ISSN: 2349-3763

IJENAS

International Journal of Environment and Natural Sciences

Website: www.ijenas.com; Email: journalijenas@gmail.com; © Centre for research in ecology, environment and social sciences (CREESS)

Water Faecal Contamination and Household Morbidity in Slums of M-Ward, Mumbai, India

Annu Baranwal[1]*, Ankit Anand[1], Emma Van Rij[2], Nobhojit Roy[2]

[1] Environmental Health Resource Hub, School of Habitat Studies, TISS, Mumbai
[2] Public Health Sciences Department, Karolinska Institute, Stockholm

*Corresponding author: baranwalannu@gmail.com

(Received: August 19, 2016; Accepted: September 8, 2016)

Abstract

This study was conducted in slums of Shivaji Nagar, an urban slum in the western M-Ward of Mumbai, India. Two slums within the area were selected, the water samples were collected from the point of use and H_2S water testing was done in resettled (Natwar Parekh Compound, 80 samples) and non-resettled (Raffiq Nagar, 72 samples) slums. Study showed that the households where the quality of water was better the morbidity conditions in those households were low as compared to the other households. Households taking water from tanker trucks were more affected by the faecal contamination of the water and more prone to water borne diseases. Source of water and access to water source (public or community water sources) was associated with diseases like fever and cough. Thus, a strong association of poor water quality with the incidence of diseases was found whether it was a resettled slum or non- resettled slum. Thus, attention must be given towards developing practical strategies to ensure safe drinking water, provided at the point of supply and consumption, also practices towards water storage handling and consumption needs to be improved no matter it is a resettled or a non-resettled slum or any other place of human habitation which will lead to reduction in water borne diseases and improved overall health.

Keywords: Faecal contamination, Drinking Water, Slum, H_2S test, morbidity, Mumbai

Introduction

The importance of water to human health and wellbeing is well mentioned in the Human Right to Water and Sanitation, which entitles everyone to ''sufficient, safe, acceptable physically accessible and affordable water for personal and domestic uses'' (Committee on Economic Social and Community Rights 2002) Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to safe drinking water can result in tangible benefits to health. Every effort should be made to achieve drinking-water that is as safe as practicable. Securing the microbial safety of drinking water supplies is based on the use of multiple barriers, from catchment to consumer, to prevent the contamination of drinking-water or to reduce contamination to levels not injurious to health. Safety of water is increased if multiple barriers are in place, including protection of water resources, proper selection and operation of a series of treatment steps and management of distribution systems along with the storage and handling at the household level (WHO 2011).

The quality of drinking-water thus may be controlled through a combination of protection of water sources, control of treatment processes and management of the distribution and handling of the water. Health-based targets should be based on an evaluation of health concerns system assessment to determine whether the drinking-water supply (from source to the point of consumption) as a whole can deliver water that meets the good health targets (WHO 2006).

Contaminated drinking water, along with inadequate supplies of water for personal hygiene and poor sanitation, are the main contributors to an estimated 4 billion cases of diarrhoea each year causing 2.2 million deaths, mostly among children under the age of five and affects millions of people worldwide with waterborne diseases like typhoid, cholera and so on (Clasen 2003). Under guidelines established by the World Health Organization (WHO), water intended for human consumption should contain no microbiological agents that are pathogenic to humans (WHO 2009).The quality of drinking water is a significant environmental determinant of health. Management of drinking water quality is the basis for the prevention and control of water borne diseases. Although water is an essential component of life, it is responsible for transmitting a number of diseases in all the countries and continents from poorest to wealthiest. Unsafe drinking water can cause several communicable diseases such as diarrhea, cholera, typhoid, dysentery and so on (Quick et al. 1999).

There are several ways in which faecal contamination of water can happen. These include contamination of drinking-water catchments (e.g. by human or animal faeces), water within the distribution system (e.g. through leaky pipes or obsolete infrastructure) or of stored household water as a result of unhygienic storage and handling (Mehta 2012). Faecal coliform bacteria or E Coli is the main indicator of the presence of faecal waste in water. It may also contain viruses, parasites and other bacterias. Contamination of drinking water with such organisms can cause major water borne diseases which can even lead to death. These effects are most dangerous in case of infants, children, elderly persons and people with immune deficiencies (Ashbolt 2004).

