

## ACCESS TO SAFE DRINKING WATER AND WATER-BORNE DISEASES IN MASABA NORTH DISTRICT, KENYA

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### **Abstract**

Consumption of contaminated water is a major cause of illness in the world and particularly in rural communities, especially in developing countries like Kenya. The objectives of this cross-sectional study were to evaluate access to safe drinking water, water purification techniques and water-borne disease incidence in Masaba North District. Some 100 households were randomly selected with structured interview questions being administered to 25 households in each of the four divisions in the District. Water testing was carried out in a make-shift laboratory using the Oxfam DelAgua kit to determine the number of *E. coli* colony forming unity (CFU) per 100ml while a hach turbidimeter was used to measure water turbidity. It was found that a high percentage of the households had access to 'improved' water sources including protected springs (79%) with 64% of the households boiling their water before consumption.. Only 17% of the households had access to water free from fecal contamination. The most effective method of purification was Biosand filtration which provided 57% reduction in turbidity and 92% reduction in *E. coli*. Out of the 100 households, 20% households indicated that at least one member of the household had suffered from water-borne diseases in the past year. Whereas many households can easily access improved water sources, access to safe drinking water was still a major challenge. Further more, water from "protected sources" was not necessarily safe for drinking. There was inconsistent and inadequate utilization of water purification techniques leading to consumption of contaminated water even after purification had been carried out.

**Key words:** Water treatment, boiling, chlorination, biosand filtration, solar disinfection

## **1.0 Introduction**

A large proportion of world population does not have access to safe and clean water. According to the World Health Organization, 1.1 billion people in the world's population- lack access to safe drinking water (WHO, 2004). As a result of this, 1.8 million people die every year from diarrhoeal diseases (including cholera); 90% being children under 5, mostly in developing countries.

The most commonly used method of water purification in rural Kenya is boiling (UNICEF, 2008). However, due to overdependence on unsustainable sources of energy such as biomass and the problems associated with their use including indoor air pollution, most households who profess to use this method for purification do not use it consistently leading to consumption of unsafe water. Another commonly used method of purification is biosand filtration which has to be proved an effective simple, inexpensive and reliable (Collins *et al*, 1992). The advantage of Biosand filtration is that it can be locally built, using locally available materials, it is easy to maintain, and does not require any energy input and is relatively inexpensive (Duke *et al.*, 2006).

Chlorination is the second most widely-practiced means of treating water at the community level, (UNICEF, 2008). There are however concerns about the taste and odour of chlorinated water with some consumers finding it objectionable. However, some studies show that this is probably exacerbated by a tendency to add more than the recommended dose of chlorine (Gurian *et al.*, 2006).

Solar disinfection, which combines thermal and UV radiation, has been repeatedly shown to be effective for eliminating microbial pathogens and reduce diarrheal morbidity (Hobbins, 2003). However, studies show that this method has many limitations ranging from the obvious fact that it is dependent on weather conditions and high turbidity and particulate materials absorb UV rays (Qualls *et al.*, 1983).

Whereas access to 'improved' water sources has increased rapidly in the last decade, little has been done to find out whether this increase in access to 'improved' water sources has led to an increase in access to safe drinking water. This research was therefore carried out with the objective of evaluating access to safe drinking water, water purification techniques and water-borne disease prevalence in Masaba North District.

## **2.0 Materials and Methods**

### **2.1 Study Area and Population**

For this study, participating households were situated in four different regions, i.e. in East Kitutu Division, Gesima Division, Gachuba Division and Mochenwa Division. From each of these four divisions, 25 households were randomly selected to make a total of 100 households in which the research instruments were administered.

### **2.2 Water Sampling and Testing**

Sterilized plastic bags were used to collect water samples from each of the 100 sampled households. From each household, water samples were collected from drinking water from the source and another sample from stored drinking water after intervention. About 500 ml of water sample from each source was collected, labeled and kept in an icebox during transportation and analyzed in the laboratory to determine fecal coliforms (*E. coli*) as well as turbidity. The samples were tested within 6-8 hours of collection (WHO, 2006).

The number of *E. coli* present in each sample was determined using the Membrane Filtration Method. This method, which is best suited to laboratory conditions, has been modified to adapt to field conditions in the DelAgua kit. Samples taken were allowed to recuperate for a minimum of 1 hour, cultured on membrane lauryl sulphate broth and enumerated after 16-18 hours of incubation at 44.5°C (+/- 0.5°C), (Earwaker, 2006). Negative controls, i.e., 100 ml contamination of water after collection of sterile distilled water, were processed after every twentieth sample to ensure that the equipment had been adequately sanitized (Rufener *et al.*, 2008).

