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ENVIRONMENTAL FACTORS ASSOCIATED WITH DIARRHOEA PREVALENCE AMONG CHILDREN UNDER FIVE YEARS IN MATHARE INFORMAL SETTLEMENT, NAIROBI COUNTY

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**ENVIRONMENTAL FACTORS ASSOCIATED WITH DIARRHOEA
PREVALENCE AMONG CHILDREN UNDER FIVE YEARS IN MATHARE
INFORMAL SETTLEMENT, NAIROBI COUNTY**

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ABSTRACT

Background: Diarrhea is the second leading cause of death globally among children under five. Nairobi County has reported 136,028 cases of diarrhea-related illnesses, with a large number occurring in informal settlements. This study assesses environmental factors associated with diarrhea prevalence among children under five in Nairobi's Mathare informal settlement.

Methods: This cross-sectional study employed both quantitative and qualitative data collection methods. The study was conducted in 13 villages of Mathare, targeting 218 main caregivers. A multistage sampling approach was used, combining purposive, stratified, and simple random sampling. Descriptive statistics were used to analyze environmental factors.

Results: Among 173 caregivers surveyed, 88% were female, mostly aged 20-29 years. Nearly half (49%) had only primary education, and 95% earned 1,000 Kenyan shillings or less monthly, reflecting high poverty levels. Significant environmental factors associated with diarrhea included water sources, sanitation practices, and waste disposal. Households using tap water had a 2.97-fold higher risk of diarrhea compared to those relying on vendors. Poor waste disposal and lack of alternative water sources further exacerbated diarrhea incidence. Key informant interviews highlighted poor sanitation, overcrowding, and limited healthcare access as critical issues. Despite public health efforts, there is a need for improved infrastructure, healthcare services, and community health support.

Conclusion: To reduce diarrhea prevalence in informal settlements, health programs should focus on improving environmental conditions, particularly water supply and sanitation.

INTRODUCTION

The population of sub-Saharan African slums faces significant health risks due to poor sanitation, lack of storm drainage systems, inadequate waste management, contaminated water supplies, and high population densities, which expose residents to human waste and contaminated water. Diarrhea, a major health concern, accounts for 122 deaths per 100,000 children in Kenya [1]. Globally, diarrhea is the second leading cause of death in children under five [2]. In 2018, Kenya reported 1,499,146 diarrhea cases among children under five, with 136,028 cases from Nairobi County, primarily in informal settlements [3]. Environmental contamination, especially improper garbage disposal, contributes to this high prevalence [3].

Unsafe sanitation practices in urban slums, exacerbated by population pressure on limited facilities, lead to unclean living conditions, unsafe drinking water, and poor sanitation—key environmental health risks identified by WHO in 2009 [4]. Over 55% of the global population now lives in urban areas, underscoring the urgency of addressing these issues through reliable waste management, sanitation, and water infrastructure. A 2017 study reported that diarrhea affected 25.6% of children under five in Nairobi's informal settlements, with some caregivers reporting cases at least biweekly [5].

This study addresses the limited research on factors influencing diarrhea prevalence in children under five in Mathare and similar settlements. Since primary caregivers manage most diarrhea cases at home, understanding their practices and challenges is crucial for developing effective health promotion strategies in Mathare and Nairobi County..

METHODS

Using both quantitative and qualitative methodologies, this community-based cross-sectional study design was conducted among children under five years old residing in the Mathare informal settlement.

Study Area: The study was carried out in Nairobi County's Mathare constituency at the Mathare informal slum. Mabatini, Kwa Kariuki, Village 1, Mathare 4A, Kiamutisya, Mathare 3A, Kosovo, Gitthuruu, Mashimoni, Mathare 3B, Mathare 3C, Mathare Area 4B, and Village 2 are the thirteen communities that make up the Mathare informal settlement. About 3 squared kilometres make up the Mathare informal settlement area [6]. Mathare was selected because it is the second largest informal settlement in Nairobi, the capital city of Kenya and a higher number of diarrhea cases.

Study Population: The study population were the children under five years in the Mathare informal settlement who had diarrhea. The rate of diarrhea among children under five in Mathare informal settlement is 82.9%, surpassing the national average of 15% cases for this age group [6]. The Mathare informal community is home to over 500,000 people [7].

