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THE EFFECTS OF WATER QUALITY AND SANITATION ON IMMUNOCOMPROMISED: A CASE STUDY OF PEOPLE LIVING WITH HIV / AIDS IN KIBERA SLUM, KENYA
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THE EFFECTS OF WATER QUALITY AND SANITATION ON IMMUNOCOMPROMISED: A CASE STUDY OF PEOPLE LIVING WITH HIV/ AIDS IN KIBERA SLUM, KENYA

C. O. AKETCH, K. NGURE and J. M. KIPLANGAT

ABSTRACT

***Background*: Closer inspection of the spread of HIV/AIDS and its implications on individuals, communities and societies reveals several significant linkages with water and sanitation. In the context of poverty, malnutrition, high prevalence of co-infections with other opportunistic diseases, and overburdened health systems, individuals may be more susceptible to acquiring HIV and less able to cope with HIV-related illnesses, both physically and economically.**

Objectives: To determine the effect of sanitation and water quality on people living with HIV/AIDS in Kibera slum.

***Design*: A cross sectional study.**

***Settings*: The study was carried out in Kibera informal settlement in Nairobi, Kenya.**

***Subject*: Randomly recruited 369 adults living with HIV/AIDS in Kibera slum**

***Results*: Logistic regression analysis employed to predict the probability that a respondent living with HIV/AIDS in Kibera slum would be infected with diseases related to taking contaminated water and living in poor environmental sanitary conditions using the predictor variables and showed a significant partial effect, x^2 (5, N = 369) = 73.912, p< 0.001.**

***Conclusions*: Safe drinking water was inaccessible to a majority of participants indicating a high risk of opportunistic diseases and high economic burden.**

INTRODUCTION

Water constitutes about 70% of the earth's total mass and all life is dependent on water (1). Water not only plays vital roles in the maintenance of the body's homeostasis but also serves as a very essential component of life. Water can also be injurious to health if its source is not free from contaminations and impurities. Inadequate sanitation is a major cause of disease worldwide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. It is estimated that less than 10% of all sewage is treated worldwide before it is discharged into the receiving environment (2) and it is estimated that throughout the world, there are 2.6 billion people living without basic sanitation, almost 40% of the world's population (3). In low and middle-income countries, 80% of all ailments are attributed to inadequate supplies of water and sanitation facilities. This includes the effects of drinking contaminated water or water acting as a breeding ground for vectors of diseases (4).

Water is related to disease in various ways. It serves as a route of transmission such as cholera; a breeding site of a stage of the lifecycle of the infective agent such as malaria; a harbour for the carrier of the infective agent such as schistosomiasis. In recognition of the critical role of water and sanitation in the quality of life of human populations, there is concerted effort, globally and locally to put in place various programs to eradicate the backlog of people without access to safe water and sanitation. In spite of the collaborative efforts to eradicate the backlog of people without access to water and sanitation, a marked inaccessibility still exists in most low and middle-income countries. At a glance, the issue of HIV / AIDS and water and sanitation would appear to bear very little relation to each other. HIV / AIDS is a pandemic that is transmitted between people primarily through sexual contact, while water is a renewable natural

resource of which the availability depends on a variety of geographic and climatic factors. However, closer inspection of the features that characterise the spread of HIV/AIDS and its implications for individuals, communities and societies reveals several significant linkages with water as HIV/AIDS and water and sanitation reflect some of the often unanticipated effects of the pandemic on society. These have long-term implications for effective water resource management and the provision of wholesome water supplies and acceptable sanitation to communities. Inadequate water supply and sanitation facilities exacerbate the risk and vulnerability environment for HIV/AIDS through increased risk of HIV infections, faster progression from HIV infection to onset of AIDS, difficult environments for proper treatment of HIV and increased socio-economic impacts of AIDS. Illness and death associated with AIDS, in turn, undermine sustainable water and sanitation services by weakening or destroying human capacity (skills, knowledge and labour), depleting control and access to other key assets, constraining options for productive activities, reducing participation in community activities, increasing time needed for reproductive and caring activities. HIV/AIDS has a great link and impact on the provision and sustainability of water and sanitation services (5).

