Integrated Science Education Journal
Vol. 7, No. 1, January 2026, pp. 63~74
ISSN: 2716-3725, DOI: 10.37251/isej.v7i1.2137

Research Article

Water, Sanitation, and Maternal Behavioral Factors Associated with Diarrhea Risk in Children 10–59 Months: An Epidemiological Analysis

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Article Info

Article history:

Received Sep 06, 2025
Revised Oct 12, 2025
Accepted Dec 19, 2025
OnlineFirst Jan 06, 2026

Keywords:

Clean Water
Diarrhea
Maternal Behavior
Sanitation
Toddlers

ABSTRACT

Purpose of the study: This study examines the relationship between clean water sanitation facilities and maternal health behaviors in relation to the incidence of diarrhea among toddlers aged 10–59 months, a persistent public health problem in many developing regions. Despite ongoing improvements in water and sanitation infrastructure, diarrhea remains a leading cause of morbidity in early childhood, suggesting that behavioral factors may play a crucial mediating role.

Methodology: This research employed a quantitative cross-sectional design involving 90 toddlers, with data collected through structured interviews with mothers and direct household observations to capture both environmental sanitation conditions and daily hygiene practices.

Main Findings: The results of the study showed that 35.6% experienced diarrhea and 64.4% did not experience diarrhea. Then, from the bivariate results with α 5%, two variables were found to be related to the incidence of diarrhea in toddlers, namely the use of latrines with a p-value of 0.024 and handwashing habits with a p-value of 0.050. Meanwhile, the variables of clean water sanitation facilities (pv 0.082) and boiling water (pv 1.000) did not have a significant relationship with diarrhea.

Novelty/Originality of this study: The novelty of this study lies in its integrated analysis of environmental sanitation and maternal practices, demonstrating that behavior-related factors may exert a stronger influence on diarrhea prevention than infrastructure alone. By highlighting the interaction between sanitation access and maternal behavior, this study provides new empirical evidence to support community-based health interventions that prioritize behavioral change communication alongside sanitation development.

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1. INTRODUCTION

Diarrhea remains a leading cause of morbidity and mortality in children under five in various countries, particularly in developing countries [1], [2]. The World Health Organization reports that millions of children die each year from preventable diarrhea. This situation indicates that diarrhea remains a serious public health problem. Toddlers are a vulnerable group because their immune systems are not yet fully developed [3], [4]. Therefore, efforts to prevent diarrhea in toddlers must be a priority in health development [5]-[7]. Environmental factors play a significant role in the occurrence of diarrhea in toddlers [8], [9]. One of the main determinants is

the availability and quality of clean water and sanitation [10], [11]. Lack of access to clean water increases the risk of contamination by diarrhea-causing microorganisms [12], [13]. Furthermore, inadequate sanitation facilities often exacerbate the spread of disease. Therefore, improving sanitation is a key strategy in controlling diarrhea in children.

In addition to environmental factors, maternal behavior also significantly contributes to the incidence of diarrhea in toddlers. Mothers play a direct role in household hygiene practices, food preparation, and child health care [14]-[16]. Handwashing habits, drinking water treatment, and cleanliness when preparing food are important aspects that influence the risk of diarrhea [17], [18]. Previous studies have shown that maternal hygiene behavior can significantly reduce the incidence of diarrhea [19], [20]. This underscores the importance of behavioral interventions alongside providing physical resources. Diarrhea in toddlers not only impacts individual health but also poses a significant social and economic burden [21], [22]. Children who frequently experience diarrhea are at risk of malnutrition, stunted growth, and impaired cognitive development [23], [24]. At the family level, diarrhea treatment requires additional costs and reduces parental productivity. Conversely, at the community level, high rates of diarrhea can increase the burden on health services. This demonstrates that diarrhea prevention is a crucial investment for sustainable development.