Sampling Size Determination

Equation 3.1 below shows how the sample size for this study was determined [8]:

$$n = \frac{z^2 pq}{e^2}$$

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 Equation (3.1)

with,

n = desired sample size

z = critical value obtained at 95% confidence interval which is 1.96

p = the proportion of people in the target population estimated (0.5).

q = weighting variable given by $1 - p = 0.5$

e = the level of statistical significance which is 0.05

$$n = \frac{1.96^2 * 0.829 * 0.171}{0.05^2}$$

n= 218 Mothers/ Caregivers

Sampling Method

A multistage sampling strategy was used. First, Mathare informal settlement was purposively selected due to high diarrhea case reports. Second, the settlement was stratified into 13 villages, each with ~1,259 households. Finally, random sampling was applied to select households from each village. Community health volunteers identified households with children under five, leveraging their local knowledge.

Data Collection

Data were collected using semi-structured questionnaires between April 1 and May 1, 2021. Enumerators entered responses into Open Data Kit (ODK), a mobile platform for data collection.

Data Analysis

Quantitative data were analyzed using descriptive statistics (means, standard deviations, frequencies, percentages) to summarize respondent and household characteristics. Bivariate analysis assessed relationships between independent variables

(e.g., caregiver gender, education level, household size, number of children under five, income range, water source, water supply frequency, diarrhea knowledge, toilet type, faeces presence, and flies) and diarrhea prevalence. Chi-square tests evaluated associations between categorical variables.

For qualitative data, thematic analysis was applied to key informant interviews (KIIs) and focused group discussions (FGDs). Responses were transcribed, coded, and categorized into themes on environmental and social factors influencing diarrhea. Qualitative findings complemented quantitative results by highlighting barriers and challenges to hygiene and sanitation practices.

Qualitative Data

FGDs included 10 community health volunteers, while KIIs involved three nurses and three clinical officers familiar with Mathare informal settlement. Discussions centered on preventing diarrhea spread, addressing challenges, and gathering suggestions for improvement.

Table 3.1

Theme from Focus Group Discussions and Key Informants

Themes	Categories	Code
1. Ways of preventing spread of diarrhea	Causes of diarrhea	Self experience
	Signs of diarrhea	Personal experience How information is spread on diarrhea
	What do community do to stop the spread	Personal experience Observations
3. Challenges in stopping spread of diarrhea	Barriers in the community	Personal experience Observations
4. Suggestions	Role of the government in stopping the spread of diarrhea	Personal experience Observations
	Role of community in stopping the spread of diarrhea	Personal experience Observations

Ethical Considerations

The study received ethical approval from the Institutional Ethics Review Committee

(IERC) of Jomo Kenyatta University of Agriculture and Technology (JKUAT), with reference number JKU/2/4/896B. A research

permit was also obtained from the National Commission for Science, Technology, and Innovation (NACOSTI), and approval was granted by the County Director of Health in Nairobi County.

RESULTS

Social Demographic Determinants

The majority of caregivers were female (88%, 152 respondents), with males comprising 12% (21 respondents) (See *Table 1*). Most caregivers were young, with 34% aged 25–29 years and 31% aged 20–24 years, together accounting for 65%. Older caregivers were few, with 2% aged 45–49 and 1% aged 50 and above.

Regarding their relationship to the children, 77% were mothers, while fathers constituted 9%. Other caregivers included siblings (2%),

grandparents (5%), relatives (6%), and house help (2%).

Educational attainment varied, with 49% having completed primary education and 19% reporting no formal education. Secondary education was reported by 29%, while only 3% had tertiary education.

Economic hardships were prevalent, with 95% of caregivers (165 respondents) earning 1,000 Kenyan shillings or less per month. Only 4% earned between 10,001 and 15,000 shillings, and 1% earned 15,001–20,000 shillings. This widespread poverty likely hinders caregivers' ability to provide adequate care, nutrition, and healthcare for their children.