MATERIALS AND METHODS

There are 12 villages in Kibera slum and each village has at least three HIV/AIDS support groups comprised of about 30 members each. The study recruited participants through a three stage cluster sampling method from the entire study area. Six villages were randomly sampled from the 12 villages in Kibera slum, three HIV/AIDS support groups were then randomly selected from each of the six randomly selected villages and then 62 respondents were randomly selected from the three HIV/AIDS support groups that were randomly selected in each village for a total of 372 respondents. A questionnaire and observation checklist was used to collect the data.

Laboratory Bacteriological analysis: Bacteriological analysis was done at national public health laboratory using membrane filtration method on four randomly selected water samples from the respondents' households and six water samples from the purposively selected water sources. The membrane-filtration (MF) was used where, a minimum volume of 10 ml of the sample (or dilution of the sample) was introduced aseptically into a sterile or properly disinfected filtration assembly containing a sterile membrane filter (nominal pore size 0.2 or 0.45mm). A vacuum was applied and the sample drawn through the membrane filter. All indicator organisms (*Escherichia coli*, *feacal stretococci*) if present were retained on or within the filter, which was then transferred to a suitable selective culture medium in a Petri dish. Following a period of resuscitation, during which the bacteria was acclimatised to the new conditions, the Petri dish was transferred to an incubator at the appropriate selective temperature where it was incubated for a suitable time to allow the replication of the indicator organisms. Visually identifiable colonies were formed and counted, and the results expressed in numbers of "colony forming units" (CFU) per 100 ml of original sample (6).

RESULTS

Socio-demographic characteristics of the people living with HIV/AIDS in Kibera slum: The mean age of the respondents was 39.8 years (standard deviation 9.5 years), the youngest respondent was 18 years old and the oldest respondent was 68 years old (range 50 years).

Table 1 shows that 29.8% (n=110) of the respondents were male and 70.2% (n=259) female. 60% of the respondents were married, 28% were single and 12% were divorced. In terms of occupation status, majority of the respondents (54%) were unemployed, 72% of the people living with HIV/AIDS in Kibera slum did not have access to health insurance cover with the most common being the National Hospital Insurance Fund (NHIF). Only 26% reported to have health insurance cover while 2% did not report on their health insurance ownership. Both gender, the employment status of the respondents and health insurance ownership showed a strong evidence of relationship with occurrence of diseases caused by taking contaminated water and living in poor unsanitary environmental conditions ($P<0.05$).

Level of Accessibility of Safe Drinking Water by people living with HIV/AIDS: Table 1 shows that 55% (n = 203) of the respondents got their household drinking water from municipal piped water directly, 39.8% (n = 147) got their water from a water kiosk, 3.8% from a borehole, 1.1% (n = 4) froma roof catchment and 0.3% (n = 1) never reported their household water source. The availability of drinking water at the sources was varied; 34.4% (n = 127) reported that water was normally available at their source once or twice a week, 30.9% (n = 114) reported that water was usually available at their source, 19.2% (n = 71) water was normally available at their source several hours per day and 13.8% (n=51) reported infrequently of water availability to their water source. The respondents transported their drinking water from the source to their households using various means; 96% (n = 354) of the respondents normally transport their drinking water on foot, 2.2% (n = 8) used hand held drawn carts especially during water shortage days while 1.9% (n = 7) used bicycle, 82% (n = 302)

of the respondents believed that drinking water that they were drawing from the public water sources was treated. However, 18% (n = 67) believed that the drinking water was not treated. The respondents employed various water treatment methods in their households; 41% (n = 154) boiled their drinking water before taking it, 35% (n = 129) used chemicals to treat the water, 2.7% (n = 10) filtered their water, 1.4% (n = 5) used solar disinfection method, 0.5% (n = 2) used sedimentation method and 0.5% (n = 2) used the three pot system. However, 18.2% (n=67) never treated their drinking water.