The issue of diarrhea is also closely related to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 6 on Clean Water and Sanitation [25]-[27]. This global target emphasizes universal access to clean water and adequate sanitation as a basic human right [28], [29]. Research on the relationship between clean water sanitation, maternal behavior, and diarrhea incidence is highly relevant in the context of achieving the SDGs [27], [30]. Therefore, this study has implications not only at the local but also global level. This makes it an important contribution to the international public health literature.

Several previous studies have identified a relationship between sanitation access and diarrhea incidence in toddlers [31], [32]. However, there is still variation in results influenced by behavioral, social, and cultural factors. Some studies have found that even when access to clean water is available, poor maternal hygiene behavior still increases the risk of diarrhea [33], [34]. Conversely, good hygiene behavior can mitigate the adverse effects of limited sanitation. Therefore, an analysis that combines environmental and behavioral factors is crucial [30], [35].

This study is urgently needed because diarrhea remains a major cause of illness and death among children aged 10–59 months, despite decades of global intervention efforts. Existing research has typically examined sanitation factors and maternal hygiene behavior separately, leaving a clear gap in understanding how these two determinants interact to influence diarrheal risk. The novelty of this study lies in its explicit integration of clean water sanitation conditions and maternal hygiene practices within one analytical model, providing new evidence that has not been addressed comprehensively in previous studies. By examining both environmental and behavioral components simultaneously, this research offers a more complete explanation of why diarrhea persists in vulnerable populations. This integrated approach is essential for designing more effective, community-based public health interventions, and therefore strengthens the urgency and relevance of the study in supporting national and global agendas such as Sustainable Development Goal 6 on clean water and sanitation.

Based on the description above, this study aims to analyze the relationship between clean water sanitation and maternal behavior on the risk of diarrhea in children aged 10–59 months. This study is expected to provide a more comprehensive picture of the determinants of diarrhea incidence in toddlers. Furthermore, the results can inform policymakers' design of public health interventions. This research also supports SDG 6 by improving access to clean water and improving family hygiene practices. Therefore, this research has strategic relevance at both the national and international levels.

2. RESEARCH METHOD

This study was designed with a quantitative approach using a cross-sectional design, meaning observations of the independent and dependent variables were conducted simultaneously at a single point in time [36], [37]. This design was chosen based on ease of implementation, simplicity, time efficiency, and the ability to obtain results quickly. The independent variables studied included clean water sanitation facilities and maternal behavior, including water boiling practices, toilet use, and handwashing habits. Meanwhile, the dependent variable in this study was the incidence of diarrhea in toddlers.

The population in this study was all toddlers aged 10–59 months. The sample in this study was toddlers aged 10–59 months, while the respondents were mothers of toddlers, a total of 90 respondents. The selection of the study location was based on the still high incidence of diarrhea in toddlers in areas with limited access to clean water and basic sanitation. In many developing countries, including Nigeria, diarrhea remains a major cause of morbidity and mortality in children under five years of age. The main contributing risk factors are the poor quality of clean water sanitation facilities, suboptimal hygiene behavior, and maternal habits in managing drinking water and household hygiene [38], [39]. Rural areas and urban slums in both countries reflect the real

conditions of vulnerable communities, as the majority of the population still relies on unprotected water sources such as dug wells or surface water, and has limited access to healthy latrines. Therefore, the study location in areas with these characteristics is considered relevant and strategic to obtain a comprehensive picture of the relationship between clean water sanitation, maternal behavior, and the risk of diarrhea in toddlers.

The instrument used in this study was a questionnaire. The questionnaire included several items regarding water boiling behavior, handwashing habits, exclusive breastfeeding, and measles immunization, as well as an observation sheet regarding the clean water sanitation facilities used and toilet use. The research data were obtained directly from interviews using a questionnaire and direct observation of respondents regarding clean water sanitation facilities and maternal behavior towards diarrhea [40], [41]. The variables included in the questionnaire were water boiling, handwashing habits, exclusive breastfeeding, and measles immunization [42], [43]. Meanwhile, the variables measured through observation were clean water sanitation facilities and toilet use. The instrument grid used in this study in Table 1.

