**Original Article**

**Environmental Determinants of Diarrhea Morbidity Among Children Under 5 Years in Migori County, Kenya.**

**(Running Title: Determinants of Diarrheal Diseases in Kenya)**

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**Abstract**

**Background :**Globally, 2.5 billion cases of diarrhoea occur among under-fives every year. Diarrhoea, a major cause of morbidity accounts for over 70% of childhood diseases in Africa. In Kenya, diarrhoea is a major public health problem, listed amongst the leading causes of mortality and morbidity amongst under-fives. **Objective:** To determine the environmental factors associated with diarrhoea among children under 5 years in Migori County. **Methodology: Q**uantitative approach was used where data collection involved a questionnaire. A total of 216 under- five children were sampled using multistage sampling technique. Analysis of data included generating descriptive and inferential statistics (Chi-square tests). **Results:** Findings revealed that the environmental factors including method of refuse disposal (p<0.001); latrine availability (p = 0.001); latrine type (p = 0.037);latrine sharing (p<0.001); source of drinking water (p = 0.009); water storage (p = 0.002); method of drawing water (p = 0.005); scooper cleaning (p<0.001); cleaning water container before refilling (p = 0.034); and drinking water treatment (p = 0.010)had an effect on the occurrence of diarrhea in under-five year old children. **Discussions :**A number of other environmental characteristics of mothers (or caregivers) of under-fives were found to be associated with diarrhoea in this study. Under five diarrhoea morbidity can be minimized if concerted efforts are made to improve waste disposal, increase latrine availability, reduce latrine sharing, improve drinking water source, treat drinking water, improve water storage and hygiene. **Conclusion:** The environmental determinants of diarrhoea morbidity identified should be addressed to prevent occurrence of diarrhoea disease among under-fives.

**Key words:** *Diarrhoea, morbidity, environmental determinants, under-fives, Oral Rehydration Therapy, and Oral Rehydration Salts.*

1. **Introduction**

Every year, there are over 2.5 billion diarrhoea cases among under fives globally. However, the disease predominantly concentrates only in 15 countries, including Kenya. [1] Research notes that a child in Africa experiences at least five diarrhoeal episodes a year. [2] Diarrhoeal disease accounted for 20% of under five deaths in Kenya in 2011 causing 38,802 deaths of under fives. [3]

Environmental factors such as refuse disposal and latrine availability can influence the diarrhoea occurrence. [4] However, poor environmental factors in Migori County such as the practice of open defecation can increase the risk of the disease. For example, 26% of the population in Migori County has no sanitation facilities. [5] The under fives are more susceptible to diarrhoea because they have an underdeveloped immune system.

Diarrhoea is a major public health problem and a leading cause of morbidity among children under five years in Kenya and accounts for about 20% deaths among under fives and about 4.7% of outpatient visits among under fives in Kenya. [6] Studies on prevention efforts to curb diarrhoea diseases report different results. Past studies drew on three systemic reviews and found that hygiene and sanitation were the most appropriate prevention strategies while others report interventions to address diarrhoea in 75 countries mentioned breastfeeding. [7, 8]

The purpose of this study was to examine the environmental factors that predispose children under 5 years to diarrhoea in Migori County. Identifying the underlying factors associated with diarrhoea morbidity among under fives in the context of Migori County in this study may be beneficial since the study participants can benefit in terms of understanding the significant factors influencing childhood morbidity and identify the amenable factors that they can change to address the situation. The study objective was to determine the environmental factors that are associated with diarrhoea among children under 5 years in Migori County.

* 1. **Related research**

Diarrhoea is defined as the passage of three or more liquid or loose stools per day. [3] It also involves having a more frequent passage of watery or loose stools than is normal for an individual. [9] Broadly, diarrhoea can be grouped into infectious and noninfectious diarrhoea. Pathophysiology of infectious diarrhoea involves two mechanisms: organisms (like *Shigella dysenteriae*) damages and penetrates intestinal mucosa cells; or toxins secreted by organisms (like *Vibrio cholera*) stimulate secretion of chloride and reduce water and sodium absorption).