Table 1
Social Demographics and Accessibility of drinking water

Social demographics	n(%)	n(%)	P Value
Sex: Male	110	29.8	P = 0.039
Female	259	70.2	
Marital Status: Married	222	60	P = 0.090
Single	102	28	
Divorced	45	12	
Occupation Status: Unemployed	198	53.7	P < 0.001
Employed	169	45.8	
Missing	2	0.5	
Health Insurance Ownership: No	267	72.4	P < 0.001
Yes	95	25.7	
Don't Know	7	1.9	
Accessibility of drinking water			
Water Source: Water Kiosk	147	39.8	P = 0.039
Piped water	203	55	
Borehole	14	3.8	
Roof catchment	4	1.1	
Missing	1	0.3	P = 0.090
Water Treatment Methods:Boiling	154	41.7	
Chemical Use	129	35.0	
Water Filter	10	2.7	
Sedimentation	2	0.5	
Three pot system	2	0.5	
Solar disinfection	5	1.4	
None	67	18.2	
Availability of Water:Usually available	114	30.9	P < 0.001
Several Hours per Day	71	19.2	
Once or Twice a week	127	34.4	
Infrequently	51	13.8	
Missing	6	1.6	
Mode of Transporting Water: Hand Drawn Carts	8	2.2	
Bicycle	7	1.9	P = 0.411
On Foot	354	95.9	
Water Treated from the source:Yes	302	81.8	P = 0.411
No	67	18.2	

The study showed that an average household was using a mean of 133 litres of water per day with the highest consuming households using 820 litres of water per day and the least consuming households consuming 5 litres of water per day. However, most households used 80 litres of water per day. The drinking water was being charged by the vendors using a standard 20 litre jerry can at mean cost of 5 (std1.622) Kenyan Shillings per jerry can. However, some of the respondents were being charged the highest cost of Kenyan shillings 10 per 20 litre jerry can. The results of bacteriological analysis of the community water sources (Table 2) showed that the drinking water contained the most probable number of coliforms per 100 millilitres of treated water that were high and varied significantly per village; Lindi B village and Gatwekera village had their community water supply sources highly contaminated with over 180 most probable number of coliforms per 100 ml of treated water. Kisumu Ndogo "A" village public water supply source had 90 most probable number of coliforms per 100 ml of treated water. Two samples collected from Umash village recorded different level of contamination, the sample collected at stand-by tap had 35 most probable number of coliforms per 100 ml of treated water. The other from stand-by tank had 3 most probable number of coliforms per 100ml of treated water. Water from Kambimuru "A" village was collected from public supply tap with suspected contamination from pit latrine, it had 20 most probable number of coli forms per 100 ml of treated water.

The four water sampleswere collected from the randomly selected respondents'households in the same villages with where the community water source samples were collected. A household located in Kisumu Ndogo A, which drew its water from a public supply storage tank and stored the water in a jerry can had over 180 most probable number of coliforms per 100 ml of treated water. A household located in Linda B village which got its water from public supply mains with no tap and stored it in a 20 litre jerry can had over 180 most probable number of coliforms per 100ml of treated water. A house located in Umash village which got its water from a public supply storage tank and stored it in 100 litres super drum in the household had over 180 most probable number of coliforms per 100 ml of treated water. A household in Gatwekera village which got its water from public supply pillar tap and stored in a 20 litre jerry can had over 1800 most probable number of coliforms per 100 ml of treated water and 6 most probable number of Escherichia coli per 100 ml of treated water. All the drinking water from the households and public water supply sources were classified as class IV.

Table 2
Results of Bacteriological analysis of drinking water samples

Village	Source of sample	Exact site sample was taken	Source of pollution	Most probable number of coli forms per 100ml of treated water	CLASS
Drinking water samples taken from public water supply system					
Kambi Muru A	Public Supply	Tap from mains	Pit latrine	20	Class IV
Kisumu Ndogo A	Public Supply	Tap from mains	None	90	Class IV
Lindi B	Public Supply	Pipe from mains (no tap)	Pipe submerged into waste water	>180	Class IV
Umash	Public Supply	Stand by tap	Pit latrines	35	Class IV
Gatwekera	Public Supply	Pillar tap	Water pipes sub-merged into waste water drink line	>180	Class IV
Umash	Public Supply	Stand by tank	Nearby filled pit latrines	3	Class III
Drinking water samples taken from Household storage containers					
Kisumu Ndogo A	Storage tank	Jerry can for drinking water	None	>180	Class IV
Lindi B	Public Supply	20 liter jerry can	None	>180	Class IV
Umash Village	Storage tank	100 liters super drum	None	>180	Class IV
Gatwekera	Public Supply	Drinking water storage container (20 liters jerry can)	None	>1800	Class IV