Table 1. Research Instrument Grid

Variable	Indicator	Grain Shape	Measurement Scale	Conformity to Results
Clean Water Sanitation Facilities (Observation)	- Type of water source (dug well, pumped well, Regional Water Company, refilled water) - Physical condition of clean water facilities (construction, distance from septic tank, risk of contamination)	Observation Checklist	Eligible/Not eligible	60% met the criteria; 40% did not meet the criteria; not significant for diarrhea (p = 0.082).
Water Boiling Behavior (Questionnaire)	- Water boiling habits - Consistency and duration of boiling	Closed-Ended Questions	Who does not	62.2% boiled water; not significant for diarrhea (p = 1.000).
Toilet Use (Observation & Questionnaire)	- Toilet type (gooseneck, plunger) - Toilet suitability (cleanliness, drainage, construction)	Checklist + Closed-Ended Questions	Eligible/Not eligible	62.2% did not meet the criteria; significant for diarrhea (p = 0.024).
Handwashing Habits (Questionnaire)	- Hand washing habits before/after activities - Soap use	Closed-Ended Questions	Yes No	54.4% did not wash their hands with soap; significant for diarrhea (p = 0.050).
Exclusive Breastfeeding (Questionnaire)	- History of exclusive breastfeeding	Closed-Ended Questions	Yes No	Included in the instrument, but not analyzed in the main results.
Measles Immunization (Questionnaire)	- Child's measles immunization status	Observation Checklist	Yes No	Included in the instrument, but not analyzed in the main results.

In the data processing process, researchers go through several important stages to ensure the quality and accuracy of the analysis results. First, editing is carried out, namely checking the questionnaire to ensure that the answers given are complete, clear, relevant, and consistent. Second, the coding stage is carried out by converting qualitative or letter-shaped data into numeric data, for example, the answer "yes" is coded (1) and "no" is coded (2), or the category "meets health requirements" is coded (1) and "does not meet health requirements" is coded (2). Third, the processing stage, namely entering the questionnaire data into a computer using statistical software [44], [45]. Next, cleaning is carried out, namely rechecking the entered data to ensure there are no input errors. After that, the data management stage is carried out by converting the data from numeric to categorical form according to the analysis needs [46], [47]. Finally, the data analysis stage is carried out by systematically processing and presenting the research results for later interpretation and reporting.

The collected data was analyzed using SPSS. The analysis stages included univariate and bivariate analysis [48], [49]. Univariate analysis was used to describe the frequency distribution of each research variable, including the independent variable (clean water sanitation facilities and maternal behavior), the dependent variable (diarrhea incidence in toddlers aged 10–59 months), and respondent characteristics. This analysis serves to simplify the measured data into more meaningful information by presenting it in the form of statistical measures, tables, or graphs. Next, bivariate analysis was conducted using the chi-square test [50], [51]. This test was chosen because it is appropriate for categorical data and can be used when the sample size is large enough

and the observations are independent. The basis for decision-making is determined by a significance level (α) of 0.05. If the p-value is >0.05, the alternative hypothesis (Ha) is rejected, whereas if the p-value is ≤0.05, the alternative hypothesis (Ha) is accepted [52], [53].

