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Original Research Article

Factors associated with diarrheal disease among children under 5 years of age in a level 5 hospital in central Kenya

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ABSTRACT

Background: Diarrheal disease remains a major cause of morbidity and preventable mortality among children under five years globally. The 2022 Kenya demographic health survey reported that 14% of children under five had diarrhea in the two weeks preceding the survey, with higher prevalence among children aged 6-23 months.
Methods: A hospital-based cross sectional unmatched case control design. The dependent variable was diarrheal disease status (yes/no). Independent variables included age group, sex, caregiver education, water source, sanitation, handwashing with soap, exclusive breastfeeding for six months, rotavirus vaccination status, and nutritional status. Bivariable and multivariable logistic regression were used to estimate crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). P value of <0.05 was considered significant.
Results: 150 cases and 150 controls were recruited. Cases were generally younger than controls, with a lower mean age in months (24.3±14.6 vs 27.2±16.5). Independent predictors for diarrhoea in the multivariate regression model were: Age 12-23 months: aOR 2.60, p=0.034, Unimproved water source: aOR 1.97, p=0.039, Unimproved sanitation: aOR 1.93, p=0.044, No handwashing with soap: aOR 2.21, p=0.009, Undernutrition: aOR 2.18, p=0.034 and larger household size: aOR 2.63 per additional household member, p<0.001.
Conclusions: Unsafe water, poor sanitation, inadequate hand hygiene, suboptimal infant feeding, and incomplete rotavirus immunization were major risk factors. Integrating child survival programs that combines clinical management with preventive WASH and immunization strategies is necessary to alleviate the burden of diarrheal disease in this setup.
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Keywords: Diarrhea, Under-five children, Risk factors, Kenya, WASH, Rotavirus vaccine, Exclusive breastfeeding

INTRODUCTION

Diarrheal disease remains an important cause of illness, dehydration, malnutrition, hospital attendance, and death among children younger than five years globally, and in sub-Saharan Africa, in particular. The World Health Organization (WHO) reports that diarrheal disease is the third leading cause of death in children aged 1-59 months and is responsible for roughly 443,832 deaths annually, while UNICEF estimates that diarrhea accounted for about 9% of all under-five deaths in 2021. South Asia and sub-Saharan Africa carry the largest burden of those deaths and these are strongly shaped by poverty, unsafe drinking water, poor sanitation, inadequate hygiene, delayed care seeking, and undernutrition.[1,2]

In Kenya, diarrheal disease continues to exert a substantial burden. The 2022 Kenya demographic and health survey (KDHS) reported that 14% of children under five had diarrhea in the two weeks preceding the survey, with prevalence peaking at 23% among children aged 6-11 months and 12-23 months. The same report showed that although oral rehydration therapy is widely promoted, important care gaps remain, and preventive risk factors are still common.[3] A policy review from Kenya has likewise highlighted continuing gaps in diarrheal prevention and treatment despite multiple national frameworks and action plans.[4] Evidence from East Africa consistently links childhood diarrhea with child age, low socioeconomic status, limited caregiver education, household crowding, delayed breastfeeding initiation, poor sanitation, unsafe water, and inadequate immunization.[4,5] In Nairobi's Mathare informal settlement, for example, low caregiver education, environmental contamination, poor waste disposal, and lack of or incomplete immunization were associated with higher diarrheal prevalence among children under five years of age.[6] Systematic and pooled analyses from the region also point to strong roles for water and sanitation quality, breastfeeding practices, and household level deprivation.[5,7]

The WHO/UNICEF Joint monitoring programme (JMP) is the global standard for monitoring access to Water, sanitation and hygiene (WASH) and tracks progress toward SDG 6 using internationally comparable service ladders. In the JMP protocol, three household services are considered: drinking water, sanitation and hygiene. The protocol gauges them up as either safely managed, basic, limited and non-available. This system allows programs and studies to assess and compare WASH exposures across different settings. This eases comparisons across various contextual scenarios relating to WASH concerns. The JMP framework also considers inequalities related to wealth, places of residence and other population characteristics and in this way offers a practical way of understanding the differences in diarrheal disease burden between various setups.