Table 1

Social demographic characteristics of the caregivers in Mathare slums

Variables		Frequencies	Percentage
Gender	Male	21	12%
	Female	152	88%
	Total	173	100%
Age	20-24	53	31%
	25-29	59	34%
	30-34	29	17%
	35-39	12	7%
	40-44	16	9%
	45-49	3	2%
	50+	1	1%
	Total	173	100%
Relation of caregiver	Mother	133	77%
	Father	15	9%
	Siblings	3	2%
	Grandparent	9	5%
	Relatives	10	6%
	House help	3	2%
	Total	173	100%
Level of education	None	33	19%
	Primary	84	49%
	Secondary	50	29%
	Tertiary	6	3%
	Total	173	100%
Monthly income	1000 and below	165	95%
	10001-15000	7	4%
	15001-20000	1	1%

	Total	173	100%
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Environmental Factors Associated

This study explored how environmental factors influence diarrhea prevalence among children under five in Mathare slums. Key factors included water sources, sanitation practices, and waste disposal methods.

Source of Drinking Water: Vendors (60%) were the reference group (OR = 1), with 38% reporting diarrhea. Tap water users (31%) had a 2.97-fold higher likelihood of diarrhea (OR = 2.97, 95% CI: 1.06–8.30). Conversely, municipal water (9%) reduced diarrhea risk (OR = 0.625, 95% CI: 0.38–1.03, $p < 0.044$), underscoring its significant influence on diarrhea prevalence.

Frequency of Water Supply: A daily supply (9%) was the reference group (OR = 1), with

50% reporting diarrhea. Weekly supply (89%) decreased diarrhea odds (OR = 0.53, 95% CI: 0.16–1.72), though not significant. Monthly supply (2%) showed no diarrhea cases. Overall, supply frequency was significant ($p < 0.039$).

Alternative Source of Water: Households without an alternative source (78%) were 1.69 times more likely to report diarrhea (OR = 1.69, 95% CI: 1.34–2.40, $p < 0.027$).

Type of Disposal: Flush toilets (3%) were the reference group (OR = 1), with 20% reporting diarrhea. Pit latrines (82%) increased diarrhea odds (OR = 2.60), though not significant. Flying toilets (14%) greatly heightened risk (OR = 8.90) but had wide confidence intervals, reflecting estimate instability. Disposal type was highly significant ($p < 0.010$).

Table 2

Environmental factors and its association with diarrhea prevalence

Diarrhea prevalence								
Variables	Category	Freq.	Perc.	Yes, n (%)	No, n (%)	O.R.	O.R. LCI, UCI	Pearson Chi-Square
Source of drinking water	Vendors	104	60%	38% (40)	62% (64)	1		$p < 0.044^{**}$
	Tap water	53	31%	28% (15)	72% (38)	2.97	1.06, 8.30	
	Municipal county	15	9%	67% (10)	33% (5)	0.625	0.38, 1.03	
Total		173	100%	38% (65)	62% (107)			
Frequency of water supply	Daily	16	9%	50% (8)	50% (8)	1		$p < 0.039^{**}$
	Weekly	154	89%	36% (56)	64% (98)	0.53	0.16, 1.72	
	Monthly	3	2%	-	100% (3)	-	-	
Total		173	100%	37% (64)	63% (109)			
Alternative source of water	Yes	38	22%	45% (17)	55% (21)	1		$p < 0.027^{**}$
	No	135	78%	36% (48)	64% (87)	1.69	1.34, 2.40	
Total		173	100%	38% (65)	62% (108)			
Type of disposal	Flush toilet	5	3%	20% (1)	80% (4)	1		$p < 0.010^{**}$
	Pit latrine	142	82%	32% (45)	68% (97)	2.60	0.28, 24.50	
	Flying toilet	25	14%	64% (16)	36% (9)	8.90	0.87, 90.55	
	Open defacate	1	1%	100% (1)	-	-	-	
Total		173	100%	36% (63)	64% (110)			
Disposing faeces	Pit latrine	73	42%	14% (10)	86% (63)	1		$p < 0.011^{**}$

	Open yards	20	12%	45% (9)	55% (11)	4.20	1.31, 13.50	
	Open drains	37	21%	43% (16)	57% (21)	4.12	1.57, 10.77	
	Along the road	34	20%	74% (25)	26% (9)	11.82	3.71, 37.64	
	Along the river	8	5%	75% (6)	25% (2)	12.68	2.12, 75.92	
Total		173	100%	38% (66)	62% (106)			
Disposing garbage	Along the road	38	22%	39% (15)	61% (23)	1		p<0.009**
	Dumping site	59	34%	20% (12)	80% (47)	0.41	0.17, 0.97	
	Along the river	73	42%	52% (38)	48% (35)	1.70	0.71, 4.03	
	Others	3	2%	-	100% (3)	-	-	
Total		173	100%	38% (65)	62% (108)			