The turbidity of each water sample was tested using the HachTurbidimeter. The HachTurbidimeter was preferred over other commonly used instruments of measuring turbidity, notably the DelAgua Turbidimeter, because it is

more accurate, faster and precise. The Turbidity was measured in NTU, with values below 5 NTU considered safe for drinking (WHO, 2008).

### 2.3 Water Sources, Purification Methods and Water-Borne Diseases

The individual most responsible for management of drinking water in the household, in most cases the mother, was identified and interviewed. Where this was not possible, the next most responsible person was interviewed. Water sources, purification methods and health data were identified through a questionnaire with structured questions administered with the help of two trained research assistants. Questions asked touched on distance to water sources, time taken to collect water, methods of water purification, sources of water and water-borne disease incidence.

## 3.0 Results

### 3.1 Drinking Water Sources

Many of the households sampled in the District got their drinking water from 'improved' water sources (protected spring, piped water, protected dug well and borehole). Only 18% of the households sampled got water from unimproved sources such as unprotected dug well, surface water and unprotected springs (Figure 1). However, 31 households reported that their major water source was seasonal while the other 69 households reported that their major water source was permanent.

A majority of these water sources were within 1 km or less from the households sampled. Out of the 100 households, 79 got their drinking water from within 500 m distance while 8 households walked for more than 1 km to access their main source of drinking water (Figure 2). Some 43 households spent less than 1 hour daily to collect their drinking water, 53 spent between 1 and 2 hours while another 4 households spent more than 2 hours to collect water daily.