Testing the microbial presence in drinking water continues to be widely practiced worldwide in order to understand the water quality and efficiency of distribution system, setting standards and guidelines for good water quality, to prepare water safety plans, assessment of risk levels and management (Schwarzenbach 2010). Other important cause of testing faecal water contamination is to teach people about the microbial water quality and making them aware about the importance of better water sanitation and hygiene conditions and practices. This leads to increased community involvement in the management and monitoring of drinking water, including its sources and treatment (Medema et al. 2003)

Contaminated water, poor sanitation and water conditions represent not only a lack of basic amenities, but also the daily sufferings and susceptibility to various infectious diseases (Jackson 2003). Diseases related to contamination of drinking-water constitute a major burden on public health. The principal risk to health is from ingestion of water contaminated with feces containing pathogens that cause infectious diseases such as cholera and other diarrheal diseases, dysenteries, and enteric fevers (White et al. 1972; WHO 2011). The burden of water-related disease varies according to context and is highest in low-income settings where diarrhea remains a leading cause of deaths (Liu 2012)

Water contamination in urban slums in India is a major challenge. The slum population of India increased from 17.4 per cent of urban population in 2001 to 18.3 percent of total urban population in 2011 (Sivaramakrishnan 2011). Maharashtra had the largest share of urban as well as the slum population of India. More than fifty per cent of Mumbai's population lives in slums. There are many studies indicating poor water and sanitation conditions in these slums. Many slum dwellers do not have access to water taps, and rely on informal water sources with high costs. Water may only be available a few hours a day and is sometimes of bad quality and unfit for drinking Also people do not follow the right storage and water handling practices (Agarwal 2011).

Thus, it is necessary to assess the microbial drinking water presence in order to improve the overall planning, management and handling of the drinking water in the slum community and the households. The aim of the study is to assess the faecal contamination of water in resettled and non resettled slum of Mumbai and analyze the association between faecal contamination and household morbidity. This study will help to understand the role of resettlement of slums in terms of drinking water quality, supervision and administration.

Study area

The area for this study is Shivaji Nagar, an urban slum in the western M-Ward of Mumbai, India. To the northeast of it is a dumping ground, which is surrounded on the eastern and northern side of a branch of the Thane creek. Estimations of the population in the slum vary from 2,00,000 by the government; to at least 6,00,000 by doctors and community health workers of Niramaya Health Foundation, a local NGO. Within the slum area, two specific sites were chosen. First slum was Natwar Parekh Compound (Resettled Slum), the catchment area of 'Doctors For You' (DFY), a local non-profit organization that operates a health facility in a section in the north-west of Shivaji Nagar. This region has been part of a slum rehabilitation project, and people have been moved into permanent housing structures, usually known as vertical slums. The second slum area was Raffiq Nagar (Non- Resettled), located in the north of Shivaji Nagar next to the Deonar dumping ground which 10000 metric tonnes of garbage everyday from different parts of Mumbai (Bhavsar et al. 2012) and a branch of the Thane Creek. This site was not part of the slum rehabilitation program, and people here live in non-permanent or semi permanent structures.

Methodology

Water testing was done in resettled and non-resettled slums of M-ward, Shivajinagar using H_2S water testing kits. The non-resettled area, was not as clearly organized and no register of the households (HH) was available. Systematic approach was adopted in non-resettled area, during initial social mapping it was found out that 18 small street were there in each side of the slum. Hence five streets were selected in each side of the slum. Random street between first and third street were selected and from that starting point next streets were selected with interval of three streets. From each street first 10 households was asked to participate in the survey.In resettled slums, a map of the area was obtained, with 61 numbered apartment buildings. A random selection of 10 buildings was made, and subsequently 10 households were selected for each building. Random starting point between one and ten, and systematically selected the following nine (HH) with a selection interval of ten. The background variables used in the study were Household Size, Education, Religion, Caste, Source of water, Access to water source, Treatment of water, Access to toilet, Cleanliness condition of toilet, Wash hand after toilet, Wash hand before having food, Wash hand before cooking and so on and their correlation with the morbidity conditions in the study slums were seen in the study.

The Hydrogen Sulphide (H_2S) test

The H_2S test is recommended for testing drinking water derived from surface water, boreholes, and rain water sources for faecal contamination (WHO 2006).The reagents used to make the H_2S paper strip test are common laboratory chemicals. By adding a measured amount of "boiled" water and a common liquid detergent to the reagents, a measured amount is impregnated on a piece of absorbent paper and dried in a low-temperature oven. The dried paper strip is placed in a clear small plastic or glass bottle or tube. A water sample is collected in the container containing the reagents and stored in the dark at room temperature for about 3 days. If the sample contains hydrogen sulphide producing organisms, the pad and water turn black. The black colour and the rotten egg smell of hydrogen sulphide clearly indicate that there is a problem. With such an indicator it is not difficult to convince uneducated villagers or slum dwellers that the water may not be safe to drink (Manja et al 1982; Wright 2012).

