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ABSTRACT

BACKGROUND INFORMATION: The post-2015 Sustainable Development Goals for sanitation call for universal access to adequate and equitable sanitation and an end to open defaecation by 2030. In Isiolo County, a semi-arid region lying in the northern part of Kenya, poor sanitation and water shortage remain a major problem facing the rural communities.

OBJECTIVE: The overall aim of the study was to assess the relationship between sanitation practices and the bacteriological quality of drinking water sources. The study also assessed the risk factors contributing to open defaecation in the rural environments of the study area.

METHODS: A cross-sectional study of 150 households was conducted to assess the faecal disposal practices in open defaecation free (ODF) and open defaecation not free (ODNF) areas. Sanitary surveys and bacteriological analyses were conducted for selected community water sources to identify faecal pollution sources, contamination pathways, and contributory factors. Analysis of data was performed using SPSS (descriptive and inferential statistics at $\alpha = .05$ level of significance).

RESULTS: Open defaecation habit was reported in 51% of the study households in ODNF villages and in 17% households in ODF villages. Higher mean colony counts were recorded for water samples from ODNF areas 2.0, 7.8, 5.3, and 7.0 ($\times 10^3$) colony-forming units (CFUs)/100 mL compared with those of ODF 1.8, 6.4, 3.5, and 6.1 ($\times 10^3$) areas for *Escherichia coli*, faecal streptococci, *Salmonella typhi*, and total coliform, respectively. Correlation tests revealed a significant relationship between sanitary surveys and contamination of water sources ($P = .002$).

CONCLUSIONS: The water sources exhibited high levels of contamination with microbial pathogens attributed to poor sanitation. Practising safe faecal disposal in particular is recommended as this will considerably reverse the situation and thus lead to improved human health.

KEYWORDS: Bacteriological water quality, open defaecation, water-related diseases

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Introduction

Sanitation has been declared as a human right by the United Nations.[1] The United Nations post-2015 Sustainable Development Goals, 3 and 6 targets, are aimed at ensuring universal access to safe and affordable drinking water, respectively, by 2030.[2] Eliminating open defaecation is increasingly seen as a key health outcome. Open defaecation is the practice of defaecating in the fields, bushes, and bodies of water or other open spaces. An area is generally 'open defaecation free' (ODF) when there is the absence of the practice of open defaecation in such a location. Implicitly it means that all members of that community have access to and are using a latrine. According to the 2015 Sanitation Update report by World Health Organization (WHO), close to 1.3 billion people were practising open defaecation, whereas another 2.6 billion people lack access to improved sanitation, almost all in developing countries and predominantly in rural environments.[1] It is also estimated that 663 million people worldwide still used un-improved drinking water sources, including un-protected wells and springs and surface water, most of them living in 2 developing regions of sub-Saharan Africa and Southern Asia.[3] Despite recent improvements in the sanitation sector, open defaecation still remains a widespread health and environmental hazard challenge that particularly needs to be addressed among many developing countries.[1,4] This lack of improved sanitation access contributes to a large global health burden, including mortality, diarrhoea, trachoma, and helminthic infections. Initiatives to improve sanitation situation has proved fruitful in certain regions of the world. For instance, in Zimbabwe, a simple comparison of 2 communities, 1 with 67% latrine coverage and 1 with no latrines, found that the community with latrines had a 68% lower diarrhoeal prevalence.[5] A study conducted in rural Ecuador found out that sanitation coverage in the surrounding households was strongly associated with child height.[6] The factors contributing to open defaecation especially in rural villages have been reported. They include habit, nomadic cultural lifestyles, and poor design of public toilets[7]; absence and non-functionality of latrines[8]; available open space; and poor understanding of health and hygiene factors.[9] In another study, outdoor defaecation has been explained as an everyday habit formed during childhood and that it is very common among people living in rural areas.[4] More researches still need to be done to explain the concept that poor sanitation has a direct effect on microbiological quality of drinking water sources.