Types of diarrhoea mainly vary in duration, cause and severity of the affected bowel area and the general health of an individual. A number of childhood diarrhoeal episodes are mild, however, acute cases may result in significant loss of fluids and hence dehydration or death. [10] Diarrhoea also causes diminished cognitive development, poor physical growth and weight loss among under fives since it can reduce a child’s appetite which alters the feeding patterns. [11]

Diarrhoea results when there is an imbalance in the secretion and absorption properties of the intestinal tract. This can be due to various causes such as metabolism errors, [12] intestinal diseases, [13] or intestinal tract infections. [14] Intestinal tract infection mainly arises from viral organisms (e.g. Rotavirus and Enteric adenovirus), parasitic organisms (e.g. *Cryptosporidium parvum*, *Giardia lamblia* and *Entamoeba histolytica*) and bacterial organisms (e.g. *Escherichia coli*, *Vibrio cholerae, Shigella dysenteriae* and *Salmonella enterica*). [15, 16]

* + 1. **Environmental factors and diarrhoeal morbidity**

Water is an important factor in the occurrence of diarrhoea among under fives, since infectious agents of diarrhoeal disease are acquired through contaminated water. [17] Unsafe water from unprotected or polluted water sources is ranked the among the top diarrhoea mortality risk factors. [18] Improving water quality through treatment of drinking water can help to reduce the diarrhoeal occurrence in developing countries. When under fives drink untreated water from unprotected sources like wells, rivers and other surface water, they are at risk of contracting diarrhoea since these sources are largely polluted. [19]

Increasing distance from water source is as a risk factor for diarrhoea among under fives since it affects the quantity of water available for hygiene practices such as regular hand washing. [20] Storage of water in containers may determine contamination of water depending on the conditions of storage. The water usage pattern in homes (e.g. obtaining water by dipping hands in a container rather than pouring) largely influences diarrhoea among under fives even if the water supply points are not polluted. [12]

Under fives tend to be less likely to contact diarrhoea in households with latrines compared to those without while proper use of latrines can reduce diarrhoea risk. [21] Sharing latrines among many households could result in unhygienic latrines. [22] The associated odour and fly problem may further deter others from using the latrines making open defecation more preferable. [23] Improper disposal of refuse increases the risk of diarrhoea among under-fives since it attracts flies. [24] Poor sanitation practices like an indiscriminate disposal of an under-five’s stool or open defecation lead to increased transmission of infectious agents of diarrhoeal disease. [25]

The presence of animals or livestock in living rooms enhances exposure to infectious agents of diarrhoea. [26] Climate changes may also result in diarrhoea, for instance, during rainy seasons, the diarrhoea morbidity is higher since water sources are polluted by runoff from open defecation in areas with low latrine coverage. [27, 28] However, it is vital to understand that the influence of environmental factors is complex and are conditioned by various behaviours, socioeconomic and demographic factors.

* + 1. **Prevention and treatment of diarrhoea**

Treatment measures include use of Oral Rehydration Salts (ORS), appropriate energy intake (food) and zinc supplementation which reduces the severity and duration of diarrhoea episodes. [29] However, these are still not accessible to many under-fives. Antibiotics are used in case of dysentery, cholera or typhoid, and intravenous saline provided in severe cases. [30] Prevention measures include educating mothers about sanitation, reduction of flies. Rotavirus vaccination in high risk regions has also been introduced but are yet to be adopted in many developing countries. [31]

Nonetheless, these measures alone have little impact on the diarrhoea occurrence without considering long term prevention of diarrhoea such healthy behaviours (e.g. hand washing with soap) and sanitation. Other ways that have been promoted for long term prevention of diarrhoea among under-fives include water treatment methods and prevention of pollution of water sources. [32, 33] As shown, in the literature review, diarrhoea is a preventable disease but it still remains to be one of the leading causes of under-five mortality in Kenya.

In summary, there are a number of environmental factors that influence the occurrence of diarrhoeal disease. However, there remains a gap in literature since no study has compared these factors in Migori County. More research on the exposure of under-fives to diarrhoea is required, particularly in Kenya since the disease remains a major cause of morbidity and mortality among under-fives.

The conceptual framework was developed based on the literature review of the causes of diarrhoea among under-fives. Past studies consider that the causes of diarrhoea in children encompass poor sanitation. [22] At the family or household level, the underlying causes were environmental factors. The conceptual framework is depicted in the Figure 1.