NB: 1 Note: ** represents significance level at 5%

The study found that the method of disposing of feces significantly affects the risk of diarrhea. Pit latrines (42%) served as the reference group, with 14% reporting diarrhea. Open yards (12%) and open drains (21%) were associated with a 4-fold increase in diarrhea risk (OR = 4.20 and OR = 4.12, respectively), while disposal along roads (20%) and rivers (5%) further increased the risk, with odds ratios of 11.82 and 12.68, respectively ($p < 0.011$). Regarding garbage disposal, those disposing along roads (22%) served as the reference group, with 39% reporting diarrhea. Dumping at official sites (34%) reduced the odds of diarrhea (OR = 0.41, 95% CI: 0.17–0.97), indicating a protective effect. Disposal along rivers (42%) increased the odds of diarrhea (OR = 1.70), though not statistically significant. The overall association between garbage disposal and diarrhea was statistically significant ($p < 0.009$), highlighting the importance of proper waste management.

Key Informant Interview Results

Factors and Causes of Diarrhea Prevalence

Key informants unanimously highlighted that the high prevalence of diarrhea in Mathare stems from several intertwined factors, including poor sanitation, unsafe drinking water, overcrowding, and inadequate health systems. Poor sanitation was identified as a significant contributor, with open defecation being common, resulting in the contamination of water sources and the environment. The overcrowded living conditions worsen this situation, making it difficult to maintain proper hygiene. One key informant emphasized, "In Mathare, the sanitation situation is dire. Many residents don't have access to clean toilets, and this leads to open defecation. It's impossible to control diarrhea in such an environment."

Another critical issue raised was the lack of access to safe and clean drinking water. Residents are often forced to buy water from vendors or fetch it from unsafe sources. During shortages, they store water in dirty containers, which further contributes to the spread of waterborne diseases like diarrhea.

According to one informant, "People here are forced to buy water from vendors or fetch it from unsafe sources. During shortages, they store water in dirty containers, and this is one of the reasons we see so many cases of diarrhea."

Overcrowding in Mathare exacerbates these challenges by limiting the availability of space for proper waste disposal and sanitation facilities. The congested living conditions, coupled with a lack of organized waste management systems, lead to environmental contamination and increase the risk of diarrhea outbreaks. A health professional explained, "Mathare is overpopulated, and there is no space to put more toilets or dispose of garbage. Waste is left lying around, and this makes it easy for diseases like diarrhea to spread."

While there have been efforts to address diarrhea in Mathare, key informants pointed out several ongoing challenges that hinder progress. The inadequacy of health facilities was a major concern, with the few available clinics often overwhelmed, especially during diarrhea outbreaks. Long waiting times are common, and many health centers lack

essential supplies, such as medications and oral rehydration salts (ORS), critical for treating diarrhea. One key informant commented, *"Our clinics are overcrowded, and there aren't enough supplies to treat everyone. When diarrhea cases increase, the health facilities are simply not equipped to handle the situation."*

The shortage of trained health personnel further compounds the problem, with the limited number of healthcare workers struggling to meet the needs of the large population. Many health workers are overworked, which impacts the quality of care provided. As one informant noted, *"There are not enough doctors and nurses in Mathare. The few we have are stretched too thin, and this affects the quality of care."*

Measures and Interventions

While some initiatives have been undertaken by the government and NGOs to curb the spread of diarrhea, these efforts are often inadequate due to insufficient resources and infrastructure. Public health awareness campaigns have been initiated to educate residents about hygiene practices, such as proper handwashing, safe food handling, and the use of oral rehydration solutions (ORS) for managing diarrhea. However, key informants pointed out that these campaigns often do not reach all residents, and more sustained efforts are needed. A CHW noted that *"We have tried to educate people about basic hygiene practices, but the campaigns are small and irregular. We need to do more to ensure everyone in the community knows how to prevent diarrhea."*

Further, WASH programs have been implemented mostly by NGOs in parts of Mathare to improve water and sanitation services. However, key informants indicated that these programs are limited in scope and have not had a widespread impact due to the rapid population growth in the slum. According to a key informant, *"There are a few WASH initiatives, but they are not enough to*

meet the needs of the entire community. The programs need to be expanded to have a meaningful impact."

