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Water, sanitation, and hygiene–specific risk factors of recent diarrheal episodes in children aged under 5 years: analysis of secondary data from the multiple indicator cluster survey (MICS 2019)

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ABSTRACT

Objectives: Access to safe drinking water, sanitation, and hygiene, collectively called WASH, is a fundamental human right and a cornerstone of public health. However, inadequate WASH practices and environments significantly contribute to the global burden of diarrheal diseases, particularly, in children aged under 5 years. Inadequate WASH conditions are the primary drivers of various infectious diseases, including cholera, dysentery, hepatitis A, typhoid, and polio.

Methods: We conducted secondary data analysis using the 2019 Zimbabwe Multiple Indicator Cluster Survey to investigate the specific WASH risk factors associated with recent diarrheal episodes in children aged under 5 years.

Results: A total of 853 (14%) of 6092 children were reported to have experienced an episode of diarrhea in the last 2 weeks preceding the survey. Having insufficient water in the household was associated with 17.0% diarrhea episodes compared with 13.6% in those who did not face this problem. The availability of soap or detergents to wash hands was associated with a risk of diarrhea, with an odds ratio and 95% confidence interval of 1.19 (1.01-1.40), $P = 0.033$. The use of surface water, including rivers, dams, lakes, ponds, streams, canals, and irrigation channels, was associated with differences in diarrheal episodes, although this was of borderline significance, $P = 0.082$. Of the children who had a recent episode of diarrhea, 41.0% had their parents or caregivers seeking medical attention.

Conclusions: There is need for an improvement in safe water supply to households and an improvement in health education on the importance of using soap after using the toilet to avoid contamination of food and water.

Introduction

Access to safe drinking water, sanitation, and hygiene, collectively called WASH, is a fundamental human right and a cornerstone of public health [1]. It plays a critical role in preventing the spread of infectious diseases, promoting good health, and fostering overall well-being. However, inadequate WASH practices and environments significantly contribute to the global burden of diarrheal diseases, particularly, in children aged under 5 years. Inadequate WASH conditions are the primary drivers of various infectious diseases, including cholera, dysentery, hepatitis A, typhoid, and polio [2]. Of these, diarrheal diseases are significant contributors to global child mortality rates [3]. The United Nations General Assembly and Human Rights Council explicitly acknowledged the rights to water and sanitation in 2010 and 2015, respectively [4]. Diarrheal diseases not only pose a severe threat to child health but also exacerbate malnutrition, underscoring the urgency of addressing WASH-related challenges to improve child well-being.

Diarrheal diseases remain a leading cause of morbidity and mortality in children under 5 years old worldwide. These illnesses are primarily transmitted through the fecal-oral route, which can be directly linked

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to poor WASH practices. Contaminated water, inadequate sanitation facilities, and improper hygiene habits can all contribute to the spread of diarrheal pathogens [5]. The burden of diarrheal diseases in children aged under 5 years remains disproportionately high, particularly, in regions with limited access to clean water and sanitation facilities. Addressing WASH-related risk factors is, thus, crucial for reducing the incidence and severity of diarrheal diseases and improving child health outcomes worldwide.

Despite significant progress in recent decades, diarrheal diseases still cause substantial morbidity in young children. These illnesses lead to dehydration and malnutrition and hinder physical and cognitive development [6]. The World Health Organization estimates that diarrheal diseases claim the lives of approximately 425,000 children under 5 years every year [7]. Diarrhea remains a significant contributor to under-5 morbidity and mortality in Zimbabwe [8]. Understanding the specific risk factors associated with recent diarrheal episodes is essential for designing targeted interventions and public health strategies to prevent and manage diarrheal diseases.

This study aims to identify key WASH-related factors contributing to diarrheal morbidity in this vulnerable population. This study utilizes secondary data from the 2019 Zimbabwe Multiple Indicator Cluster Survey (MICS) to investigate the specific WASH risk factors associated with recent diarrheal episodes in children under 5 years. With findings from this study, authors aimed to identify critical areas for intervention and improvement in WASH practices to reduce the burden of diarrheal diseases in this vulnerable population.