It is also a known fact that diarrhoeal disease has many causes and pathways of evolvement, this being a consequence of widely differing conditions even between neighboring communities. This is especially so in urban informal settlements where access to safe water and sanitation can vary from one household to the other. Due to these reasons, a clear understanding of the specific risk factors operating within each epidemiological setting is necessary in order to design effective interventions. Relying on broad generalized assumptions is unlikely to produce the results that address the different and unique situations in diverse communities.

METHODS

Study design

This study is a hospital-based case control study.

Study objectives

The main study objective was to determine factors associated with diarrheal disease among children under 5 years of age attending Thika level 5 Hospital. The specific objectives were to assess associations between diarrheal disease (case status) and sociodemographic characteristics, environmental and WASH indicators, and child related factors. The sociodemographic characteristics included child age and sex; caregiver age, education, occupation; household size and crowding as proxies for socioeconomic status. The environmental and WASH indicators considered were drinking water service level and handling, sanitation service level, handwashing facility availability, and child stool disposal practices. The child health and care related factors encompassed feeding practices, nutritional status screening, immunization/rotavirus vaccine status, care-seeking and home management prior to facility presentation.

Study population

Children aged 0-59 months presenting to paediatric outpatient, emergency, or admitted paediatric wards during the study period, accompanied by a primary caregiver. A case was defined as a child aged 0-59 months presenting with acute diarrhoea, operationalized as ≥3 loose/liquid stools in the past 24 hours (caregiver report), consistent with WHO definition, with illness duration <14 days (to distinguish acute from persistent diarrhoea), while a control was defined a child aged 0-59 months presenting to the same facility for conditions other than diarrhoea, and with no diarrhoea in the past 14 days (caregiver report). Controls were sampled from the same care-seeking base population as cases to reduce selection bias. Sample size was calculated using the Schlesselman formula for unmatched case control study designs with a confidence level (1-α) set at 95%, and the other considerations set as follows: power: 80%, control-to-case ratio: r=1:1, exposure prevalence among controls (p0): 0.46 (proxy based on Kiambu county having ~54% appropriate disposal among youngest children <2 years; thus ~46% inappropriate).[3] A total sample of 300 children was generated, anchored on a key exposure with strong prior evidence, that is, inappropriate disposal of child stools, which is repeatedly linked to diarrheal outcomes.[8]

$P1=(OR\times P0)/(1+P0\times(OR1)), n=((Z\alpha/2+Z\beta)^2\times(P1\times(1P1)+P0\times(1-P0)))/(P1-P0)^2$ Where: n=sample size required per group, Zα/2=standard normal deviate for the chosen confidence level, Zβ=standard normal deviate for the chosen power P0=proportion exposed among controls P1=proportion exposed among cases, OR=2.0 (minimum detectable association (for moderate effect size relevant for public health prioritization).

Sampling method

Cases were recruited consecutively as they presented. Controls were recruited using a systematic sampling approach from non-diarrhea paediatric patients. Triage identified presumptive case/control status. For those who were very ill stabilization was given priority, eligibility was then determined by the research assistant and consent was then sought. To enhance confidentiality, the interviews and record abstractions were conducted in a private area free from noise and interruptions.

Data collection

Two main tools were used in the study. The first was a structured questionnaire that was administered to the caregiver by a trained interviewer. The second tool was a data abstraction form that was used to capture information pertaining to triage vitals and dehydration severity (none/some/severe). Treatments given e.g. fluids, zinc, antibiotics were documented. The admission status and the outcomes after treatment were also noted in the data abstraction form.

Data analysis

Data was first entered into an excel dataset. This is after data cleaning was done. Jamovi statistical analyses software version 2.6.25 was used to analyze data. The analysis was framed around a binary outcome: presence or absence of diarrheal disease at presentation. The explanatory variables included child age group (0-11, 12–23, 24–35, and 36–59 months), sex, caregiver education level, main household water source, household sanitation, handwashing with soap, exclusive breastfeeding for the first 6 months, rotavirus vaccination status, and nutritional status. Tables with frequencies and percentages stratified by case/control status were generated and variables were described using JMP-style ladders for interpretability. Bivariate analysis with Chi square test (or Fisher's exact where expected counts <5), crude odds ratios (cOR) with 95% Confidence interval (CI) was done. Multivariable logistic regression with diarrhea case status as the dependent variable was then carried out to get the adjusted odds ratios (aOR).

