Rural Communities' Perception on Water Quality and Water Borne Disease: the Case of Bungamati Village Development Committee in Kathmandu Valley, Nepal

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Abstract

Introduction In Nepal, health problems of general people due to poor quality water is a major issue. Of total rural population, sixty-six percent has access to pipe drinking water. The water related diseases are among the top ten diseases in the country. The water borne diseases can be minimized by adopting effective preventive measures such as health and sanitation awareness, protection of water sources, avoiding any kind of contamination and so on. If effective efforts are given to these preventive measures, water borne diseases can be minimized.

Objectives This study aims to investigate the quality of drinking water used by the communities and their perception towards water quality and water borne diseases.

Methods The study is a cross sectional and descriptive type. Data and information have been acquired from the field survey by using semi-structured questionnaires containing both open and close-ended questions. Observation checklist was used to record the environment and sanitation conditions of the water sources, and settlement localities. Water samples at sources and consumption points were collected and analyzed their physico-chemical and bacteriological parameters in laboratory. Sharing of study's findings was performed among the local communities and meanwhile solar disinfection (SODIS) was intervened for the water purification.

Results The results showed that the physical and chemical parameters of the water samples of different sources were found lying within the WHO guideline value, whereas the values of the bacteriological parameters such as coliform bacteria and *E. coli* were above the WHO guidelines. It was found that the traditional or religious beliefs have been deeply rooted into the minds of the community people and therefore their perception towards the causes of diarrhoeal disease were found traditional rather than real ones such as consumption of contaminated water, poor sanitation, etc. The solar disinfection method was introduced among the local communities for water disinfections.

Conclusion The drinking water in the study area was not suitable for human consumption because of bacteriological contamination. The communities were unaware of the quality of water. Incidence of water borne diseases was often a health problem among the sampled households. It was found serious during the dry and rainy seasons. Sanitation around the localities was a basic problem due to open defecation. Therefore, continuous awareness program should be promoted in order to encourage the community to use toilets and water purification methods such as SODIS.

Keywords Water borne disease, Water quality, Rural community, Nepal.

Introduction

Nepal is predominantly a rural country with nearly 85 percent population living in rural area. The literacy rate of the rural population is below 40 percent[1]. Sixty six percent of the rural population has an access to piped water, and others are dependent on locally available water sources such as spring, stream and tube well for drinking and household uses. The per capita water consumption in the rural area is 45 liter as compared to 60 liter in the urban area. Rural people in the hills require much travel time for fetching water from the locally available sources. Drinking water quality is a major issue in rural area of Nepal. Rural people have used the most convenient sources of water in their areas irrespective of quality due to lack of pipe water. Studies carried out elsewhere in the country indicated that about one third of the total death of children below five years

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of age in the rural region of Nepal was due to water borne diseases such as cholera, typhoid, dysentery and gastro-entities[2-5]. Yet the vital connection between water and health is given little emphasis in the government policy measures[4,6-8].

This study investigates the quality of the drinking water used by the communities and their perception towards the quality of the water, water borne disease and sanitation.

Methodology

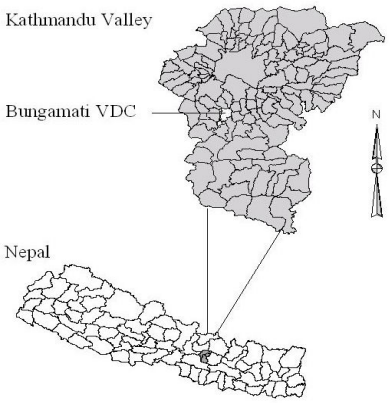
This study has been based on data and information acquired from the field survey carried out in March 2003. Semi structured questionnaire sheets containing both open and close-ended questions regarding water borne diseases and perception of the communities were administered to 110 sample households of Bungamati Village Development Committee (VDC) of Lalitpur district in the Kathmandu Valley, Nepal. In addition, focus group discussion was conducted through participatory approach to gather information of water quality issues and problems. Observation checklist was used to record the environment and sanitation conditions of the water sources, and living area.

