absence of septic tanks. These findings are consistent with previous studies, including Yantu (2021) in Waleure Village and research conducted at Puskesmas Sapta Taruna (2022), both of which reported no significant association between latrine conditions or availability and diarrhea incidence among toddlers.

The chi-square test yielded a p-value of 0.361 ($p > 0.05$), indicating no significant relationship between solid waste management and diarrhea incidence among toddlers in Medan. Although all respondents had waste disposal facilities, many still used uncovered bins. These findings are consistent with previous studies, including Prawati and Haqi (2019) in Surabaya and a study in Tasikmalaya (2018), which also reported no significant association between waste management practices and diarrhea incidence among toddlers.

The chi-square test yielded a p-value of 1.000 ($p > 0.05$), indicating no significant relationship between wastewater disposal facilities and diarrhea incidence among toddlers in Medan. Although all respondents had drainage systems, most discharged wastewater into open channels, and some drains were clogged or stagnant. These findings are consistent with previous studies, including Samiyati et al. (2019) in Pekalongan and Putra (2022) in Bandar Lampung, which also reported no significant association between wastewater management and diarrhea incidence among toddlers.

CONCLUSIONS

This study found that the incidence of diarrhea among toddlers in Medan remains relatively high at 50.8%. Statistical analysis showed no significant relationship between environmental sanitation factors and diarrhea incidence, including clean water sources ($p=0.456$), latrine ownership ($p=1.000$), solid waste management ($p=0.361$), and wastewater disposal facilities ($p=1.000$). These findings suggest that the mere availability of sanitation facilities does not necessarily reduce diarrhea incidence without being supported by proper hygiene practices at the household level. Therefore, diarrhea prevention efforts should adopt a comprehensive approach

by integrating improvements in sanitation infrastructure with the promotion of clean and healthy behaviors, such as proper handwashing, safe food handling, and hygienic water management. In addition, continuous health education and strengthened community-based surveillance are needed to improve early detection and prevention of diarrhea cases.

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