Ethical considerations

Approval was obtained from the JKUAT Institutional scientific and Ethics review committee, and the appropriate hospital permission was also sought. Informed consent was sought from the caretakers and confidentiality was maintained by use of unique participant IDs and coded responses to ensure participant anonymity. The interviews were delayed until clinical stabilization and there was no interference with care to the patient.

RESULTS

Socio-demographic characteristics

A total of 300 participants were included, comprising 150 cases and 150 controls. Cases were generally younger than controls, with a lower mean age in months (24.3±14.6 vs 27.2±16.5) though this was not statistically different between the groups. There were also no statistically significant differences between cases and controls in age group distribution, sex, or caregiver education. Cases came from households that had significantly more members compared controls. Table 1.

Table 1: Baseline sociodemographic characteristics.

Characteristics	Category	Overall (n=300)	Cases (n=150)	Controls (n=150)	P value
Age (months), mean±SD		25.8±15.6	24.3±14.6	27.2±16.5	0.114
Age group (months) N (%)	6-11	89 (29.7)	44 (29.3)	45 (30.0)	0.185
	12-23	65 (21.7)	40 (26.7)	25 (16.7)	
	24-35	68 (22.7)	31 (20.7)	37 (24.7)	
	36-59	78 (26.0)	35 (23.3)	43 (28.7)	
Sex, N (%)	Female	165 (55.0)	80 (53.3)	85 (56.7)	0.642
	Male	135 (45.0)	70 (46.7)	65 (43.3)	
Caregiver education, N (%)	Primary or<	90 (30.0)	49 (32.7)	41 (27.3)	0.162
	Secondary	121 (40.3)	64 (42.7)	57 (38.0)	
	College+	89 (29.7)	37 (24.7)	52 (34.7)	
Household size, mean±SD		4.30±1.48	5.09±1.44	3.51±1.01	<0.001

Abbreviations: SD:Standard deviation.

Table 2: Clinical, nutritional and behavioral characteristics.

Characteristics	Category	Overall (n=300) N (%)	Cases (n=150) N (%)	Controls (n=150) N (%)	P value
MUAC (cm), mean±SD		14.06±1.42	13.83±1.51	14.28±1.30	0.006
Nutritional status, N (%)	Normal	231 (77.0)	106 (70.7)	125 (83.3)	0.005
	MAM	58 (19.3)	34 (22.7)	24 (16.0)	

Continued.

Characteristics	Category	Overall (n=300) N (%)	Cases (n=150) N (%)	Controls (n=150) N (%)	P value
	SAM	11 (3.7)	10 (6.7)	1 (0.7)	
Undernourished, N (%)	No	231 (77.0)	106 (70.7)	125 (83.3)	0.014
	Yes	69 (23.0)	44 (29.3)	25 (16.7)	
Water source, N (%)	Improved	207 (69.0)	93 (62.0)	114 (76.0)	0.013
	Unimproved	93 (31.0)	57 (38.0)	36 (24.0)	
Sanitation, N (%)	Improved	191 (63.7)	81 (54.0)	110 (73.3)	<0.001
	Unimproved	109 (36.3)	69 (46.0)	40 (26.7)	
Handwashing with soap, N (%)	Yes	166 (55.3)	67 (44.7)	99 (66.0)	<0.001
	No	134 (44.7)	83 (55.3)	51 (34.0)	
Exclusive breastfeeding 6 months, N (%)	Yes	172 (57.3)	74 (49.3)	98 (65.3)	0.007
	No	128 (42.7)	76 (50.7)	52 (34.7)	
Rotavirus vaccine status, N (%)	Up to date	213 (71.0)	94 (62.7)	119 (79.3)	0.002
	Not up to date	87 (29.0)	56 (37.3)	31 (20.7)	
Fever, N (%)	No	172 (57.3)	68 (45.3)	104 (69.3)	<0.001
	Yes	128 (42.7)	82 (54.7)	46 (30.7)	
Vomiting, N (%)	No	191 (63.7)	47 (31.3)	144 (96.0)	<0.001
	Yes	109 (36.3)	103 (68.7)	6 (4.0)	
Dehydration, N (%)	None	127 (42.3)	1 (0.7)	126 (84.0)	<0.001
	Some	115 (38.3)	92 (61.3)	23 (15.3)	
	Severe	58 (19.3)	57 (38.0)	1 (0.7)	