The research was carried out through several systematic stages to ensure the accuracy and reliability of the data collected. The preparation stage began with the development of research instruments, including a structured questionnaire and an observation checklist based on the study variables: clean water sanitation facilities, water boiling behavior, toilet use, handwashing habits, exclusive breastfeeding, and measles immunization. These instruments were reviewed for clarity and content validity before use in the field. Ethical approval and permission from local authorities were obtained prior to data collection. The researchers then coordinated with local health workers and community leaders to explain the study objectives and sampling process, followed by briefing and training for field enumerators to maintain consistency during interviews and observations. Data collection was conducted through face-to-face interviews with mothers of toddlers aged 10–59 months, using the questionnaire to obtain information on hygiene practices and child health behaviors, while direct observations were carried out to assess the condition of clean water sanitation facilities and toilet use in each household. After completing data collection, all instruments were reviewed through an editing and verification process to ensure completeness and consistency. The responses were then coded into numerical form and entered into SPSS, followed by data cleaning to identify and correct any errors or inconsistencies. Data were subsequently analyzed using univariate analysis to describe variable distributions and bivariate analysis through chi-square testing to examine relationships between sanitation and behavioral factors with diarrhea incidence, using a significance level of α = 0.05. Finally, the research findings were compiled and interpreted to produce conclusions and recommendations aligned with the purpose of the study and the requirements of the journal. The flowchart of this research procedure can be seen in the following image:

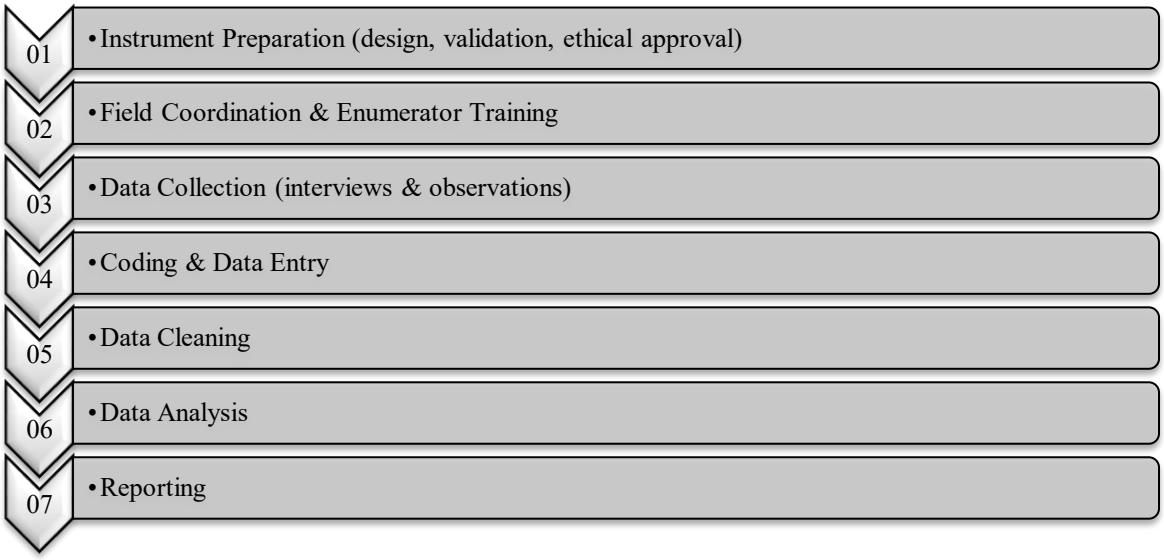

Figure 1. Research Procedures

3. RESULTS AND DISCUSSION

Overview of Diarrhea in Toddlers

The results of the study on the incidence of diarrhea in toddlers were obtained from interviews with respondents. The variable for the incidence of diarrhea in toddlers was categorized into two categories: diarrhea and non-diarrhea. The results obtained regarding the incidence of diarrhea in toddlers can be seen in Table 2.

Table 2. Frequency Distribution of Diarrhea Incidents in Toddlers Aged 10-59 Months

Diarrhea Incidence	Frequency	Percentage (%)
Diarrhea	40	44.4
No Diarrhea	50	55.6
Total	90	100

Based on Table 2, the analysis of diarrhea incidence in toddlers shows that of the 90 toddlers, 40 (44.4%) experienced diarrhea and 50 (55.6%) did not. This table shows that more respondents had toddlers who did not experience diarrhea.

Overview of Clean Water Sanitation Facilities

Clean water sanitation facilities are one of the variables that can influence the incidence of diarrhea in toddlers. Below, we describe the distribution of clean water sanitation facilities used by respondents for cooking, washing, and other purposes.