1. **Materials and Methods**

The study design was a cross-sectional descriptive study to describe the prevailing situation in a target population as it occurs naturally. [34] The cross-sectional study design was deemed the most appropriate for the study because it is non-experimental, descriptive research and allows for associations among variables to be tested given that all data for each sample is collected at one point in time. The independent variable included environmental factors such as refuse disposal, water storage and drawing methods, safe drinking water, latrine availability, water source and distance to water source. On the other hand, the dependent variable was the occurrence of diarrhoea among under-fives in the past two weeks preceding the study. This was defined as the passage of three or more loose or liquid stools per day (or more frequent passage than is normal for the individual). [3]

* 1. **Sample size calculation**

Fisher’s formula was used to determine the sample size. [35] This formula was deemed the most appropriate for this study because it provides a representative sample when the target population is greater than 10,000.

$$n=\frac{Z^{2}pq}{d^{2}}$$

Where;

$n$ was the desired sample size,

$Z$ was standard normal deviate (1.96) which corresponds to 95% confidence level,

$p$ was the proportion in a target population estimated to have a particular characteristic (e.g. 15% of under fives have diarrhoea in Migori County),

$q$ was $1-p$

$d$ was degree of accuracy desired (i.e. 0.05).

The calculation was computed as follows:

$\frac{1.96^{2} x 0.15 x 0.85}{0.05^{2}}$ = $195.92$

= 196 under fives

 = 216 (after 10% adjustment)

Total sample size after 10% adjustment was 216 under fives. The adjustment was to provide 10% adjustment to cater for survey non-response and item non-response.

* 1. **Research instrument**

Research instrument was a structured questionnaire with closed ended questions. Justification of using questionnaire as the study instrument as opposed to other tools was because it enables quantitative data to be gathered in the study. Moreover, the study was objective, involved a quantitative approach to address the research questions, and tests the hypothesis. The questionnaire also offers advantages during data collection, such as quick data collection and quick coding.

The questionnaires were researcher administered to enhance reliability of data. Kiswahili language was used since there are various ethnic communities in Migori County who understand Kiswahili. English questionnaire was translated into Kiswahili then back translated into English to ensure the translation does not lead to distortion of the questions.

* 1. **Data and analysis**

Questionnaires were administered in Kiswahili to mothers (or caregivers) of the under-fives in the households after obtaining informed consent. Those who consented were asked to sign the consent form before participating. However, those who consented, but could not write were asked to affix their left thumbprint on the consent form before participating. The actual interview was conducted in the home of mothers (or caregivers) of under-fives running from 24 July 2015 to 28 August. The village elders were used where necessary as the study guides to help in locating the enumeration areas (EAs) and to introduce the interviewer to the participants.

Involving village elders as study guides increased the trust of participants in the investigator. To minimize the rate of non-response or non-availability of the participants, the day and time the data was gathered was vital hence households of mothers (or caregivers) of under-fives were visited in the morning to access the respondents when they are available. In case of non-availability, then a return visit to the selected households was done.

Descriptive analysis and inferential statistics were performed to analyze the data. This included generation of inferential statistics such as chi-square test and descriptive statistics such percentages, frequencies, means, standard deviation, median and maximum or minimum values to describe dataset trends. The association between dependent and independent variables were tested using chi-square test and fishers’ exact test analyses. In this regards, independent variables were identified and their effect on diarrhoea occurrence examined and estimated. Hence, the impact of independent variable constructs (Distance from home to water source, Drinking water treatment, Method of treating water, Flies in latrine, Latrine availability, Latrine cleaning, Latrine sharing, Latrine type, Refuse disposal, Water source, Water storage, Waste water disposal, Water drawing method, Scooper cleaning, and Water container cleaning) in the conceptual framework on dependent variable (diarrhoea occurrence) was established.

1. **Results**

Overall, 18.1% of under-fives had diarrhoea two weeks before the study. Among under-fives with diarrhoea, a considerable number (63.6%) had diarrhoea lasting more than 7 days. Among under-fives with diarrhoea, the majority reported that it was watery (78.8%).

Over half of mothers (or caregivers) of under-fives (55%) disposed their refuse in open land, field or farm. According to the results, latrine coverage was 67.6%, while the remaining 32.4% of the households had no latrines. Out of those owning a latrine, 59.1% had unimproved latrine, 29.9% were sharing a latrine facility, 25.6% of the latrines were reported to have flies and over half (56.1%) cleaned the latrines over 3 times per week while 43.9% cleaned the latrines 3 times per week or less, or when dirty (Table 1).