Table 3: Bivariate analysis of selected factors associated with diarrhoeal disease (n=300).

Variables	Comparison	Crude OR	95% CI	P value
Age groups (months)	36-59 (ref)	Ref		
	24-35 vs 36-59	1.03	0.54-1.98	0.931
	12-23 vs 36-59	1.97	1.01-3.84	0.048
	6-11 vs 36-59	1.20	0.65-2.21	0.556
Sex	Female (ref)	Ref		
	Male vs female	1.14	0.73–1.80	0.562
Caregiver education	College+ (ref)	Ref		
	Primary or less vs college+	1.68	0.93–3.03	0.086
	Secondary vs college+	1.58	0.91–2.74	0.106
Water source	Improved (ref)	Ref		
	Unimproved vs improved	1.94	1.18–3.20	0.009
Sanitation	Improved (ref)	Ref		
	Unimproved vs improved	2.34	1.44–3.80	<0.001
Handwashing with soap	Yes (ref)	Ref		
	No vs yes	2.40	1.51–3.83	<0.001
Exclusive breastfeeding	Yes (ref)	Ref		
	No vs yes	1.94	1.22–3.08	0.005
Rotavirus vaccination	Up to date (ref)	Ref		
	Not up-to-date vs up-to-date	2.29	1.37–3.83	0.002
Undernourished	No (ref)	Ref		
	Yes vs no	2.08	1.19–3.62	0.010
Household size	Per 1-person increase	2.73	2.14–3.50	<0.001

Table 4: Multivariable logistic regression.

Variables	Comparison	AOR	95% CI	P value
Age groups (months)	36-59 (ref)	Ref		
	24–35 vs 36–59	1.29	0.57–2.93	0.543
	12–23 vs 36–59	2.60	1.08–6.29	0.034

Continued.

Variables	Comparison	AOR	95% CI	P value
	6–11 vs 36–59	1.05	0.47–2.34	0.898
Sex	Female (ref)	Ref		
	Male vs female	1.30	0.71–2.38	0.393
Caregiver education	College+ (ref)	Ref		
	Primary or less vs college+	1.44	0.66–3.15	0.365
	Secondary vs college+	1.67	0.82–3.40	0.160
Water source	Improved (ref)	Ref		
	Unimproved vs improved	1.97	1.03–3.74	0.039
Sanitation	Improved (ref)	Ref		
	Unimproved vs improved	1.93	1.02–3.65	0.044
Handwashing with soap	Yes (ref)	Ref		
	No vs yes	2.21	1.21–4.03	0.009
Exclusive breast feeding 6 months	Yes (ref)	Ref		
	No vs yes	1.18	0.64–2.17	0.598
Rotavirus vaccination	Up to date (ref)	Ref		
Undernourished	Not up-to-date vs up-to-date	1.86	0.96–3.60	0.068
	No (ref)	Ref		
	Yes vs no	2.18	1.06–4.47	0.034
Household size	Per 1-person increase	2.63	2.01–3.44	<0.001

Clinical, nutritional and behavioral characteristics

In the clinical, nutritional and behavioral parameters, it was found that children with diarrhea (the cases) had lower MUAC, were more likely to be undernourished, and were more likely to come from households with unimproved water, unimproved sanitation, and no handwashing with soap.

They were also less likely to have been exclusively breastfed for 6 months and less likely to be up to date on rotavirus vaccination. Fever, vomiting, and dehydration were much more common among cases. Clinical symptoms showed strong associations with diarrhoea status.