In most rural environments, surface and shallow groundwater sources are often considered by many to be aesthetically acceptable for drinking and domestic uses.[10] The water sources could, however, harbour many microbial pathogens, even where the water is clear and perceived to be clean. The factors leading to contamination of water sources are often not well-understood but are frequently ascribed to pollution by on-site sanitation facilities such as pit latrines and defaecation along boundaries of water sources as these represent an obvious source of faecal contamination.[11] However, information is lacking on the safety of these water sources used especially for domestic purposes. Open defaecation has been reported to not only deteriorate the quality of drinking water but also make the water unfit for drinking purposes. A study to assess the water quality index and multivariate analysis for groundwater quality assessment of villages of rural India cited faecal contamination as a key threat to quality of water sources.[12] Open defaecation contributes to the conversion of large areas of land within the community into faecal fields. These 'faecal fields' potentially put the village and consequently water sources at risk of flooding with faecal material from surrounding areas during rains.[13] Wind-blown dust particles often deposited in or near water sources have also been proven to potentially carry faecal pathogens potentially harbour microbial pathogens leading to contamination.[11] Even where water containers are used for fetching water, poor handling such as placing them on the ground could introduce faecal pathogens when used to fetch water. The epidemiologic significance of these scenarios lies in the health risks posed by such contamination. Studies underscore that water contaminated with faecal matter can cause disease outbreaks including cholera, dysentery, and hepatitis.[13,14] For instance, it is estimated that 80% of all diseases and of one-third deaths in developing countries have been attributed to consumption of contaminated water. Furthermore, an average of one-tenth of each person's productive time is sacrificed to water-related diseases in developing countries.[3] Studies that link water sources used, sanitation, and hygiene to diarrhoea have been conducted.[15,16] Most of them point to the negative health impacts associated with poor faecal disposal behaviour.

Challenges in setting up potable water supplies for communities have been a matter under discussion. Most cited reasons range from poor quality of borehole water, high seepage rates of water pans, and seasonality of streams.[17] Sustainability of existing water projects has also proved difficult owing to poor management systems. Worse enough, prevailing poor sanitation conditions pose the greatest threat to water points. Previous studies in both urban and rural areas have concluded that contamination from on-site sanitation is a principal cause of contamination of water sources.[11] In Isiolo County, Kenya, rampant practice of open defaecation has been identified as one of the major sanitation problems faced by the residents. For instance, in the year 2009 to 2010, at least 18 children under 5 years of age died in Isiolo County, Kenya, due to diarrhoeal complications related to poor faecal disposal. Furthermore, high prevalence rates (10.5%) of diarrhoea have been reported in these households, and water scarcity was cited as a major cause.[18] According to the Isiolo County Integrated Development Plan 2013 to 2017 report, at least 65% of the households rely on un-protected water sources.[19] However, little attention has been paid to relate the effects of poor household sanitation practices to faecal contamination of adjacent water sources. Sanitation interventions that strive to protect human health by safely containing faecal material and preventing its release into household or community environments is a modest step in finding a long-lasting solution to the problem.[20] In 2010, the United Nations Children's Fund (UNICEF) in partnership with the Ministry of Health (MOH) in Kenya geared up efforts to improve on sanitation with the aim of eradicating open defaecation in Isiolo County by 2013.[21] Through the concept of Community-Led Total Sanitation (CLTS) approach, there were concerted efforts that classify villages into ODF and non-open defaecation free. This approach was based on a participatory approach for mobilizing communities to eliminate open defaecation. A village is declared ODF once all community members are using latrines and there is no trace of faeces in the environment as confirmed by a third party. The verification process generally seeks to validate the submission of communities and builds on the key indicators of ODF areas.[10] These indicators include that there is no evidence of open defaecation, households have access to latrines, hand-washing with soap facilities are present, and children's faeces are disposed of safely.[22] This initiative has so far led to a total of 65 villages (32%) being declared ODF in Isiolo County alone. This marked improvement in open defaecation eradication has brought sanity in community health and sanitation in the pilot areas. More efforts are, however, needed to achieve the set targets.