Materials and methods

Sample design and data collection

This study used data from the most recent nationally representative MICS (2019), whose methodology, study design, and data collection approach have been described elsewhere [9]. The sample for MICS 2019 was designed to provide estimates for many indicators of the situation of children and women in urban and rural areas and the 10 provinces of Zimbabwe. Briefly, each province's urban and rural areas were identified as the main sampling strata, and the sample of households was selected in two stages. A specified number of census enumeration areas (clusters) were selected systematically within each stratum with probability proportional to size. After a household listing was carried out within the selected enumeration areas, a systematic sample of 26 households was drawn in each sample enumeration area. A total of 462 clusters and 12,012 homes were selected nationally. All selected enumeration areas were visited during the fieldwork period. Six questionnaires were used in the survey. Data used in the analysis are based on the questionnaire for children under 5 years administered to their parents or caregivers, the individual questionnaire administered to the women themselves, and WASH questions and tests administered and available in the household questionnaire. The total sample size used was 6102 children aged under 5 years.

Statistical analysis

STATA (Version 18, Texas, USA) was used for statistical analysis [10]. We used survey-weighted proportions to describe the characteristics of children under 5 years and women in the study. Because the outcome was binary, we used chi-square tests and logistic regression to calculate the odds ratio for diarrhea-associated WASH factors, notably, water sauce, water treatment, and type of toilet facilities. We also used the same statistical tests for factors related to seeking treatment after a diarrheal episode. The statistical significance cutoff for describing the association between various factors and ever having diarrhea was set at $P < 0.05$. The outcomes considered for this analysis were episodes of diarrhea and seeking medical treatment after the episode—both of which are binary outcomes. Notably, because the MICS 2019 sample is not self-weighting, appropriate sample weights were applied in all analyses.

Results

There were equal proportions of girls and boys and about 70% resided in rural areas. A small proportion, 6.2%, had health insurance coverage. Most of the mothers or caregivers (58.7%) had attained secondary level of education and belonged to the apostolic sect (33.8%) (Table 1).

A total of 853 of 6092 children (14%) were reported to have experienced an episode of diarrhea in the last 2 weeks preceding the survey. A couple of factors were associated with episodes of diarrhea in children under 5 years (Table 2). These include having insufficient water in the household, which was associated with an episode percentage of 17.0% compared with 13.6% in those who did not face this problem. The availability of soap or detergents to wash hands was also an essential factor and was associated with a risk of diarrhea, with odds ratio and 95% confidence interval of 1.19 (1.01-1.40), $P = 0.033$. The use of surface water, including rivers, dams, lakes, ponds, streams, canals, and irrigation channels, was associated with differences in diarrheal episodes, although this was of borderline significance, $P = 0.082$.

Table 1
Mother and baby demographic characteristics for Multiple Indicator Cluster Survey.

Variable	Frequency n (%) N max = 6102
Baby demographics	
Age category in months	
0-5	605 (10.0)
6-11	584 (9.6)
12-23	1153 (19.0)
24-35	1248 (20.6)
36-47	1220 (19.9)
48-59	1292 (21.0)
Sex	
Male	3042 (49.6)
Female	3060 (50.4)
Area	
Urban	1857 (29.4)
Rural	4245 (70.6)
Child's functional difficulties (age 2-4 years)	
Has functional difficulty	149 (3.8)
Has no functional difficulty	3611 (96.2)
Health insurance	
Has coverage	361 (6.2)
Has no coverage	5739 (93.8)
Mother or caregiver demographics	
Education level	
Pre-primary or none	150 (2.4)
Primary	1913 (31.5)
Secondary	3576 (58.7)
Higher	462 (7.5)
Religion of head of household	
Roman Catholic	356 (5.8)
Protestant	861 (13.6)
Pentecostal	931 (15.3)
Apostolic sect	1967 (33.8)
Zion	596 (8.3)
Other Christian	151 (2.4)
Islam	40 (0.7)
Traditional	231 (3.6)
No religion	936 (16.1)
Other religion	31 (0.4)
Don't know	2 (0.1)
Wealth index quintile	
Poorest	1426 (23.4)
Second	1260 (21.3)
Middle	1171 (19.3)
Fourth	1186 (19.4)
Richest	1059 (16.7)

Table 2
Water, sanitation, and hygiene factors associated with a recent episode of diarrhea in children aged 0-59 months.