According to the results, 69% of the mothers (or caregivers) of under-fives used water from unimproved sources for drinking and half of them (50%) covered over 1 Kilometer to obtain the water. The majority (82.9%) stored drinking water in a covered container, 73.8% of them drew water from the storage container by dipping a scooper and 87.1% did not empty or clean the water container before adding fresh water. According to the results, 44.5% cleaned the scooper 1-3 times per week or when dirty. Over half of the mothers (or caregivers) of under-fives (55.7%) reported to treat drinking water. The majority (82.8%) boiled or added chlorine or water guard or PUR (P&G Purifier of Water) as the treatment method (Table 2).

Chi-square tests showed that refuse disposal, latrine availability, latrine type, latrine sharing, source of drinking water, drinking water treatment, water storage, method of drawing water, scooper cleaning and cleaning container before refilling were significantly associated with diarrhoea (Table 1a and 1b). The rest of the environmental characteristics did not show a significant association with diarrhoea among under-fives.

1. **Discussion**

Several other environmental characteristics of mothers (or caregivers) of under-fives were found to be associated with diarrhoea in this study. For example, diarrhoea was high among under-fives living in households with improper refuse disposal than those in households disposing wastes properly. This concurs with the report a study in Kolkata. [16] Improper refuse disposal such as in open fields attracts flies, which increase the exposure of food to flies as noted in a study in India. Hence, there is a need for developing solid waste management systems and to improve refuse disposal in households and reduce the risk of contracting diarrhoea.

Households without latrines are more likely to report the diarrhoea occurrence among under-fives compared to those that have latrines. A similar finding was reported by a study in Uganda on acute diarrhoea among children. [14] Lack of latrines in 32.4% of the households increases dangers posed by open defecation and latrine sharing. This is a public health concern since disease causing agents found in excreta are exposed to flies and rainwater and create risks of diarrheal infection from contaminated community grounds. In this study, latrine availability was found to be significantly associated with diarrhoea among under fives. Latrine availability within the compounds increases the possibility of latrine utilization and facilitates safe human excreta disposal. Consequently, this is one approach that can be used in Migori County to decrease the contact between hosts and diarrhoeal causative organisms.

Diarrhoea occurrence is also more likely in households with unimproved latrines compared with households with improved latrines. This finding was expected given that unimproved latrines tend to have poor hygiene, operational deficiencies and repugnant smells, which attract flies, as noted in systemic reviews by various studies. [7] Unimproved latrines and their association with diarrhoea were documented in rural western Kenya. [31] Consequently, it is important for households in Migori County to be encouraged and enabled to upgrade their latrines to improved types if substantial changes in the reduction of diarrheal disease are expected. Such intervention can be similar to the community lead total sanitation (CLTS) approach by Plan International in Mathare 10, Nairobi. This intervention included creating awareness on sanitation practices and galvanizing the citizens to drive the steps themselves towards ending open defecation, constructing latrines, demanding sanitation facilities in residential areas from landlords and identifying subsequent health impact as noted by a past study in Mathare in Kenya. [11]

Similar to the results reported by a study in Nigeria which found that households with shared latrines had a higher occurrence of diarrhoea among under-fives compared to those that had did not share their latrine. [23] This is not surprising because shared latrines are more likely to be in unkempt and unsanitary conditions. Such unsanitary conditions in latrines are favourable environment for vectors (flies and cockroaches) that transmit pathogens (protozoa, bacteria and viruses) of diarrhoea and other diseases. Moreover, there is a possibility that such pathogens may be transmitted from an infected person to healthy others. [26] The study community could possibly benefit if concerted efforts are made to increase the number of latrines. [24]

The study also established that diarrhoea occurrence was more common among under-fives of mothers (or caregivers) who used unimproved source of drinking water than those who relied on an improved source of drinking water. This significant association between water source for drinking and occurrence of diarrhoea among under-fives was also mentioned in a study in Mandera District, Kenya. [36] This could be attributed to the fact that improved water sources (such as piped water) are likely to be less contaminated compared to unimproved water sources (such as rivers). Besides, the probability of a water source being contaminated depends on the protection of the source. [36] These results emphasize on the importance of protecting water sources in the study community. Water storage was found to be a risk factor of diarrhoea among under-fives. These results are consistent with past studies which mentioned that poor water storage was a key determinant of diarrhoea among under-fives due to the higher likelihood of contamination from dust, flies and other contaminants in water stored in open or uncovered containers. [37]