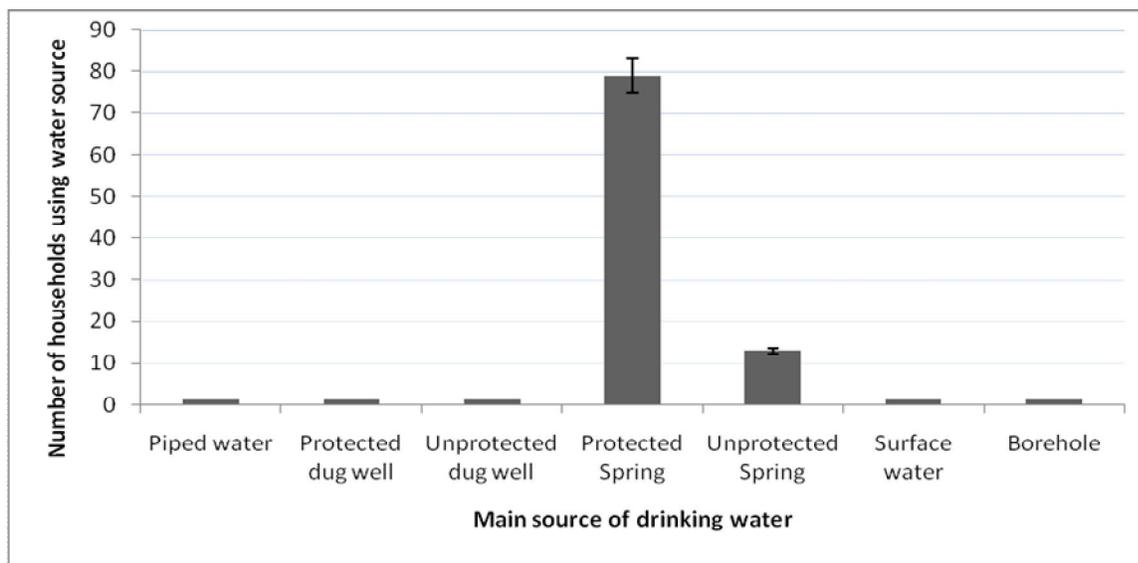


Figure 1: Major sources of drinking water in Masaba North District

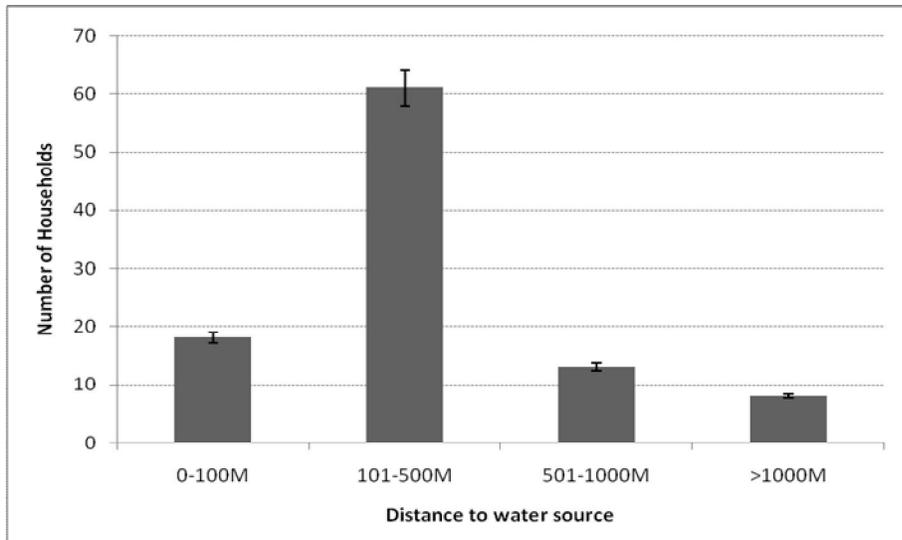


Figure 2: Distance to water sources

### 3.2 Water Purification Methods

The commonly used water purification technologies in the district included boiling (64%), disinfection using chlorination (4%), biosand filtration (3%) and cloth filtration (3%), while 26% of the population did not purify their water (Figure 3). Some 14% of the households could not remember when they last purified their water using their preferred method while another 3% had used their method more than a week before. The most preferred method of water purification was chlorination (41%) with only 1% indicating that they preferred boiling most.

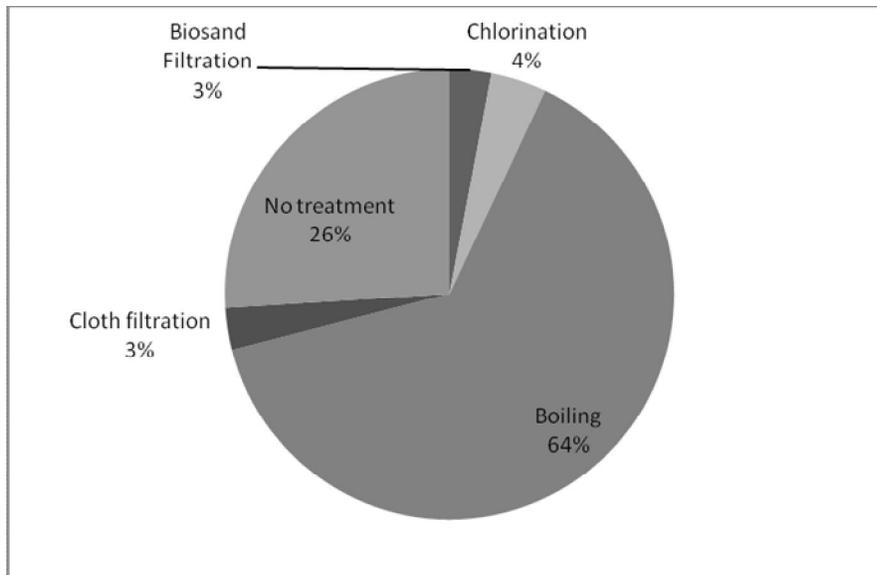


Figure 3: Water purification methods in Masaba North District

### 3.3 Drinking Water Quality

Out of the 100 sampled households, 26 households did not purify their water while 12 households that claimed to purify their water before consumption did not have any treated water readily available for testing.

Only 17 households achieved the recommended 0 CFU per 100 ml in their drinking water while 50 households had 1-100 CFU/100ml and 21 households had 101-1000 CFU/100 ml in their drinking water. For the turbidity tests, 71 households achieved the WHO recommended standard of less than 5 NTU while the household with the highest turbidity in drinking water had 12.3 NTU (Figure 4).

All methods showed a general reduction in turbidity with biosand filtration showing the highest reduction of 57%. The same method also showed the highest reduction in colony forming unity (CFU) of 92%.

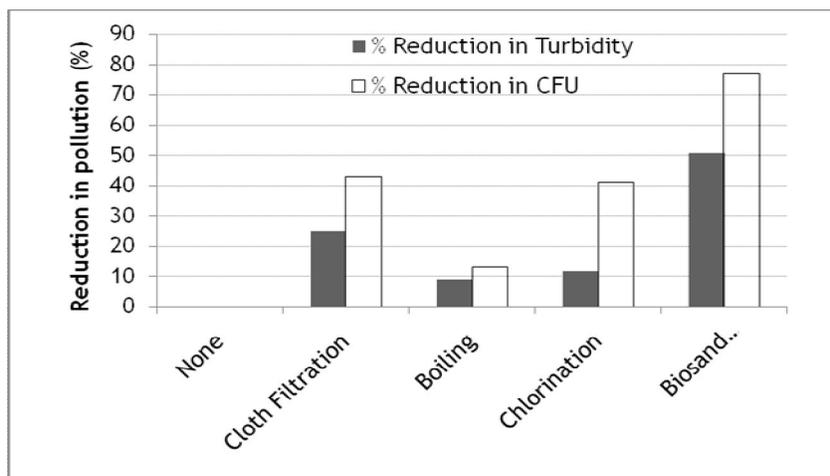


Figure 4: Effectiveness of water purification methods

### 3.4 Water- borne Diseases

Typhoid most commonly reported water-borne disease in the district, as 13% of the households reported that at least one family member suffered from the disease in the past one year. Amoeba was the second-most widely reported disease at 3%, while 4% of the households reported that there had been both typhoid and amoeba in the household in the past year. Majority of households did not report that anyone in the household had suffered from any disease related to consumption of poor water quality (Figure 5).