Table 3. Distribution of Toddlers According to Clean Water Sanitation Facilities Used

Clean Water Sanitation Facilities	Frequency	Percentage (%)
Dug Wells	12	13.3
Pump Wells	65	72.2
Regional Drinking Water Companies	10	11.1
Others	3	3.4
Total	90	100

Based on the clean water sanitation facilities used by respondents (Table 3), the majority of households still rely on pumped wells (65 respondents (72.2%). Twelve respondents (13.3%) use dug wells, while 10 respondents (11.1%) use services from the Regional Drinking Water Company. Meanwhile, three respondents (3.4%) use water sources other than those mentioned above. These results indicate that pumped wells remain the primary source of water for the community, although a small number have begun accessing the Regional Drinking Water Company or other alternative sources [54], [55].

The condition of clean water facilities in this study refers to the physical condition of the clean water facilities in the homes where the toddlers live.

Table 4. Distribution of Toddlers According to Clean Water Sanitation Facilities Conditions

Condition of Clean Water Sanitation Facilities	Frequency	Percentage (%)
Does Not Meet Requirements	36	40.0
Meets Requirements	54	60.0
Total	90	100

Based on the condition of clean water sanitation facilities (Table 4), the majority of respondents (54 respondents or 60.0%) already use facilities that meet health requirements. However, there are still 36 respondents (40.0%) who have clean water facilities that do not meet the requirements. This finding indicates that although the majority of the community has access to adequate clean water facilities, a significant proportion still has facilities that are potentially contaminated [56], [57]. This condition risks the spread of disease, particularly diarrhea in infants, so it is necessary to monitor and improve the quality of clean water sanitation in the community.

Boiling Water Illustration

Boiling water is a common method of drinking water treatment. Below, we describe the sources of drinking water used by respondents for consumption.

Table 5. Distribution of Toddlers According to Drinking Water Source

Clean Water Sanitation Facilities	Frequency	Percentage (%)
Dug Wells	8	8.9
Pump Wells	40	44.4
Regional Drinking Water Companies	12	13.3
Refillable Water (Gallons)	30	33.4
Total	90	100

Based on the distribution of clean water sanitation facilities (Table 5), the majority of respondents use pumped wells, amounting to 40 households (44.4%). Furthermore, refilled water (gallons) is also quite widely used by 30 households (33.4%). Meanwhile, 12 respondents (13.3%) utilize the Regional Drinking Water Company, and only 8 respondents (8.9%) still rely on dug wells. These results indicate that the use of pumped wells is still the primary choice, but access to more appropriate water sources such as the Regional Drinking Water Company and refilled water is also starting to increase, while the use of dug wells is relatively less.

Table 6. Distribution of Drinking Water Sources: Pump Wells and Refill Water

Drinking Water Source	Diarrhea Incidents in Toddlers			
	Diarrhea		No Diarrhea	
	N	%	n	%
Pump Well	18	40.0	27	60.0
Water Refill (Gallons)	12	30.0	28	70.0

Based on the distribution table of drinking water sources and the incidence of diarrhea in toddlers (Table 6), it can be seen that in the group using pumped wells, there were 18 toddlers (40.0%) who experienced diarrhea and 27 toddlers (60.0%) who did not experience diarrhea. Meanwhile, in the group using refilled water (gallons), the number of toddlers who experienced diarrhea was recorded at 12 toddlers (30.0%), while those who did not experience diarrhea were 28 toddlers (70.0%). These results indicate that the percentage of diarrhea incidents in toddlers is higher in pumped well users compared to refilled water users. Thus, the quality and management of water from pumped wells are suspected to play an important role in influencing the risk of diarrhea in toddlers.

Table 7. Distribution of Toddlers According to Water Cooking Treatment

Boiling Water	Frequency	Percentage (%)
No	34	37.8
Yes	56	62.2
Total	90	100

Based on Table 6, it can be seen that of the 90 respondents, 56 respondents (62.2%) boiled water before consuming it, while 34 respondents (37.8%) did not boil water before consuming it.