Variable	Had recent diarrhea N = 853 n (%)	Did not have recent diarrhea N = 5239 n (%)	Unadjusted odds ratio (95 confidence interval)	*P*-value
Baby sex				
Female	399 (13.7)	2656 (86.3)	1	
Male	454 (14.9)	2583 (85.1)	1.10 (0.94-1.29)	0.222
Area				
Urban	252 (14.1)	1602 (85.9)	1	
Rural	601 (14.4)	3637 (85.7)	1.02 (0.85-1.21)	0.842
Improved water[a]				
Yes	638 (14.1)	3996 (85.9)	1	
No	215 (14.8)	1243 (85.2)	1.06 (0.89-1.27)	0.512
Surface water[b]				
No	638 (14.1)	3996 (85.9)	1	
Yes	78 (17.4)	388 (82.6)	1.28 (0.97-1.69)	0.082
Treat drinking water				
Yes	88 (14.0)	549 (86.0)	1	
No	765 (14.3)	4690 (85.7)	1.02 (0.78-1.34)	0.866
Time to source water				
<30 mins	405 (14.4)	2501 (85.6)	1	
≥30 mins	182 (14.9)	1044 (85.1)	1.05 (0.85-1.28)	0.659
Had insufficient water in last month				
No	627 (13.6)	4136 (86.4)	1	
Yes	226 (17.0)	1100 (83.0)	1.30 (1.08-1.56)	0.005
Soap for handwashing present				
Yes	399 (13.2)	2656 (86.8)	1	
No	414 (15.3)	2376 (84.7)	1.19 (1.01-1.40)	0.033
Improved toilet facility				
Yes	543 (14.2)	3401 (85.8)	1	
No	310 (14.4)	1838 (85.6)	1.02 (0.86-1.20)	0.828
Number of *E. coli* in house water				
<100	105 (14.0)	649 (86.0)	1	
≥100	56 (15.3)	319 (84.7)	1.11 (0.76-1.63)	0.585
Number of *E. coli* in source of water				
<100	121 (14.2)	747 (85.8)	1	
≥100	34 (13.8)	209 (86.2)	0.96 (0.62-1.49)	0.859

[a] Improved water includes piped water (into dwelling, compound, yard, or plot; to neighbors; public tap/standpipe), tube well/borehole, protected dug well, protected spring, rainwater collection, and packaged or delivered water.
[b] Surface water (river, dam, lake, pond, stream, canal, irrigation channel).

(i) Improved water includes piped water (into dwelling, compound, yard, or plot; to neighbors; public tap/standpipe), tube well/borehole, protected dug well, protected spring, rainwater collection, and packaged or delivered water.
(ii) Surface water (river, dam, lake, pond, stream, canal, irrigation channel).

Of the 853 children who had a recent episode of diarrhea, less than half (41%) had their parents or caregivers seeking medical attention. We also found out that children already having functional disabilities did not have their parents or caregivers seeking care for the diarrhea episode (Table 3).

Discussion

This study revealed that insufficient water in the household in the previous month, absence of soap for handwashing, and the use of surface water were significantly associated with a recent episode of diarrhea in children aged 0-59 months. Furthermore, children with functional difficulties were less likely to seek medical treatment after a recent episode of diarrhea. However, this study also revealed that health insurance did not significantly influence medical treatment-seeking behavior after a recent episode if diarrhea.

The findings of this study concur with those of a study conducted in low-to-middle–income countries, which revealed that improved access to water resulted in a decrease in diarrhea occurrence in children under the age of 5 years [11]. A possible explanation to these findings is that when there is inadequate water supply, people are unlikely to wash their hands after using the toilet, which will result in contamination of surfaces and food items they touch [12]. This contamination ultimately results in the spread of bacteria that cause diarrheal diseases, such as *Vibrio cholerae* and *Shigella*. Furthermore, inadequate water supply usually results in households storing water in containers in the houses. The stored water can easily get contaminated with diarrhea-causing bacteria, which will result in diarrhea in children under the age of 5 years.