Figure 1: The H_2S testing kit showing the faecal contamination of water (one with black colour and rotten egg smell)

Household non response, leakage or broken H_2S testing bottles and missing H_2S strips caused the reduction in number of sample to be tested. The total final numbers of water samples tested in the resettled and non resettled slums are given in (fig 2). It shows that 80 samples of water were tested from Natwar Parikh Compund

(Resettled slum) and 72 samples of water were tested from Raffiq Nagar (Non-Resettled Slum).

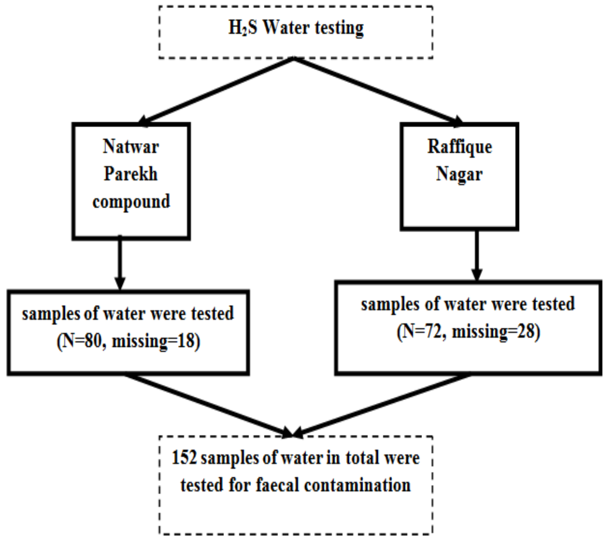

Figure 2: Sample for H_2S water testing

Statistical analysis

Cross tabulation was done to see the faecal contamination and morbidities in the households by type of slums and different socio-economic variables. Spearman's rank correlation was done to see the correlation between these variables. SPSS-version 20 was used to perform this analysis.

Results

In slums of M-Ward, Mumbai, in total 69.7% (106 out of 152) of samples (Fig. 3) were tested positive for faecal contamination. In non-resettled slums, 75% (54 out of 72) of sample were positive for faecal contamination. In resettled slums, 65% (52 out of 80) of sample were found positive for faecal contamination. It was found (Fig.4) that the percentage of households in which the H_2S water test came positive had poorer health conditions. Highest percentage of households was sufferer of cough and fever followed by Diarrhoea. Table 1, shows the correlation between H_2S test results, household morbidities (diarrhoea, fever and cough) with other background variables. It was important to find out that faecal contamination was not significantly related with any of the background variable as well as with household morbidities except for religion and source of water. Household taking water from tanker trunks was positively related with faecal contamination of the water. Belonging to muslim household was also significantly correlated with increased faecal contamination. Increasing household size was positively related with diarrhea. Source of water and access to water source (public or community water sources) was significantly associated with fever and cough. Cleanliness of the toilets were also found significantly negatively correlated with diarrhea and fever. In hygiene practices, habit of washing hands with soap was negatively correlated with diarrhea, fever, cough. All the morbidities were also associated with each other.

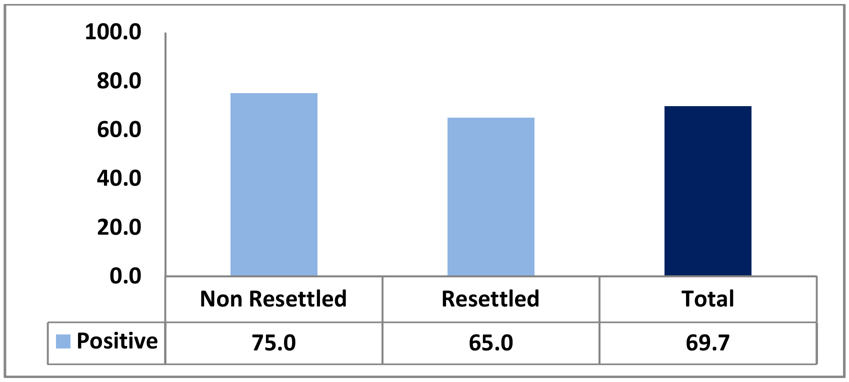

Figure 3: Percentage of water sample resulted into positive for faecal contamination