Efforts to eradicate open defaecation and improve sanitation access are unlikely to achieve health benefits unless interventions reduce microbial exposures. As millions of people worldwide continue to rely on shallow groundwater sources and on-site sanitation, it is important to develop an understanding of the causes of microbiological contamination of groundwater when considering the potential for improvement in water supplies and sanitation. It is against this background that this study was conceived to assess the contribution of open defaecation on the bacteriological contamination of drinking water sources in Isiolo County, Kenya.

Materials and Methods

Study area

Isiolo County is situated in North Eastern region Kenya covering an expansive semi-arid area of 25 336.1 km². The County lies within the GPS coordinates 0° 21′ 0″ North, 37° 35′ 0″

East. Isiolo County has a total population of 143 294 with a population density of approximately 6 people/km^2.[23] Most of the residents are nomadic pastoralists with sedentary lifestyles. Poor sanitation is a major challenge that is faced by most of the residents living in rural environments of Isiolo County. The main water sources present in the County predominantly include surface and shallow water sources such as boreholes, water pans, sand dams, and shallow wells distributed across the region.[19] The study was conducted within the rural villages of Ngare Mara and Burat wards which approximately occupy a total area of 3852 km^2 of the total County size. The study areas were purposively selected for the study due owing to their high number of functional drinking water sources.[23] In addition, the 2 wards form targets for the eradication of open defaecation practices because they clearly vividly present both improved sanitation and un-improved sanitation scenarios.

Data collection

Before data collection, approval was sought from the County Government of Isiolo and the National Council for Science and Technology (NACOSTI) in Kenya, both who issued the researchers with permits to conduct the study. The researchers thereafter gained informed consent from the respondents to participate in the study. The study targeted both ODF and open defaecation not free (ODNF) rural villages of Isiolo County. In this study, a total of 15 villages (7 ODF and 8 ODNF villages) were randomly sampled from each ward based on the mapping adopted during the Kenya ODF roadmap.[21] Additional data were obtained from the local administration and records from the public health department.[18] A cross-sectional survey was conducted in 150 households, involving simple random sampling of the households within the proximity of each of the water points within the study area. Information on sanitation access and the predisposing factors in relation to water contamination were obtained using questionnaire interviews and through observation by the field enumerators. Sanitary inspection aimed at identifying the potential sources of faecal contamination of water sources was conducted as per the guidelines as proposed by the WHO.[24] In these guidelines, the WHO established a format for sanitary inspection forms consisting of a set of questions which have 'yes' or 'no' answers. The questions are structured such that 'yes' answers indicate that there is a reasonable risk of contamination (ROC) and 'no' answers indicate that the particular risk appears to be negligible. Each 'yes' answer scores 1 point and each 'no' answer scores 0 points. At the end of the inspection, the points are totalled, yielding a sanitary inspection risk score (in this study, referred to as an ROC score). The ROC scores range from a low ROC (scores = 0%-30%), through a medium (40%-50%) or high (60%-70%) ROC, to a very high ROC (80%-100%). A higher ROC score represents a greater risk that drinking water is contaminated by faecal pollution from the area immediately surrounding the water point.[24,25] Thus, in this study, the inspection was conducted for each of the 15 water sources and ROC with faecal pollution determined.