Description of Latrine Use

The research results regarding toilet use were obtained from interviews and observations at respondents' homes. The results regarding toilet use can be seen in Table 8-9.

Table 8. Distribution of Toilet Types Used by Respondents

Types of Toilets	Frequency	Percentage (%)
Pond Toilets	6	6.7
Gooseneck Toilets	84	93.3
Total	90	100

Based on Table 8, it can be seen that of the 90 respondents, 6 respondents (6.7%) still use the pond type toilet, while 84 respondents (93.3%) are already using the gooseneck type toilet.

Table 9. Distribution of Toddlers According to Toilet Use

Latrine Use	Frequency	Percentage (%)
Not eligible	56	62.2
qualify	34	37.8
Total	90	100

Based on Table 9, in the variables above, there were 56 (62.2%) toilets that did not meet the requirements, while there were 34 (37.8%) toilets that met the requirements.

Overview of Hand Washing Habits

Handwashing habits are one of the variables that can influence the incidence of diarrhea in toddlers. The results regarding handwashing habits can be seen in Table 10.

Table 10. Distribution of Toddlers According to Handwashing Habits

Handwashing Habits	Frequency	Percentage (%)
No	49	54.4
Yes	41	45.6
Total	90	100

Based on the results from the table above, 49 respondents (54.4%) did not wash their hands using soap before/after carrying out activities, while 41 respondents (45.6%) washed their hands using soap before/after carrying out activities. Bivariate analysis was conducted to determine the hypothesis test between the independent variable and the dependent variable using a statistical test in the form of chi-square (X2). so that the P-value can be determined where for cross-sectional research, the P value shows the relationship between the independent variable (clean water sanitation facilities, boiling water, toilet use, and handwashing habits) and the dependent variable (the incidence of diarrhea in toddlers).

The Relationship between Clean Water Sanitation Facilities and the Incidence of Diarrhea in Toddlers

The results of statistical testing between the variables of clean water sanitation facilities and the incidence of diarrhea in toddlers aged 10-59 months are as Table 11.

Table 11. Analysis of the Relationship between Clean Water Sanitation Facilities and the Incidence of Diarrhea in Toddlers Aged 10-59 Months

Clean Water Sanitation Facilities	Diarrhea Incidents in Toddlers				Total		P-value
	Diarrhea		No Diarrhea				
	n	%	n	%	n	%	
Not eligible	19	45.2	23	54.8	42	100	0.082
Qualify	13	27.1	35	72.9	48	100	
Total	32	35.6	58	64.4	90	100	

From Table 11, it is known that respondents with conditions of clean water sanitation facilities that do not meet the requirements and experienced diarrhea in their toddlers were 19 respondents (45.2%), while respondents with conditions of clean water sanitation facilities that meet the requirements and experienced diarrhea in their toddlers were 13 respondents (27.1%). The results of the chi-square test showed that there was no relationship between clean water sanitation facilities and the incidence of diarrhea in toddlers aged 10-59 months, because the P-value was 0.082 at 5%.

The Relationship Between Water Boiling Behavior and the Incidence of Diarrhea in Toddlers

The results of the statistical test between the variables of boiling water and the incidence of diarrhea in toddlers aged 10-59 months are as Table 12.

Table 12. Analysis of the Relationship between Water Boiling Behavior and the Incidence of Diarrhea in Toddlers Aged 10-59 Months

Water Boiling Behavior	Diarrhea Incidents in Toddlers				Total		P-value
	Diarrhea		No Diarrhea				
	N	%	N	%	N	%	
No	12	35.3	22	64.7	34	100	1.000
Yes	20	35.7	36	64.3	56	100	
Total	32	35.6	58	64.4	90	100	

Based on Table 12, it is known that 12 respondents (35.3%) did not boil their water and experienced diarrhea in their toddlers, while 20 respondents (35.7%) did boil their water and experienced diarrhea in their toddlers. The results of the statistical test showed that the P-value was 1.000, which means that at 5% there is no relationship between the behavior of boiling water and the occurrence of diarrhea in toddlers aged 10-59 months.