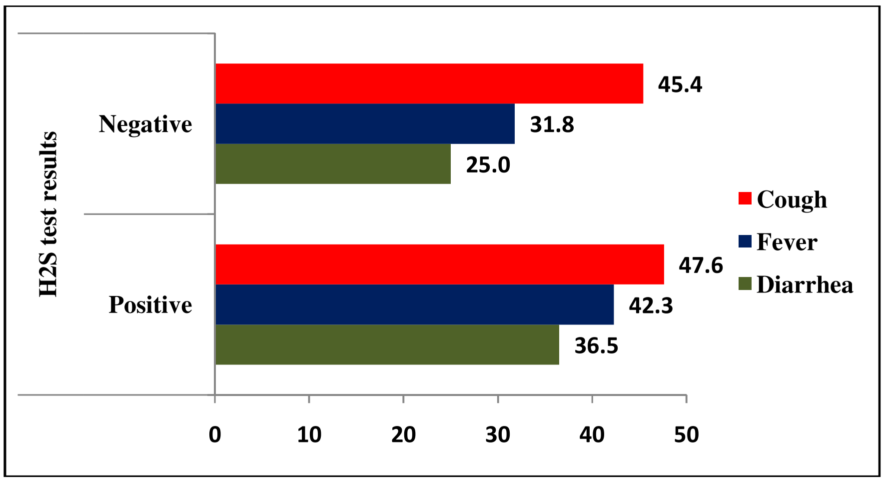

Figure 4: Percentage of households had person with diarrhea, fever and cough by H_2S test result

Table 1: Showing correlation of background variables with H_2S test results and morbidity conditions

Background Variables	H_2S Results	Diarrhea	Fever	Cough
Household Size	-0.108	.211***	0.078	0.078
Education	0.093	-.145**	0.054	0.051
Religion	.219***	-.144**	-.173**	-0.089
Caste	-0.08	-0.039	.240***	0.085
Source of water	0.02	-0.066	-.314***	-0.045
Access to water source	0.127*	0.015	-.221***	-0.087
Treatment of water	0.058	-0.006	-0.072	0.019
Access to toilet	0.097	-0.015	-.230**	-0.07
Cleanliness condition of toilet	0.093	-0.132*	-.172**	-0.072
Wash hand after toilet	0.003	-0.125*	-0.081	-0.077
Wash hand before having food	-0.08	-0.015	-.188***	-0.091
Wash hand before cooking	-0.018	0.006	-.220**	-.149**
H_2S results	-	-0.112	-0.098	-0.02
Diarrhea	-	-	.288***	.337***
Fever	-	-	-	.407***

Discussion and Conclusion

We would argue that there is a considerable body of evidence to indicate that the households where the quality of water was better the morbidity conditions in those households were low whether it is a resettled and non resettled slum. Household taking water from public tanker truck was more affected by the faecal contamination of the water and more prone to water borne diseases. Source of water and access to water source (public or community water sources) was associated with diseases like fever and cough. Thus, we have found a strong association of poor water quality with the incidence of diseases whether it is resettled slum or non-resettled slum. Thus, the arguments put forward by VanDerslice and Briscoe (1993) may be valid under certain conditions, there are several scenarios imaginable where there is a strong probability that disease transmission will be the outcome of in-house water pollution due to supply handling and storage. It would be important to safeguard drinking water between collection and consumption. Household stored water might be one route by which new pathogens are introduced to the household along with the other several reasons like supply of water and handling practices. Social interaction and water and sanitation practices by children and adults alike will lead to the transmission of pathogens via water, food and physical contact (VanDerslice 1993). The dramatic increase in contamination after collection indicates the point at which the biggest health impact can be made is at the household level storage and handling. Studies have shown that households with contaminated stored water samples did not show significant differences in demographics, water handling, hygiene practices, or sanitation (Eschol et al. 2009). There are severe deficiencies in water-related health is found in despite of different socio economic status of localities. Mostly bacterial contamination of drinking water occurred due to post-source contamination during storage in the household, except during the monsoon season, when there was some point-of-source water contamination. This suggests that safe storage and household water treatment interventions may improve water quality in slums. Problems of excessive expense, inadequate quantity, and poor point-of-source quality can only be remedied by providing slums with equitable access to municipal water supplies (Subbaraman et al. 2013).Thus, attention must be given towards developing practical strategies to ensure safe drinking water, provided at the point of supply and consumption and practices towards water storage handling and consumption, No matter it is a resettled or a non resettled slum. As just providing people houses to live doesn't change their behavioural practices towards water, sanitation and hygiene .As per the study, the practice of households in the slums to store and consume unsafe drinking water remains the same even if they are given a proper place to live and have got resettled . Thus, improvement in practices related to safe drinking water supply storage and consumption is needed for any place of human habitation which will lead to reduction in water borne diseases and improved overall health.