Water samples collection and analysis

Purposive sampling techniques were used to determine the water sampling points. This involved sampling of water sources with the highest number of users and functionality status within the study wards. Water samples were obtained from the community water points including 2 rivers, 6 boreholes, 5 hand-dug wells, and 2 water pans and analysed for the presence of faecal streptococci, *Escherichia coli, Salmonella typhi*, and total coliform bacterial pathogens and their indicators. The water sources were drawn from the 2 wards across all the villages. Aseptic techniques were practised in all stages of the sampling and analysis processes to avoid sample contamination. To ensure sample preservation, the bottles with water samples were placed under cold conditions of 4°C in cool box and transported for a maximum period of 3 hours prior to laboratory analysis. The bacteriological analysis was performed using the membrane filtration technique as per the standard guidelines developed by the American Public Health Association (APHA).[26] The analysis involved passing samples through sterile 0.45-µm filters prior to incubation. Numbers of cell growth were expressed as colony-forming units per 100 millilitres. For total coliforms and *E coli*, the filters were placed onto Chromocult Coliform Agar (Merck) plates and incubated at 37°C for between 18 and 24 hours. Typical colonies appearing pink and dark blue were counted as total coliforms. *Escherichia coli* were the blue colonies only. *Enterococcus faecalis* was used as a control organism and gave no indication of colony growth. For faecal streptococci counts, filters were placed onto CRITERION CLED media (Merck) plates and incubated at 18°C for 18 to 24 hours. Typical colonies appearing yellow (0.5 mm diameter) were counted as intestinal enterococci and numbers were expressed as colony-forming units per 100 millilitres. Negative control entailed culturing un-inoculated medium under same culturing conditions. No bacterial colony growth was, however, recorded 7 days after incubation in same conditions. As a positive control mechanism, *Staphylococcus aureus* ATCC 25923 was cultured on CLED medium. Deep yellow colonies, uniform in colour were observed. For *S typhi*, filters were placed onto CRITERION Salmonella Shigella Agar (Merck) plates and incubated at 35°c for 24 to 48 hours. Typical pink colonies with dark centred spots were counted as *S typhi* and were expressed as colony-forming units per 100 millilitres. Negative control was performed using *Enterococcus faecalis* ATCC 29212, with the results being no growth observed.

Data analysis

A normality test of the data was done using Kolmogorov-Smirnov test. Data were managed using SPSS software, and all tests were performed at 95% confidence level. Pie charts and

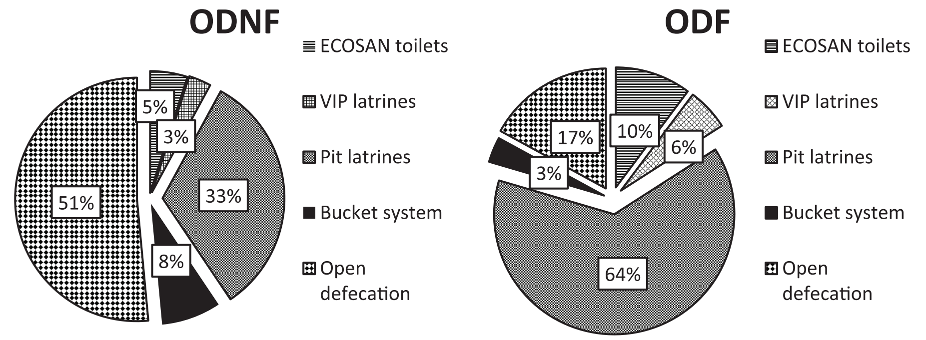

Figure 1. Sanitation types among ODF and ODNF villages. ODF indicates open defaecation free; ODNF, open defaecation not free; VIP latrines, ventilated improved pit latrines.