Diarrhoea among under-fives is more likely to be reported from households that do not treat their drinking water compared to those that treat their drinking water. This finding is in line with systemic review of various studies which pointed out that water treatment and diarrhoea are related. [38] Indeed, treatment of drinking water, such as boiling or addition of chlorine or water guard or PUR kills germs that cause diarrhoea. Treatment of drinking water should be promoted through health education and awareness. In addition, improved access to water treatment chemicals like PUR and chlorine contribute to the prevention of diarrhoea morbidity among under-fives in the county.

It was also found in this study that the method of drawing water was significantly associated with diarrhoea, implying that diarrhoea occurrence is less likely among under-fives of households that draw water by pouring than dipping with a scooper. The finding is in conformity to that of a study in rural western Kenya, which found that poor handling and drawing of water were risk factors for diarrhoea in households. [19] Dipping a scooper to draw drinking water increases the danger of contamination of the water by microbes, when the water gets into contact with contaminated hands. Besides, not cleaning the scooper can also create contamination of water by dirty scoopers thus cause diarrhoea and this is why scooper cleaning was significantly associated with diarrhoea. In this regard, it is important for good water handling methods to be practiced. This can be promoted through community sensitization and health campaigns to avoid water contamination and transmission of diarrheal agents.

Improper wastewater disposal flies around or inside latrine, latrine cleaning, method of treating water, and distance to water source have been revealed by past studies to be related to diarrhoea morbidity among under-fives in Migori County. [6] and past reports on low- and middle-income countries. [17, 32] However, such associations were not found in this study. Although in this study, these factors were not significantly associated with diarrhoea among under-fives, they play a vital role in transmission of infectious agents of diarrhoea given that diarrhoea determinants are interdependent and interrelated as noted by a study in rural community of Madhya Pradesh. [25] Hence, prevention measures aimed at addressing these determinants are also right and cost-effective ways of significantly reducing diarrhoea among under-fives.

Programmes for safe water provision are also necessary to increase access to adequate and improved water sources. Moreover, improving access to water can enable the households to practice hand washing, clean latrines regularly, wash fruits or food thoroughly, wash utensils and other food preparation materials or surfaces which block contamination paths directly and indirectly such as flies and fingers.

* 1. **Conclusion and recommendations**

As long as the determinants of diarrhoea among under-fives identified in this study are not successfully addressed, then the under-fives are continually at risk of exposure to infectious agents of diarrhoea, and they can contract the disease – and many are at risk of dying unnecessarily. Based on the findings and discussion, the study can conclude that the environmental factors that are predisposing children under 5 years to diarrhoea in Migori County, the results showed that the method of refuse disposal, latrine availability, latrine type, latrine sharing, source of drinking water, water storage, method of drawing water, scooper cleaning and drinking water treatment where the environmental factors that determine diarrhoea occurrence. Among the three categories of determinants of diarrhoea among under-fives in Migori County, environmental factors had more significant associations.

Recommendations are that latrine ownership should be encouraged in every homestead in the study area. This can be implemented by the household members to increase latrine availability and reduce latrine sharing practices. Concerned health authorities can also develop intervention programmes that encourage latrine construction in homesteads that have no latrines. Such intervention can be similar to the community lead total sanitation (CLTS) approach by Plan International in Mathare 10, Nairobi and the Total Sanitation Campaign on latrine coverage and use by the Government of India which have been found to be successful.[11, 33] Furthermore, intervention programmes on refuse disposal should also be implemented to create awareness and encourage proper refuse and waste water disposal.

Provision of safe and reliable water is key to actualizing the recommended hygiene practices and the prevention of diarrhoea. Migori County government can implement this by scaling up the provision of adequate safe water, such as constructing protected wells, improvement of water points, and protection of water sources like springs from pollution. Other prevention measures that also need to be maintained or introduced in Migori County based on recommendations of past studies in other areas or countries include measles vaccination, rotavirus vaccination, exclusive breastfeeding, nutrition, micronutrient supplementation and creation of employment to reduce poverty. [10, 28] Although these factors were not significantly associated with diarrhoea, they can play a vital role given that diarrhoea determinants are interdependent and interrelated. [25]

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