The Relationship between Toilet Use Behavior and the Incidence of Diarrhea in Toddlers

The results of statistical testing between the variables of toilet use and the incidence of diarrhea in toddlers aged 10-59 months are as Table 13.

Table 13. Analysis of the Relationship between Toilet Use Behavior and the Incidence of Diarrhea in Toddlers Aged 10-59 Months

Toilet Use Behavior	Diarrhea Incidents in Toddlers				Total		P-value
	Diarrhea		No Diarrhea				
	n	%	n	%	n	%	
Does Not Meet Requirements	25	44.6	31	55.4	56	100	0.024
Meets Requirements	7	20.6	27	79.4	34	100	
Total	32	35.6	58	64.4	90	100	

From table 13, it is known that respondents with toilet conditions that do not meet the requirements and experienced diarrhea in their toddlers were 25 respondents (44.6%), while respondents with toilet conditions that meet the requirements and experienced diarrhea in their toddlers were 7 respondents (20.6%). The results of the chi square test showed that there was a relationship between toilet use and the incidence of diarrhea in toddlers aged 10-59 months, because the P value was 0.024 at 5%.

The Relationship between Handwashing Habits and the Incidence of Diarrhea in Toddlers

The results of the statistical test between the variables of hand washing habits and the incidence of diarrhea in toddlers aged 10-59 months are as Table 14.

Table 14. Analysis of the Relationship between Handwashing Habits and the Incidence of Diarrhea in Toddlers Aged 10-59 Months

Hand Washing Habits	Diarrhea Incidents in Toddlers				Total		P-value
	Diarrhea		No Diarrhea				
	n	%	n	%	n	%	
No	22	44.9	27	55.1	49	100	0.050
Yes	10	24.4	31	75.6	41	100	
Total	32	35.6	58	64.4	90	100	

Table 14 shows that 22 (44.9%) respondents did not wash their hands with soap before/after activities and experienced diarrhea in their toddlers. Meanwhile, 10 (24.4%) respondents did wash their hands with soap before/after activities and experienced diarrhea in their toddlers. The statistical test results showed a P-value of 0.050, indicating a 5% association between handwashing with soap before/after activities and diarrhea in toddlers aged 10-59 months.

Diarrhea is a major public health problem in Nigeria and is characterized by an increase in the frequency of bowel movements to more than three times a day, accompanied by a change in stool consistency to watery, with or without blood or mucus. According to global health standards, diarrhea is divided into acute (<2 weeks) and chronic (≥2 weeks). In this study, diarrhea incidence was measured using a questionnaire based on this definition, potentially introducing information bias, particularly due to mothers' limited recall of their toddlers' diarrhea history. Furthermore, measurements based solely on respondents' reports without a doctor's clinical diagnosis can impact data accuracy.

Although most toddlers in this study did not experience diarrhea, this condition still requires serious attention because Nigeria has a high diarrhea-related mortality rate in children under five. If left untreated, diarrhea can lead to severe dehydration complications and has the potential to spread throughout the community. Therefore, health workers in Nigeria need to strengthen education on diarrhea management according to WHO standards, including the use of oral rehydration salts (ORS), providing nutrition during illness, and preventing complications. Promotional efforts are also crucial, including education on clean water, hygienic behaviors, and safe waste disposal.