Fever was present in 54.7% of cases compared to 30.7% of controls, demonstrating significance at $p<0.001$. Vomiting showed the strongest association, present in 68.7% of cases but only 4.0% of controls, also with a significance of $p<0.001$. This kind of significance is not surprising though, since it reflects the clinical presentation of acute gastroenteritis, where vomiting and diarrhea frequently occur together table 2.

Bivariate analysis

In the unadjusted analysis, diarrhea was significantly associated with age 12–23 months, unimproved water source, unimproved sanitation, lack of handwashing with soap, non-exclusive breastfeeding, not being up to date with rotavirus vaccination, undernutrition, and larger household size.

Sex and caregiver education level did not show significant associations with diarrhea in bivariate analysis table 3.

Multivariable regression model

After adjustment for the other variables in the model, the factors that remained independently associated with diarrhea were; Age 12–23 months: aOR 2.60, $p=0.034$, unimproved water source: aOR 1.97, $p=0.039$, unimproved sanitation: aOR 1.93, $p=0.044$, no handwashing with soap: aOR 2.21, $p=0.009$, undernutrition: aOR 2.18, $p=0.034$ and larger household size: aOR 2.63 per additional household member, $p<0.001$ table 4.

DISCUSSION

Six independent risk factors for childhood diarrheal disease were identified in this study, and these factors spanned three major domains: WASH infrastructure and practices (non-basic sanitation service, non-basic handwashing facilities); child specific characteristics (age 12 to 23 months, malnutrition); and socioeconomic determinants (increased household size). This supports the widely established fact that childhood diarrhoeal disease is rarely driven by a single exposure but by many interlinked determinants. Environmental conditions and nutritional vulnerability play major roles, and so do the day-to-day household practices. This means that prevention efforts focused on only one area may not produce significant impacts.[9,10]

Cases and controls participating in this study had some noticeable differences. Children with diarrhoeal disease tended to be younger on average (24.3 months versus 27.2 months). They also often lived in larger and potentially more crowded households, while their caregivers were also more likely to have lower levels of education. These patterns are not entirely surprising and mirror what has been reported in many poor rural and urban settings, where the burden of childhood diarrheal disease tends to fall more heavily on socioeconomically disadvantaged families. At the same time, the relationship is probably more complex than income or education alone, since factors such as caregiving demands in large households, inconsistent water access, and overcrowded living conditions may all interact in ways that increase exposure risk.[11]

Children aged 12-23 months had slightly higher odds of diarrheal disease compared to children in other age groups (95% CI: 1.08-6.29, p=0.034). This age group comprised 26.7% of cases but only 16.7% of controls, and highlights the particular vulnerability of children in this developmental period. This age group 12 to 23 months suffers this increased risk as a reflection of multiple biological and environmental factors that converge during this period of growth. Their increased mobility and exploration and environmental exposure to dirt during play with other children and animals may also explain why their risk of being afflicted with diarrheal illness is higher than other brackets in the childhood period. In perspective, this is consistent with known global epidemiological patterns and information gathered in several studies. A study in Nigeria found that children aged 12-23 months had the highest diarrheal disease prevalence.[12] A longitudinal study in Northern Kenya's drylands also identified age related patterns in diarrheal disease risk, though the specific age groups examined differed somewhat.[13]

The multivariable logistic regression model showed adjusted odds ratios ranging from 1.05 to 2.63, indicating mild to strong associations between the identified risk factors and childhood diarrheal disease. The strongest associations were observed for huge household sizes (aOR 2.63), age 12 to 23 months (aOR 2.60), non-basic handwashing with soap (aOR=2.21) and malnutrition (aOR 2.18). A number of previous case control and cross-sectional studies from sub-Saharan Africa have demonstrated almost similar effect sizes.[14-16] Even though the effect sizes from these other studies were somewhat larger compared to those observed in our study, they reflect the severity of WASH deficits in different contexts and draws attention to the critical importance of WASH infrastructure for diarrheal disease prevention.