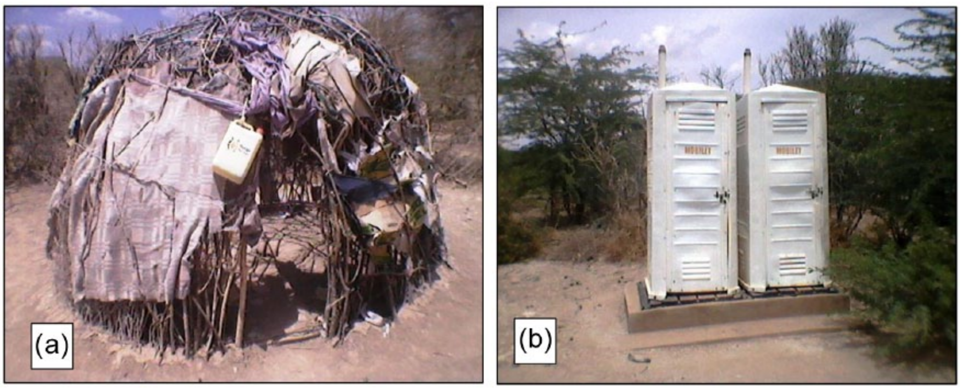

Plate 1. Open defaecation free verification efforts in Ngare Mara, Isiolo, Kenya: (A) traditional pit latrine with a handwashing facility and (B) ventilated improved pit latrines.

graphs were used to organize and present the data. Spearman correlation was used to establish whether there was a statistically significant relationship among the various bacteriological parameters tested.

Results

Household sanitation characteristics

Of the 150 households interviewed, 72% of the respondents were women (n = 108), whereas the rest were men (n = 42). The education levels of the respondents included the following: no formal education (67%), primary (24%), secondary (7%), and tertiary (2%). On average, the households had between 10 and 15 members. According to the findings of the research, it was found that on average, a single latrine was shared between 8 and 10 households in 68% of the households. The type and presence of sanitation facilities among the residents included simple pit latrine (64% ODF and 33% ODNF), EcoSan toilets (10% ODF and 5% ODNF), and ventilated improved pit latrines (6% ODF and 3% ODNF; Figure 1).

According to the study results, a significant gap still exists between handwashing knowledge and practices, thereby exhibiting poor hygiene among households. Handwashing facilities in latrines were present in 78% of latrines in ODF areas, whereas only 27% were present in ODNF areas. Furthermore, households that routinely washed their hands, however, reported 18% cases of waterborne diseases as compared with 73% cases in the houses that did not wash their hands. Latrine coverage was 49% in villages where CLTS villages compared with 13% in non-CLTS villages. Plate 1 shows images of open defaecation eradication efforts in Ngare Mara ward, Isiolo County, Kenya.

Regarding sharing of latrines among households, it was found that on average, a single latrine was shared by between 8 and 10 households in 68% of the households. This was found high considering that each household had an average number between 10 and 15 individuals. Most residents cited long queues to use latrines as a hindrance to shared latrine use, further promoting open defaecation practice. The respondents' reasons for not using latrines included absence of latrine facilities (43%), ignorance (32%), and cultural barriers (25%). In 75% of the households, the respondents cited high construction costs as a barrier to toilet construction. In such households, the construction of toilets was generally seen as a responsibility of the government. A comparison of improved versus un-improved sanitation among households is presented in Figure 2.

According to the study findings, the disposal methods of the child faeces among households included the following: leaving in the open to dry (53%), bush disposal (17%), burying (24%), and toilet disposal (6%). Also, 78% of the respondents admitted

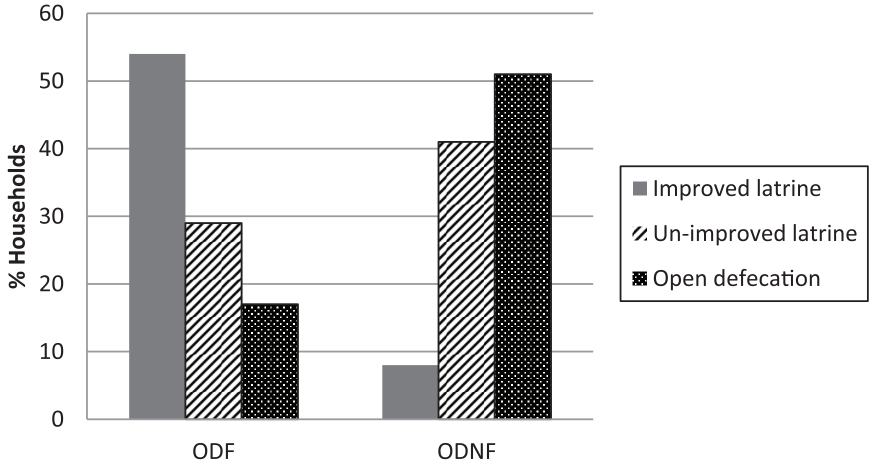

Figure 2. Sanitation modes among households in ODF and ODNF villages. ODF indicates open defaecation free; ODNF, open defaecation not free.