This study revealed that the absence of soap for handwashing was associated with a recent episode of diarrhea in children under the age of 5 years. Several studies demonstrated a reduction in diarrhea in children below the age of 5 years when handwashing with soap was practiced [13–15]. Handwashing with soap or other recommended detergents after toilet use reduces diarrheal diseases because soap breaks down grease and dirt that carry disease-causing organisms [15]. The findings of this study that the use of surface water was significantly associated with a recent episode of diarrhea in children below the age of 5 years concur with those of a study conducted in Nigeria [16]. A possible explanation to these findings is that non-protected water sources get easily contaminated by runoff water, making the water biologically unsafe for drinking. If such water is consumed, children get infected with the bacteria that cause diarrhea. However, it is important to note that from improved sources is not always safe because it can be contaminated during transportation and storage at home. Surprisingly, the current study did not find a significant relationship between improved toilet facilities and recent episodes of diarrhea in children under 5 years. A study conducted in sub-Saharan Africa revealed an association between an improved toilet facility and diarrhea in children under the age of 5 years [17]. We expected to find a reduction in episodes of diarrhea in children under the age of 5 years because improved toilet facilities reduce flies in the community. An increased quantity of flies in the community

Table 3
Factors associated with seeking medical treatment after a recent episode of diarrhea in children aged 0-59 months.

Variable	Received treatment N = 352 n (%)	Did not receive any treatment N = 501 (%)	Unadjusted odds ratio (95 confidence interval)	*P*-value
Age category in months				
0-5	34 (62.6)	18 (37.4)	1	
6-11	79 (56.6)	64 (43.4)	0.78 (0.38-1.60)	0.497
12-23	140 (60.0)	98 (40.0)	0.90 (0.46-1.77)	0.757
24-35	122 (60.4)	77 (39.6)	0.91 (0.46-1.82)	0.792
36-47	68 (50.8)	63 (49.2)	0.62 (0.30-1.27)	0.188
48-59	58 (65.0)	32 (35.0)	1.11 (0.51-2.42)	0.788
Sex				
Male	232 (58.1)	167 (42.0)	1	
Female	269 (59.7)	185 (40.3)	1.10 (0.94-1.29)	0.222
Area				
Urban	156 (63.6)	96 (36.4)	1	
Rural	345 (57.0)	256 (43.0)	1.07 (0.79-1.44)	0.654
Child's functional difficulties (age 2-4 years)				
Has functional difficulty	238 (59.7)	157 (40.3)	1	
No functional difficulty	9 (36.9)	15 (63.1)	0.39 (0.16-0.96)	0.040
Health insurance				
Has coverage	15 (44.0)	18 (56.0)	1	
Has no coverage	485 (59.4)	334 (40.6)	1.86 (0.85-4.08)	0.121
Education level				
Pre-primary or none	22 (75.3)	8 (24.7)	1	
Primary	174 (58.6)	114 (41.4)	0.46 (0.19-1.12)	0.087
Secondary	273 (58.5)	207 (41.5)	0.46 (0.20-1.09)	0.079
Higher	32 (56.0)	23 (44.0)	0.42 (0.15-1.17)	0.096
Religion of head of household				
Roman Catholic	25 (59.0)	20 (41.1)	1	
Protestant	56 (52.4)	55 (47.6)	0.77 (0.36-1.64)	0.493
Pentecostal	80 (64.7)	45 (35.4)	1.27 (0.60-2.71)	0.530
Apostolic sect	146 (53.8)	123 (46.2)	0.81 (0.41-1.62)	0.551
Zion	59 (70.9)	27 (29.2)	1.69 (0.75-3.82)	0.205
Other Christian	17 (58.5)	10 (41.5)	0.98 (0.34-2.87)	0.973
Traditional	14 (55.9)	9 (44.1)	0.88 (0.29-2.64)	0.823
No religion	96 (62.3)	59 (37.7)	1.15 (0.56-2.39)	0.702
Other religion	8 (67.6)	4 (32.4)	1.45 (0.36-5.92)	0.601
Wealth index quintile				
Poorest	127 (58.4)	93 (41.6)	1	
Second	94 (56.9)	71 (43.1)	0.94 (0.61-1.46)	0.783
Middle	95 (56.0)	74 (44.0)	0.91 (0.59-1.41)	0.664
Fourth	113 (64.4)	64 (35.6)	1.29 (0.83-2.00)	0.254
Richest	72 (59.2	50 (40.8)	1.04 (0.63-1.71)	0.889