The Effect of sanitation and water quality on people living with HIV/AIDS: The study showed that in the last 12 months more than half of the sampled population (62%) had suffered from diseases caused by contaminated water and poor sanitation. There was a strong evidence of relationship between the employment status of the respondent and occurrence of diseases due to poor environmental sanitation and contaminated water (chi square = 18.009, df = 2, p< 0.001). The most commonly reported waterborne and sanitary related diseases in the last 12 months were diarrhoea 32% (n =229), malaria 30% (n = 111), dermatitis 14% (n = 51),conjunctivitis 3% (n = 12), scabies 2% (n = 8), dysentery 1% (n = 4) and worms 1% (n = 3). There was a self-reported mortality of 39% of the people known in that community that were HIV seropositive and died due to diseases caused by taking contaminated water or living in poor sanitary environment. 94% of the respondentsliving with HIV/AIDS in Kibera slum who suffered from the diseases caused by taking contaminated water and poor environmental sanitation went to the health facilities to seek treatment and care. Among those who went for treatment (94%), 115 (53.4%) went to government health facilities, 75 (34.9%) went to faith based health (FBO) facilities or non-governmental organization (NGO) health facilities, 16 (7.4%) went to private medical clinics, 8 (3.7%) went to private medical centres and one (0.5%) went to nursing homes for care and treatment. The study revealed that more than half (58%) of the respondents who reported that they had suffered from the infections related to poor sanitary conditions and contaminated water had symptomsmore than once in the last 12 months; Only 42% (n = 91) of them were infected at least once in the last 12 months, 27% (n = 58) were infected at least twice, 20% (n = 43) at least three times, 9% (n = 20) at least four times, 2% (n = 4) more than four times in the last one year (Table 3).

Table 3

Effects of water quality and environmental sanitation and distribution of treatment facilities used

	Yes n(%)	No n(%)	Total
Disease suffered in the last 12 months	229(62.1)	140(37.9)	369
Diseases:			
Diarrhoea	119(32.2)	250(67.8)	369
Pneumonia	74(20.1)	295(79.9)	369
Tuberculosis	76(20.6)	293(79.4)	369
Malaria	111(30.1)	258(69.9)	369
Dermatitis	51(13.8)	318(86.2)	369
Conjunctivitis	12(3.3)	357(96.7)	369
Intestinal worms	3(0.8)	366(99.2)	369
Dysentery	4(1.1)	365(98.9)	369
Scabies	8(2.2)	368(97.8)	369
Self reported HIV/AIDS mortality due to Poor Environmental sanitation and water related diseases	144(39)	223(60.4)	367
Treatment of the environmental and water related diseases	217(58.8)	15(4.1)	232
Facilities used for treatment			
Government	115(53.5)	N/A	215
Faith Based/ NGO health facility	75(34.9)	N/A	215
Private medical Clinic	16(7.4)	N/A	215
Private medical Centre	8(3.7)	N/A	215
Nursing Home/Maternity Health Centre	1(0.5)	N/A	215
Frequency of Occurrence of the Disease:		N/A	216
At least Once	91(42)	N/A	216
At least Once Twice	58(27)	N/A	216
At least Three times	43(20)	N/A	216
At least Four Times	20(9)	N/A	216
More than Four Times	4(2)	N/A	216

The average treatment cost for the respondents who were infected due to taking contaminated water or due to poor environemntal sanitation was Kenyan Shillings 1125, (std 6709). Majority of the respondents were being treated for free. The highest cost of treatment reported by the respondents was Kenya Shillings 69,000. Overall a majority of respondents (62%) suffered from diseases related to taking contaminated water and living in poor environmental sanitary conditions. Logistic regression analysis was employed to predict the probability that a respondent living with HIV/AIDS in Kibera slum would be infected with diseases related to taking contaminated water and living in poor environmental sanitary conditions. The predictor variables were: respondent's household drinking water treatment behaviour, taboos, beliefs and cultures practised that affects water quality and sanitation measures, food storage practices, availability of Standard Sanitary bin in the respondent's latrine and Presence of waste storage bin at household level. A test of the full model versus a model with intercept only was statistically significant, x^2 (5, N = 369) = 73.912, p< .001.