Clean water and sanitation facilities in Nigeria still face significant challenges, particularly in rural areas and urban slums [58], [59]. Many households still rely on unprotected water sources such as shallow dug wells and surface water. Clean water facilities must meet health requirements, including a minimum distance of 10 meters from septic tanks to prevent contamination [60], [61]. However, limited infrastructure and a lack of water quality monitoring increase the risk of contamination by diarrhea-causing bacteria and parasites. Household drinking water should be treated before consumption. A simple recommended method is to boil water for 5–10 minutes to kill pathogenic microorganisms. However, in Nigeria, many families still do not boil their water due to fuel constraints or the habit of relying on refilled water without ensuring its safety. This may explain why not all water treatment practices were significantly associated with diarrhea incidence in this study. The use of sanitary latrines also remains a challenge in Nigeria, particularly as most rural households lack access to improved latrines. Open defecation is still common and increases the risk of diarrhea transmission. Of the various types of latrines, the gooseneck latrines are considered to meet health requirements because their water-closing system prevents odor and the spread of disease vectors. However, public access to this type of toilet remains limited.

In addition to sanitation factors, maternal behavior also plays a significant role in preventing diarrhea. This study shows that some mothers still dispose of toddler feces unhygienically, such as in gardens or trash cans. The assumption that children's feces are harmless makes this behavior difficult to change. However, improperly disposed feces can become a breeding ground for flies, which then transmit disease. The habit of washing hands with soap is also not yet fully adopted by the Nigerian public. Some respondents reported washing their hands, but only with water without soap. This low awareness increases the risk of spreading diarrhea. Therefore, the promotion of clean and healthy living behaviors, particularly handwashing with soap,

must be further encouraged as an inexpensive, simple, and effective prevention strategy to reduce the incidence of diarrhea among toddlers in Nigeria.

The findings of this study provide important implications for public health efforts aimed at reducing diarrhea in children aged 10–59 months. The significant influence of toilet quality and handwashing habits highlights the need for integrated sanitation and hygiene interventions at the household level. Improving access to proper latrines and strengthening behavior change programs—particularly handwashing with soap—may substantially reduce diarrhea risk, even in communities where clean water facilities already exist. However, this study also has several limitations that must be acknowledged. First, the cross-sectional design does not allow for determining causal relationships, as exposure and outcomes were measured simultaneously. Second, the reliance on mothers' self-reported data for diarrhea history and hygiene practices may introduce recall bias and social desirability bias, potentially affecting data accuracy. Third, some variables such as exclusive breastfeeding and immunization were measured but not analyzed in relation to diarrhea, which limits the comprehensiveness of the findings. Additionally, the study was conducted only in one geographical area, which may limit the generalizability of the results to broader populations. Despite these limitations, the study provides valuable evidence on the combined environmental and behavioral determinants of diarrhea, serving as a basis for more targeted interventions and future longitudinal research.

4. CONCLUSION

The results showed that the majority of respondents had an average age of 29 years, most had a high school education, and the majority worked as housewives. Of the total toddlers studied, 35.6% experienced diarrhea and 64.4% did not experience diarrhea. Regarding clean water sanitation facilities, most respondents used pump wells, with 53.3% meeting health requirements and 46.7% not meeting the requirements. Mothers' behavior showed that most boiled water before consumption, used gooseneck latrines, but more than half of the latrines did not meet health requirements, and more than half did not wash their hands with soap consistently. Bivariate analysis showed no significant relationship between clean water sanitation facilities or water boiling behavior with the incidence of diarrhea, but there was a significant relationship between latrines use and handwashing habits with the incidence of diarrhea in toddlers aged 10–59 months. Future studies are recommended to employ longitudinal or experimental designs to better establish causal relationships between sanitation, maternal behavior, and diarrhea incidence. Additionally, further research should incorporate broader contextual variables—such as environmental contamination levels, socioeconomic factors, and community-based hygiene interventions—to provide a more comprehensive understanding of diarrhea prevention in early childhood.

ACKNOWLEDGEMENTS

The author expresses his deepest gratitude to all respondents who participated in this research. He also thanks all parties who provided support, both directly and indirectly, so that this research could be successfully completed.

AUTHOR CONTRIBUTIONS

Conceptualization, methodology, software, investigation, validation, JOS; formal analysis, writing original draft preparation, data curation, writing review and editing, JOS and BMM.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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