contaminates water sources, leading to an increase in diarrheal diseases in children under the age of 5 years. It is also possible that unavailability of toilet facilities results in soil contamination where children play by liquid and solid waste [18]. Another surprising finding in this study is that drinking water treatment was not associated with a recent episode of diarrhea. We would have expected to see an association because treating drinking water with chemicals, such as chlorine, results in the death of bacteria leading to a reduction in a recent episode of diarrhea in children under the age of 5 years [19].

This study revealed that children with functional disabilities were more likely to seek medical treatment after a recent episode of diarrhea in children under the age of 5 years. However, no association was noted between health insurance and medical care utilization after a recent episode of diarrhea in the children. A possible explanation for the association between functional disabilities and medical care utilization is that parents of disabled children may be more concerned about their children's health status than parents of children who have no functional disabilities [20]. Moreover, diarrhea in children with disabilities may be more likely to be noticed because they require assistance compared with children without functional disabilities because they may use the toilet unnoticed. There was no association between health insurance and medical care utilization after a recent episode of diarrhea in the children, possibly because, in Zimbabwe, children under the age of 5 years are treated free of charge at public health care facilities. Therefore, not having health insurance is not a hindrance to medical care utilization in this age group.

Based on these findings, we recommend improving safe water supply to households. This can be achieved through an increase in piped water supply in the country. There should be health education using client driven approaches on the importance of using soap after using the toilet to avoid contamination of food and water. Health education can be provided through various channels such as social media, mass media, schools, and health care facilities while providing all health services. People should also be discouraged from using surface water sources since these can be easily contaminated. Where surface water is the only option, people should treat the water using recommended methods before drinking.

One of the strengths of this study is because since it was an MICS, it provided statistically sound and internationally comparable estimates of a recent episode of diarrhea in children under the age of 5 years. Another strength is that the use of nationally representative data ensured that the findings can be generalizable to the whole country and replicable. However, the analyses could only look at the observed factors because the study only used secondary data. Furthermore, it is impossible to rule out recall and social desirability bias because the mothers self-reported the variables. Moreover, causality on the observed outcomes cannot be deduced from the MICS because a cross-sectional design was used.

Conclusion

Diarrheal diseases remain a leading cause of morbidity and mortality in children under 5 years old worldwide. Diarrheal diseases not

only pose a severe threat to child health but also exacerbate malnutrition, underscoring the urgency of addressing WASH-related challenges to improve child well-being. This study revealed that insufficient water in the household in the previous month, the absence of soap for handwashing, and the use of surface water were significantly associated with a recent episode of diarrhea in children aged 0-59 months. To reduce diarrhea in children under the age of 5 years in Zimbabwe, we recommend an improvement in safe water supply accessible to households and an improvement in health education on the importance of using soap after using the toilet to avoid contamination of food and water.

Declarations of competing interest

The authors have no competing interests to declare.

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Author contributions

GM and MM conceived the article. GM, MM, RBM, TD wrote the first draft. MM, RBM carried out the statistical analysis. All authors (MM, RBM, IC, EM, TD, BM, OM, GM) contributed to the writing of the article. All authors (MM, RBM, IC, EM, TD, BM, OM, GM) read and approved the final article.

Data availability

All data used are available from the UNICEF MICS team upon reasonable request.

Disclaimer

None.

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