Table 4

Logistic Regression predicting disease outcome from explanatory variables

Variable	B	SE	Wald X^2	P	OR
Constant	-1.312	0.353	13.809	<0.001	0.269
Drinking Water treatment at household level					
Didn't treat their Drinking water (Base = Treated their drinking water)	-0.655	0.306	4.589	0.032	0.519
Taboos, Cultures and Beliefs					
Yes (Base = No)	1.105	0.330	11.232	0.001	3.018
Display of Food, uncovered in the household					
Present (Base = Absent)	0.349	0.346	1.017	0.313	1.418
Standard Sanitary Bin Present in the Latrine					
Absent (Base = Present)	2.058	0.534	14.838	<0.001	7.832
Presence of waste storage bin at household level					
Absent (Base = Present)	1.257	0.257	23.942	<0.001	3.514

-2LL	415.951
	X2 = 73.912, df = 5, p<0.001
Nagelkerke R2	25%
Hosmer & Lemeshow test	P = 0.561
Classification accuracy	73%

DISCUSSION

Majority of the people living with HIV / AIDS in Kibera informal settlement were getting their drinking water from the municipal piped water. These findings were in agreement with (1). The availability of water at the sources was varied as municipal water was available only specific days of the week making water kiosks more valuable as they store water and sell it even during the water scarce days.

The drinking water was being sold by the vendors using a standard 20 litre jerry can which was being charged at mean cost of Kenyan Shillings 5 (std 1.6). However, some of the vendors were charging as high as Kenyan Shillings 10 per 20 litres jerry can especially during water shortage days. The employed proportion of the people living with HIV / AIDS had a median income of Kenyan Shillings 3000 per month. This means a daily income of Kenyan Shilling 100 (taking a 30 day monthly period). An average household was using a mean of 133 litres of water per day with the highest consuming household using 820 litres of water per day and the least consuming household using 5 litres of water per day with most households using 80 litres of water per day. In terms of water expenditure and using the average cost of 20 litres jerry can (Kshs 5) and the median monthly income, this means that an average household was spending Kenyan Shillings 33.25 per day on water which amounts to 33% of their total monthly income. The highest consuming household which was using 820 litres of water per day was therefore spending Kenyan Shillings 205 per day on water. Such a household was therefore earning more than the median monthly income. Assuming that the household was earning Kenyan Shillings 10000 which majority of the employed population was earning as the maximum monthly income, this would mean that they have a daily income of Kenyan Shillings 333.33 and spending Ksh 205 of this income daily on water means they are spending 62% of their total monthly income on water. The majority of the population who were consuming 80 litres of water per day were spending a significant amount of Ksh 20 per day. This proportion of the community was therefore spending 20% of their total monthly income in purchasing water (using the monthly median income of Ksh 3000). The water cost was therefore very expensive and based on this, the sanitary conditions was highly likely to be compromised factored in that other high priority household needs such as food, clothing, education, and rent were also dependent on the same income. The household quality of life will therefore be affected and will affect negatively on HIV / AIDS management and treatment. This problem will even be much more severe in HIV seropositive mothers especially in their nutrition requirements and the quality of replacement feed for the baby if it's being utilised. This was in agreement with (7,8)Water, Transport, Healthcare, and sanitation among others on the burden of water on slum dwellers.

This population was transporting their water from the water source to the households using small containersmostly by foot (96%), hand drawn carts (2%) and bicycles (2%) especially during water scarce days. These containers used by the majority of the residents have been reported to be the source of contamination of drinking water between water source and household (9).

Majority of the people living with HIV / AIDS (82%) believed that the water they were purchasing expensively from the public water sources was treated and therefore safe for human consumption with 18% reporting that the water was not safe for human consumption and household water treatment methods was necessary before consumption. Despite majority of the respondents thinking that the water from the source was safe for drinking they still employed various water treatment methods at household levels before drinking the water. It was evident that most of this population employed boiling (41%) and chemical (35%) treatment as their most preferred water treatment mechanism.