It was also noted during the interviews that Community health volunteers play a vital role in providing health education and distributing essential supplies such as ORS and zinc supplements. According to an informant, *"Our community health volunteers are dedicated, but they don't receive enough support. They need more resources and better pay if they are going to make a real difference in controlling diarrhea."* Therefore, despite the efforts of the CHVs, they are often underpaid and lack the necessary resources to conduct effective outreach.

Recommendations for Improving Diarrhea Control

Key informants provided several recommendations to address the challenges identified and improve diarrhea control in Mathare. Their suggestions focused on enhancing infrastructure, expanding health services, and increasing support for community health workers. The following were the informants comments:

"We need better housing and more toilets. The government should help improve the infrastructure here to reduce the spread of diseases like diarrhea."

"We need more investment in WASH programs. If everyone had access to clean water and proper toilets, diarrhea cases would go down significantly."

"We need more health centers and more staff. If we had enough doctors, nurses, and supplies, we could handle diarrhea cases much more effectively."

"Our community health volunteers are doing a lot of good work, but they need more support from the government. If they were better compensated and had more resources, they could do even more to help control diarrhea."

DISCUSSION

The findings of this study underscore the significant influence of socio-demographic factors on the prevalence of diarrhea among children under five years in the Mathare informal settlement. Caregivers in this context are predominantly young and female, with a large proportion possessing low levels of education and earning minimal income. These socio-economic conditions directly affect their ability to provide adequate care, nutrition, and access to healthcare for their children, as highlighted by [9].

The strong association between caregivers' socio-economic status and child health outcomes is well-established. The study reveals that the majority of caregivers earn a monthly income of 1,000 Kenyan shillings or less, illustrating widespread poverty in the community. This economic hardship significantly restricts access to essential resources, such as nutritious food and healthcare services, and compromises the quality of care provided at home. Poverty remains a fundamental determinant of health, impacting both the availability and quality of healthcare services and the ability to maintain proper child health within resource-constrained households [10].

The study revealed strong associations between environmental factors and the prevalence of diarrhea, particularly highlighting the significant role of water sources. Tap water users were nearly three times more likely to report diarrhea compared to those relying on vendor water, supporting existing literature on the critical link between water quality and diarrheal diseases [9]. Additionally, households without an alternative water source faced increased diarrhea risks, emphasizing the dangers of depending on a single, potentially contaminated water supply [11].

Sanitation practices also played a major role in diarrhea risk. The use of open defecation and flying toilets, common in Mathare, significantly worsened the situation. Key informants noted that poor sanitation in the settlement led to widespread environmental contamination, facilitating the spread of waterborne diseases. These findings are consistent with previous research linking inadequate sanitation to higher diarrhea rates in informal settlements [12].

Despite efforts to address the issues, challenges persist, such as inadequate healthcare infrastructure and a shortage of trained personnel. Overwhelmed health facilities in Mathare, as reported by key informants, hinder effective diarrhea response, reflecting broader healthcare system issues in low-income areas [13]. Community health volunteers (CHVs) are crucial in managing these challenges by providing health education and essential supplies. However, their impact is limited by a lack of resources and support, as success depends on proper training, resources, and compensation [14].

CONCLUSION

The study highlights the complex relationship between environmental factors, socio-economic status, and health infrastructure in diarrhea prevalence among children under five in Mathare. Addressing these issues requires a comprehensive approach, including improved infrastructure, healthcare services, and continued community involvement.

The findings from the key informant interviews reveal that while there are efforts to address diarrhea in Mathare, significant challenges remain. Poor sanitation, unsafe drinking water, overcrowding, and inadequate health care services continue to contribute to the high prevalence of diarrhea. Key informants recommend that the

government and relevant stakeholders focus on improving housing and sanitation infrastructure, expanding WASH programs, increasing health facilities and personnel, and providing greater support for community health volunteers to mitigate the spread of diarrhea in the informal settlement.

RECOMMENDATIONS

Based on the findings and key informant insights, several recommendations are proposed to address the high prevalence of diarrhea in Mathare. These include improving sanitation infrastructure, expanding access to safe drinking water, and enhancing healthcare facilities. Additionally, investing in WASH programs and supporting community health initiatives can significantly reduce diarrhea incidence and improve overall health. Informants emphasized that these interventions should be comprehensive, addressing both immediate health needs and the underlying social and economic factors impacting health.

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