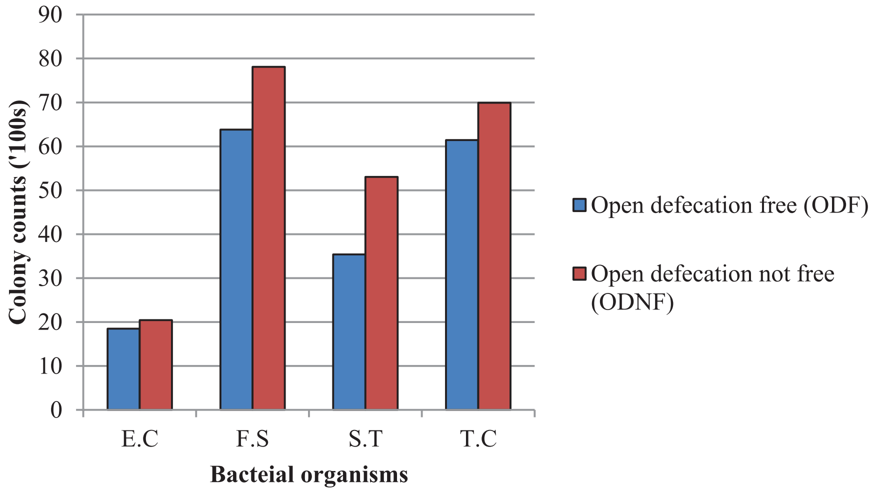

Figure 3. Bacterial concentrations among water sources in ODF and ODNF villages. E.C., *Escherichia coli*; F.S., faecal streptococci; S.T., *Salmonella typhi*; T.C., total coliforms.

that they aware of the negative health implications of engaging in open defaecation, whereas the rest considered it as non-issue.

Sanitary survey of the water sources

Sanitary inspection was conducted for various water sources. According to the sanitary survey results, river sources had very high ROC at 0.82 (82%), water pans had high risk at 0.64 (64%), whereas boreholes and hand-dug wells showed medium ROC scores at 0.41 (41%) and 0.55 (55%), respectively. Total sanitary risk score showed a significant relationship with median level of contamination ($P = .004$). Latrines being near water sources, sharing water with livestock, and open defaecation along stream channels were found to be major risks for water contamination.

Bacterial quality of water sources

In the study, 92% of the households interviewed relied on unimproved water sources, whereas only 8% relied on improved water supply. The study sought to establish the relationship between the concentrations of various organisms analysed. The results presented in Table 1 reveal that there is no significant relationship among most of the bacterial pathogens.

The concentration of different bacterial organisms was compared between the ODF and ODNF villages (Figure 3). The findings revealed higher contamination levels in water sources occurring in ODNF compared with ODF locations.

Discussion

Faecal disposal practices among households

This study assessed the sanitation characteristics regarding faecal disposal and latrine use practices in rural villages of Isiolo County, Kenya, while relating them to potential effect on microbiological quality of water sources. Improving latrine use has been argued to guarantee a wide range of benefits to an individual, the household, and community at large.[10] Reducing open defaecation also requires access to and use of improved sanitation facilities, which are defined as facilities that prevent

Table 1. Correlation among different organisms.