To determine the safety of the drinking water both at the source and in the households the study collected 10 water samples for bacteriological analysis; Six drinking water samples were collected from community water supply sources which were purposively chosen within the selected villages and 4 water samples were collected from the randomly selected respondent's households who got their water from the 6 selected water sources. The results showed that the water from the water sources were contaminated and unsatisfactory for human consumption. For instance, Lindi B village and Gatwekera village had their community water supply highly contaminated with over 180 most probable number of coliforms per 100 ml of treated water and Kambi Muru 'A' village water from public supply tap had 20 most probable number of coli forms per 100 ml of treated water. The waters were heavily contaminated at the source, unsafe for human consumption and requires further treatment before consumption. These results confirmed the findings from (10). The defective water supply system and inadequate environmental sanitation were the potential source for contamination of the water sources (9).

The four water samples collected from households in the same villages showed a significant secondary contamination of water at household. For instance, a household located in Kisumu Ndogo "A" which drew its water from a public supply storage tank and stored the water in a jerry can had its drinking water having over 180 most probable number of

coliforms per 100 ml of treated water. A household located in Lindi B village which got its water from public supply and stored it in a 20 litre jerry can had over 180 most probable number of coliforms per 100ml of treated water and a household in Gatwekera village which got its water from public supply and stored in a 20 litre jerry can had over 1800 most probable number of coliforms per 100 ml of treated water and 6 most probable number of Escherichia coli per 100 ml of treated water. Therefore, these waters were unsatisfactory for human consumption.

The water was contaminated along the supply system due to leakages and bursts, at the community water supply points due to poor storage, between the source and the final consumption point due to severe contamination caused by the consumers' personal sanitation measures in terms of sterility of equipment used to draw water, transport and storage. Their hygienic behaviour such as not washing hands after visiting toilets and latrines would lead to contaminating the water with faecal matter when they get into contact with water drawing or storage equipment. The water distribution network which is mainly through plastic pipes and passing through unsanitary environments such as ditches, crude dumping sites and near pit latrinescontaminates the water before reaching consumers. These findings are in line with previous research, which noted that despite the treatment of source water and the use of chlorine disinfectant, contamination of piped water supply continues to occur, without necessarily causing large easy-to-recognise outbreaks, through leaks, or at other vulnerable parts of the system, and during maintenance work (11). Once in the system, bacteria, fungi and protozoa can attach to the inner surfaces of the pipes and some may grow to produce bio films. It also noted that chlorine is the most widely-used drinking-water disinfectant in public water supply systems and in most homes. However, it has some limitations in the sense that although chlorine is effective against most vegetative bacteria and viruses when used at the normal concentration for treatment, it will not inactivate Cryptosporidium oocysts. Furthermore, chlorine has a very limited effect upon pathogens growing in bio films (11).

Similar to previous research, this study showed that in the last 12 months more than half of the sampled population living with HIV/AIDS had suffered from diseases caused by poor sanitation measures and exposure to contaminated drinking water (12,13). There was a strong evidence of relationship between the occupation status of the respondent and occurrence of diseases due to taking contaminated water. The employed population (46%) mostly work as manual casual labourers that consists of constructing expensive new apartments, repairing roads, digging trenches, working in factories or working with cars and machines in Nairobi. The work is strenuous and many walk two or three hours each way to reach construction sites. Once there, they are unprotected by any kind of labour laws or safety regulations. When injuries occur, compensation is almost never considered (14). Therefore, the nature and type of employment of this population impacts negatively on their health and the effect is even severe if the individual is HIV seropositive. This relationship was also reported by (12). The high occurrence of the water related infections such as diarrhoea (62%), dermatitis 14%, scabies 2%, conjunctivitis 3%, dysentery 1% and intestinal worms 1% was due to the people living with HIV/AIDS taking contaminated drinking water or coming into contact with water that was contaminated with the disease causing pathogens. (15) reported that HIV/AIDS was a major contributor to burden of poor health among residents of Nairobi Slums. These results were also in support of the findings from other studies (16,17).

Drinking water sources were contaminated beyond human consumption. The water contamination was further increased at the household level. Of much more concern was the sample that was collected from Umash village standby tank water source and had 3 total coliform count but after the water was drawn from this water source and taken to the respondent household and stored in a 100 litres super drum water storage vessel, the total coliform count increased to over 180 total coliform count. (18)found the same results in South Africa.