Acknowledgements

This research will be incomplete without the mention of all those people without the support of whom this research would have not been possible. First of all we would like to express our heartfelt gratitude towards our project head, Prof. Thiagarajan Jayaraman, Dean, School of Habitat Studies, Tata Institute of Social Sciences, Mumbai, who has given his full support and encouragement throughout this endeavor. We are highly grateful to Elizabeth Weber, for the financial support for the resource hub and for research officers salaries without which this project would have been impossible. We are really thankful to NGOs; Doctors for You (Natwar Parekh Compound) and Nirmaya Foundation (Raffiq Nagar), without their help this survey would not have been possible.

References

Agarwal S [2011] The state of urban health in India; comparing the poorest quartile to the rest of the urban population in selected states and cities, *Environment and Urbanization* 23(1): 13-28

Ashbolt NJ [2004]. Microbial contamination of drinking water and disease outcomes in developing regions, *Toxicology* 198(1): 229-238

Bhavsar S, Mahajan H, Kulkarni R [2012] Assessment of the Nutritional Status and Immunization Coverage of Anganwadi Children in Rafiq Nagar, Mumbai, *Public Health Research* 2(6): 229-234

Clasen TF, Bastable A [2003] Faecal contamination of drinking water during collection and household storage: the need to extend protection to the point of use, *Journal of water and health* 1(3): 109-115

Committee on Economic Socal and Community Rights [2002] General comment no. 15, *The right to water*. UN Doc. E/C.12/2010. New York: United Nations

Eshcol J, Mahapatra P, Keshapagu S [2009] Is fecal contamination of drinking water after collection associated with household water handling and hygiene practices? A study of urban slum households in Hyderabad, India, *Journal of water and health* 7(1): 145-154

Jackson LE [2003] The relationship of urban design to human health and condition, Landscape and urban planning., 64(4): 191-200

Liu L, Johnson HL, Cousens S, Perin J, Scott S [2012] Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 379: 2151–2161

Manja KS, Maurya MS, Rao KM [1982] A simple field test for the detection of faecal pollution in drinking water, *Bulletin of the World Health Organization* 60(5): 797

Medema GJ, Payment P, Dufour A, Robertson WAITE, Waite M, Hunter P, Andersson Y [2003] *Safe drinking water: an ongoing challenge*. Assessing Microbial Safety of Drinking Water 11

Mehta P [2012]. Impending water crisis in India and comparing clean water standards among developing and developed nations. *Archive of Applied Scientific Research* 4, 497-507

Quick RE, Venczel LV, Mintz ED, Soleto L, Aparicio J, Gironaz M, Chavez D [1999] Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage: a promising new strategy, *Epidemiology and infection* 122(01): 83-90

Schwarzenbach RP, Egli T, Hofstetter TB, Von Gunten U, Wehrli B [2010] Global water pollution and human health, *Annual Review of Environment and Resources* 35 :109-136

Sivaramakrishnan KC [2011] Re-visioning Indian cities: The urban renewal mission, SAGE Publications India

Subbaraman R, Shitole S, Shitole T, Sawant K, O'brien J, Bloom DE, Patil-Deshmukh A [2013]. The social ecology of water in a Mumbai slum: failures in water quality, quantity, and reliability, *BMC Public Health* 13(1): 1

VanDerslice J, Briscoe J [1993] All coliforms are not created equal: A comparison of the effects of water source and in house water contamination on infantile diarrheal disease, *Water resources research* 29(7):1983-1995

White GF, Bradley DJ, White AU [1972] Drawers of water: domestic water use in East Africa. Chicago: The University of Chicago Press

WHO [2006] Guidelines for Drinking Water Quality, Vol. 2, Health Criteria and Other Supporting Information. World Health Organisation, Geneva

WHO [2009] Guidelines for Drinking Water Quality, Vol. 2, Health Criteria and Other Supporting Information. World Health Organisation, Geneva

WHO [2011] Guidelines for Drinking Water Quality, Vol. 2, Health Criteria and Other Supporting Information. World Health Organisation, Geneva

Wright JA, Yang H, Walker K, Pedley S, Elliott J, Gundry SW [2012]. The H_2S test versus standard indicator bacteria tests for faecal contamination of water: systematic review and meta‐analysis, *Tropical Medicine & International Health* 17(1): 94-105