ORGANISM		*ESCHERICHIA COLI*	FAECAL STREPTOCOCCI	*SALMONELLA TYPHI*	TOTAL COLIFORM
E coli	Pearson correlation	1	.158	.454	.664**
	Sig. (2-tailed)		.574	.089	.007
Faecal streptococci	Pearson correlation	.158	1	.539*	.375
	Sig. (2-tailed)	.574		.038	.169
S typhi	Pearson correlation	.454	.539*	1	.210
	Sig. (2-tailed)	.089	.038		.451
Total coliform	Pearson correlation	.664**	.375	.210	1
	Sig. (2-tailed)	.007	.169	.451	

**Correlation is significant at the .01 level (2-tailed). N = 15.
*Correlation is significant at the .05 level (2-tailed).

human faeces from re-entering the environment. In the study, latrine coverage was found to play a critical role in determining sanitation at both household and at community levels. The respondents cited lack of latrines among households as the major reason behind open defaecation behaviour. Similar claims have also been put forward in other studies conducted.[20,22] The use of latrines as a preferred means of faecal disposal for faecal disposal among the respondents was pegged on their simplicity and relative affordability. This aspect of latrine use has been supported in another study for reasons such as convenience, privacy, and status of latrines.[27] Latrines have also proved sustainable at ensuring a healthy environment, good sanitation, or the prevention of faecal-related diseases such as diarrhoea and cholera.[28] Efforts to ensure adequate sanitation can best be addressed through empowering communities to adopt latrine ownership and use especially at the household level. As noted, 75% of the households had cited inadequate funds as major reason for not setting up good latrines within their households. Although other studies have cited cultural barriers, incomplete knowledge, inadequate space in households, and water scarcity as reasons behind not using toilets, the role played by socio-economic conditions on determining household sanitation needs to be emphasized.[9,28] These reasons in themselves create a scenario where most households resort to defaecate in the open.

Even in communities or households where latrines are present, certain barriers to latrine use exist. Widely noted in the study was the sharing of latrine between 20 and 30 households on average. A Joint Monitoring Report on proposals to define the post-2015 Millennium Development Goals and indicators for sanitation recommends that improved sanitation be shared among no more than 5 households or 30 people.[1] This scenario not only results in a dilapidated state of sanitation facilities in place but also attracts serious health concerns especially when people resort to open defaecation as an alternative. Open defaecation contributes to negative health implications in the lives of the people especially women and children.[29,30] As the number of users of a latrine increases the proper maintenance, hygiene, privacy, and safety of the users are not always guaranteed.[31] Proper practices during latrine use also need to be emphasized as a means of attaining improved sanitation and personal hygiene. This study particularly focused on the provision of handwashing facilities in latrine settings. The findings revealed that handwashing facilities were predominantly present in ODF villages where CLTS interventions had taken effect as opposed to those that did not. The presence of handwashing facilities and their use after latrine visits improves hygiene by ensuring that transfer of faecal microbes does not take place through contaminated hands.[32,33] A study conducted to explore the gap between handwashing knowledge and practices in Bangladesh recommended that washing of hands be done with soap for better hygiene prospects.[34]

With increased focus and growing interest on open defaecation by adults, disposal of child faeces in the environment has often been given little attention in many rural settings of developing nations. In this study, we found out that in most of the households, child faeces were thrown into the open spaces around the house or near bodies of water. This is because child faeces were perceived as harmless and therefore were left in the open to dry. Similar findings have been put forward in a study conducted in rural districts of Tamil Nadu, India.[9] Poor disposal practices of child faeces have equally negative health implications on the receiving environment. This is because children's faeces too contain as many germs as an adult's and it is very important to dispose the faeces quickly and safely.[20,28]

High proportion of latrine coverage translated into improved faecal disposal practices and consequently improved sanitation. The reason behind this is the enhanced CLTS efforts that advocate for access to latrines by each and every household within rural villages, a characteristic common with the ODF villages. Improved sanitation condition and latrine coverage have been cited is outstanding characteristic of ODF areas.[29] In similar interventions conducted in rural Madhya Pradesh, India, the CLTS approach has led to modest increases in availability of individual household latrines and even more modest reductions in open defaecation.[35]