There was a 2.21-fold increase in the odds of childhood diarrheal disease related to the absence of proper handwashing (95% CI: 1.21-4.03, p=0.009), representing one of the strongest associations seen in this study. This is shown by 55.3% of cases lacking access to regular soap during handwashing compared to 34% of controls. Proper handwashing habits in preventing fecal oral disease transmission of infections is a long-established tenet of hygiene, and studies from sub–Saharan Africa have documented similar associations between handwashing habits and childhood diarrheal disease. In Bishoftu, Ethiopia, households with no hygiene service had 3.43 times the odds of childhood diarrhea, while those with limited hygiene service had 2.13 times the odds.[16] In Rwanda, a study looking at links between household WASH practices and diarrhea from 2010 to 2020 found that improvements in handwashing facilities and practice were significantly related to lower rates of diarrhea.[19] Non-basic water service level was associated with 1.97 times the odds of childhood diarrhea (95% CI: 1.03-3.74, p=0.039). Among cases, 38% had non-basic water service compared to 24% of controls. This finding concurs with the well-established role of safe water access in preventing waterborne and water-washed diseases, including diarrhea, and also relates to a study done in Kersa, Eastern Ethiopia, that found significant associations between drinking water source and diarrheal disease among children under five.[20]

Children from households with no basic sanitation services had 1.93 times the odds of diarrheal disease compared to those with at least basic sanitation (95% CI: 1.02-3.65, p=0.044). In our cohorts, 46.0% of cases came from households with non-basic sanitation compared to 26.7% of controls, highlighting the substantial sanitation deficit among the children with diarrheal disease. Extensive evidence from sub-Saharan Africa has consistently demonstrated the critical role of improved sanitation in preventing childhood diarrheal disease, with a number of studies from the region documenting similar associations.[16-18] Non-basic sanitation was a significant problem in the study area. It indicates that many families lacked access to improved sanitation facilities or were using shared facilities, which compromise hygiene. There is also a possible increase in the risk of disease transmission. In Thika and similar peri urban settings, a top priority for diarrhoeal disease prevention would be to initiate interventions that improve sanitation coverage and quality as a matter of public urgency.[21]

Multiple risk factors in our study’s multivariable regression model remained significant even after adjustment for potential confounders. This supports the fact that these determinants relate closely to one another. It is on this basis that pursuing and implementing integrated multidimensional approaches at the same time in the control of diarrheal disease would give better outcomes than focusing on the factors individually. Targeting single determinants is unlikely to realize significant reductions in the overall disease burden.

There are three main shortcomings for this research, the first being the cross-sectional design. This restricts the ability to draw causal relationships from this work. Being a single site setting also limits broad generalization of the findings. The third limitation relates to the lack of microbiological diagnosis hence an inability to precisely identify the causative agents in the diarrheal cases. Further research, preferably multicenter in nature, will help gather more information that would borrow data from this and similar studies, in order to have a more concrete picture about the risk factors associated with diarrhoeal disease in our setup.

CONCLUSION

There are diverse and interrelated factors associated with childhood diarrhoeal disease, and this study identifies nine of these independent risk factors. These factors cut across different domains, among them WASH related infrastructure and practices. Others are child level characteristics and socioeconomic conditions. This highlights the multifaceted nature of diarrhoeal disease transmission. In urban and rural sub-Saharan African settings, strategies that improve WASH conditions while addressing underlying socioeconomic vulnerabilities are likely to offer the greatest potential for sustained reductions in childhood diarrheal illnesses. The observed adjusted odds ratios on the multiple determinants, ranging from 1.05 to 2.63, indicate that interventions focusing on these modifiable risk factors could contribute in a big way to reducing the occurrence of childhood diarrheal disease in similar settings.

Recommendations

To effectively manage the burden of diarrheal disease, consideration for integrated child survival programs is necessary. This means combining prompt clinical management (treating dehydration and illness) with preventive strategies. Improving WASH (water, sanitation, and hygiene) infrastructure at household and community level and promoting optimal infant nutrition are some of the important preventive actions that need to be promoted incessantly. Together with these actions, ensuring complete rotavirus vaccination among infants should be an eminent child health policy in the health sector. Community health education on all the aspects of hygiene and diarrhoeal disease prevention should be done at every possible opportunity.

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