The World Health Organisation guideline values for bacteriological quality of drinking water requires that treated water entering distribution system must not have any detectable E. coli or thermotolerant Coliform bacteria in any 100 ml sample and the total coliform bacteria must not be detectable in any 100 ml sample. Therefore these waters were not suitable for human consumption. The results showed a similar trend from other studies (9,17,19).

Piped water system do offer great benefits to the population being served. However, the potential for disseminating pathogens is greatly increased if the water source protection mechanism and rudimentary treatment systems are breached. Piped distribution without adequate treatment can spread contamination to large populations. The relationship between the occurrence of water related infections and environmental sanitation is outlined clearly by WHO organisation where it stipulates that water safety management relies largely on identifying hazards and ensuring that adequate control measures are available. The proper management of excreta through the use of appropriate sanitation acts as the primary barrier to prevent the spread of pathogens in the environment. Environmental management is very key to control of infections. Therefore simple sanitary measure put in place such as proper waste disposal mechanisms and proper food storage would

help in the infections prevention as was reported by (11).

There was a self- reported a high mortality from water related infections of people known to be HIV seropositive. High frequency of repeated infections from water related infections was also reported where more than half of the infected individuals were infected more than once in the last 12 months. This supports the study conducted by (15).

The median monthly income of the people living with HIV/AIDS in this population was Kenyan shillings 3000 and the average treatment cost for the infections for the respondents infected due to taking contaminated water or due to poor environemntal sanitation was Kenyan Shillings 1125 for those who paid their medical bills. This was about 38% of their total monthly income for the employed population, 72% of the respondents did not have acccess to health insurance cover including the government subsidized National Hospital Insurance Fund. Therefore, most respondents had to pay for the treatment out of pocket. Majority of the health facilities were offering treatment for free to the people living with HIVAIDS with government health centers (53%) and faith based health facilities (35%) as the most preffered health faclities. The free medical treatment has enabled the unemployed (54%) population to get access to health services but to limited number of infections. Therefore, there is more preasure in health facilties due to diseases caused by poor sanitary conditions and taking contaminated water by the people living with HIV/AIDS just as was reported by (7)

Overall a majority of respondents suffered from diseases related to taking contaminated water and living in poor environmental sanitary conditions. Logistic regression analysis was employed to predict the probability that a respondent living with HIV/AIDS in Kibera slum would be infected with diseases related to taking contaminated water and living in poor environmental sanitary conditions. A test of the full model versus a model with intercept only was statistically significant showing a partial significant evidence of relationship.

In conclusion, the safe drinking water was inaccessible to the majority of people living with HIV/AIDS in Kibera slum. The bacteriological analysis of water samples showed that the drinking water was contaminated at the source with secondary contamination in the household storage vessels. Defective water delivery system and inadequate sanitary measures in place were the potential source of contamination for water sources while sterility of the storage equipment and scoops were the source of contamination for household drinking water stored.

The people living with HIV/AIDS in Kibera slum are over burdened with diseases caused by taking contaminated water and living in unsanitary environments coupled with poor hygiene status.

Taking contaminated water and living in unsanitary environment led to high economic burden to people living with HIV/AIDS in Kibera slum due to high drinking water costs and medical bills. This is a huge financial expenditure burden to the population who are already over burdened with HIV/AIDS infection and it will go along way to affect the quality of their life and other sector of development such as education and their investment capacity.

RECOMMENDATION

There is need for the integration of water quality management issues in HIV/AIDS management and treatment.

The Municipal water supply companies should ensure that they treat their drinking water to the required standards established by the WHO with frequent monitoring of the water supply system to check for any malfunctioning that might result in water contamination. This include doing routine chemical and bacteriological analysis of the water samples taken at the various points along the system. These analysis should be able to detect the new emerging water related pathogens that are known to cause high morbidity and mortality in the immune compromised populations.

The government should ensure that water is supplied to this population using the means that will provide safe drinking water and lower the cost of water to the community such as removing the middle men (water vendors) who hike the water costs or constructing Community Ablution Blocks or provision of water filters to the people who are immune compromised.

The public health professionals should do a lot of health education on the importance of good sanitation and water quality at the household level. Teach the community, especially the immune compromised, on the viable water treatment methods in details and water storage methods that are safe.

There is need for a comparative study to compare the risk of poor water quality and sanitation in immune-competent and immune-compromised populations.

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