Sanitary survey of the water sources

Epidemiologic studies indicate that sanitary surveys have played an important role in determining pollution sources in water bodies.[11] Based on the sanitary survey conducted, high ROC was high especially for surface water sources. This was attributed to the presence of a high number of anthropogenic activities uniquely taking place around the water sources in addition to open defaecation activities hence contributing to their faecal contamination. Unsanitary practices such as defaecation in stream channels and riverbeds during dry seasons were found to contribute to faecal contamination. Rajgire[14] reports that defaecation on boundaries of water bodies results in bacteriological contamination.

Bacterial quality of water sources

In the study, most of the households relied on un-improved sources of contamination most being shallow wells. Most shallow wells were un-covered even when not in use presenting an ROC with faecal laden dust. Un-improved sources due to their un-protected nature are easily prone to contamination and hence unfit for drinking.[11,25] The study also demonstrates that there was a significant correlation between *S typhi* and faecal streptococci organisms (Table 1). This relationship could point to the presence of a contamination source mostly faecal in nature across the different water sources. The results presented in Figure 3 also indicate higher bacterial contamination in water sources in ODNF areas as opposed to ODF areas. The high bacterial counts can be attributed to the high open defaecation rates, a consequence of low latrine coverage especially in ODNF areas. Studies have often demonstrated the impacts of sanitation coverage on the presence of bacteriological pathogens on the environment especially on water sources contamination. For instance, a study conducted in Amravati District, India, showed that drinking water in ODF villages was 17% faecally contaminated, whereas ODNF villages was 48%.[12] The observations point to poor sanitation occasioned by low latrine coverage and use among households.

In a different approach, there is a growing interest to provide safe consumption of drinking water through adopting safe point of use treatment technologies. For the time being, it is our conviction that there is already sufficient evidence that communal sanitation has many advantages in ensuring safe water access. We recommend that attention be given to developing practical strategies to ensure that safe drinking water is ensured at source rather than at the point of consumption.

Conclusions

The eradication of open defaecation greatly remains a matter of discussion if significant steps have to be made to ensure access to improved sanitation and potable drinking water. In our study findings, we demonstrate the rampant practice of open defaecation among rural villages of Isiolo, Kenya, that is largely attributed to lack of latrines among households. In addition, the widely noted reliance on un-protected surface and shallow water sources and general water scarcity generally points to serious health concerns from contamination. As per the study findings, the high bacterial loads recorded in the water samples reveal the magnitude of faecal contamination of the water sources. This scenario is not only unhygienic environmentally but also poses a risk to human health of the residents such as contracting waterborne diseases. Because a large proportion of communities in developing countries depend on water systems that require the users to collect and store drinking water, it is important that we are able to assess the significance of any associated health risks. Solutions aimed at improving the sanitation situation is therefore a modest step towards safeguarding the bacteriological quality of the water sources. In particular, CLTS is a strategy that remains viable for tackling open defaecation menace among many rural communities especially in developing countries.

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Author Contributions

JOO, WNM, and GMO conceived and designed the experiments; agreed with the manuscript results and conclusions; jointly developed the structure and arguments for the paper; made critical revisions and approved final version; and contributed to the writing of the manuscript. JOO and WNM analysed the data. JOO wrote the first draft of the manuscript. All authors reviewed and approved the final manuscript.

Disclosures and Ethics

As a requirement of publication, the author(s) have provided to the publisher signed confirmation of compliance with legal and ethical obligations, including but not limited to the following: authorship and contributorship, conflicts of interest, privacy and confidentiality, and (where applicable) protection of human and animal research subjects. The authors have read and confirmed their agreement with the ICMJE authorship and conflict of interest criteria. The authors have also confirmed that this article is unique and not under consideration or published in any other publication and that they have permission from the rights holders to reproduce any copyrighted material.

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