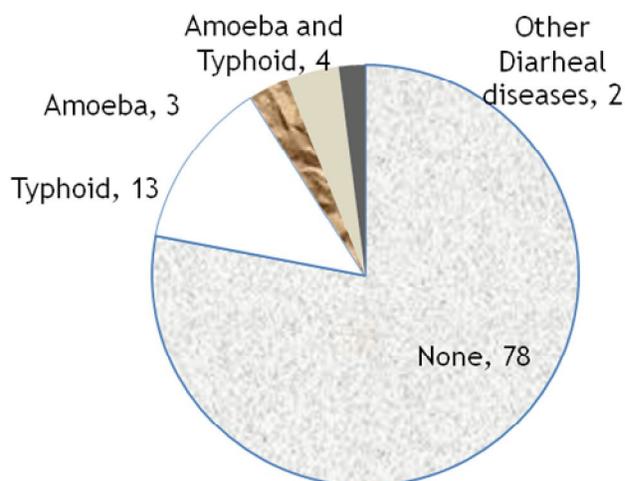


Figure 5: Number of households reporting Water-borne diseases in Masaba North District

#### **4.0 Discussion and Conclusions**

A high percentage of the households had access to 'improved' water sources including protected springs (79%). However, many households identified their water sources as unreliable with 31% indicating that their main water source was seasonal. This may lead to use of water from other sources, especially during the dry season, which may be of poorer quality than the main source. Only 1% of the households sampled had access to piped water due to the fact that the district is predominantly rural. Many of the households lived less than 1 km away from their main water source with only 8% indicating that their main source of drinking water is more than 1 km away. This can be attributed to the fact that the district is in a high altitude region with high rainfall and many springs.

The most commonly used method of water purification was boiling which mostly relies on non-renewable sources of energy such as charcoal and firewood. These materials were not always available and as a result households fail to purify their water, exposing themselves to water-borne diseases. Majority of households consider chlorination to be the most suitable method of water purification. This can be attributed to the fact that chlorination is considered a much faster, cheaper and convenient alternative, although its unavailability in this rural district has led to minimal use.

Only 17% of the treated water samples met the WHO/KEBS recommended standard of 0 CFU/100ml for drinking water (WSREB, 2007; WHO, 2006). This low turn out can be attributed to several factors including inadequate treatment, recontamination due to poor storage and long periods of drinking water storage. Another 17% of the households were found to consume water above the 5 NTU recommended by WHO.

The poor results from boiling could be due to the fact that there is no residual disinfectant in boiled water, longer period of water storage increasing the likelihood of recontamination or inadequate boiling. The major challenge in boiling was lack of consistency with 14 households who claimed to use the method not able to recall when the method was last used. The better results obtained from households using chlorination can be explained by the presence of residual disinfectant (Rufener *et al.*, 2008) while those from biosand filtration could be due to the fact that water treatment is carried out everyday leading to shorter periods of water storage.

Reduction in turbidity for households using methods of water purification such as boiling and chlorination which do not reduce turbidity was due to the fact that the samples tested were of stored water where settling of sediments had taken place leading to a reduction in the turbidity of the stored drinking water.

In the past one year, 20 households reported at least one household member having suffered from a water-borne disease. This is not surprising especially since the water quality tests indicated that only 17% of the households consume water which can be classified as safe.

Further research needs to be done to ascertain the sources of recontamination of treated water in the district, the most appropriate duration of drinking water storage in respect to each method and ways through which the government and development partners can promote use of such methods as chlorination and biosand filtration, which may be more appropriate than boiling.

In conclusion, whereas many households could easily access improved water sources, access to safe drinking water is still a major challenge. There was inconsistent and inadequate utilization of water purification techniques leading to consumption of contaminated water even after purification had been carried out. There's need to promote more economically and environmentally viable water purification methods, sensitize households about hygiene and sanitation practices aimed at reducing drinking water re-contamination which will ultimately help in increasing access to safe drinking water and reduce the high incidence of water-borne diseases in the district.

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