Twenty-five water samples, each with one replicate, were collected representing all drinking water sources such as wells, stone spouts, ponds, streams, and public and private taps and analyzed in the laboratory for physical, chemical and bacteriological parameters. The physico-chemical parameters included temperature, pH, Iron, Chlorine, total hardness, Chloride, N-NH_4 (Nitrogen Ammonia), PO_4–P (Phosphate-Phosphorus) and Fluoride and the bacteriological parameters comprised of *E. coli* and coliform bacteria. The analysis of the physico-chemical parameters was done based on the methods of APHA-AWWA-WEF[9]. The Coliform bacteria has been measured in terms of presence and absence of bacteria by Hydrogen Sulphide Paper Strip Method[10] while the *E. coli* has been measured in terms of colony forming unit (cfu) per 100 ml of *E. coli* by membrane filter technique on Chromocult media[9]. For culture of *E. coli*, 100 ml of three consecutive dilutions of each sample water such as 10, 10^{-1}, 10^{-2} for each of the water samples were used, and computed their average, range and standard deviation. SODIS is a Solar Disinfection method, in which ultraviolet radiation from sunlight inactivates the bacteria in the water of the plastic bottle, thus making the water safe for drinking. The results of SODIS at various places indicated that more than 99 percent of faecal bacteria were found to be removed in most cases. Only on fully cloudy days, the removal rate was found to be low[20].

Results

Bungamati VDC consists of three village localities, Bungamati, Chundevi and Phasidol (Figure 1). The VDC extends over an area of 3.8 square km with a density of 1,491 persons per square kilometre and the average household size is 5.1. Agriculture is the main economic base of the rural communities, which is characterized by an integrated farming system of crop and livestock. The water sources used by the communities included stone spout, well, pond, stream and tap. There were 5 wells, locally called *Inar*, 2 stone spouts, 6 public water taps, 5 ponds and 2 rivers in Bungamati VDC. The inhabitants used the water of the wells for washing clothes, bathing and even for drinking. The use of water of these wells has diminished in recent years due to coming up of pipe water system. The water of stone spouts is used for drinking, cooking and bathing. The pond water is used for ritual and religious purposes and washing clothes. The water of two rivers, the Bagmati and the Nakhu is used for washing clothes and bathing during the dry season when there is inadequate pipe water supply. Bungamati locality has 6 public water taps and its 74 households have also water pipe connections in their houses.

Figure 1



The result of the physical and chemical parameters *viz.* temperature, pH, Iron, Chlorine, total hardness, chloride, N-NH_4, PO_4–P and Fluoride of the water samples is shown in table 1 and found lying within WHO guidelines. But the values of the bacteriological parameters, such as *Coliform bacteria* and *E. coli*, which are indicators of faecal contamination and measured in terms of presence and absence of bacteria by Hydrogen Sulphide Paper Strip Method (H_2S Method) and colony forming unit (cfu) per 100 ml of *E. coli* by membrane filter technique on Chromocult have

shown above the WHO guidelines. Particularly in case of some sample source like taps, the coliform bacteria was absent (negative) at source point but was present (positive) at consumption point. In other cases, although a great variation in number of *E. coli* bacteria have occurred, the water of all sources found to be not potable in terms of the presence of indicator bacteria (Table 1). Chlorination is one of the popular methods for water disinfection in developing countries. In our water supply system its effectiveness has been measured in terms of the concentration of free residual Chlorine (FRC) present in the distribution system. In the present study, FRC could not be detected in the water samples of both public and private taps.

Table 1: Analysis of drinking water quality

Parameter	Water source				WHO values
	PVT TW n = 14	PB TW n = 6	Well n = 3	S. Spout n = 2	
pH	6.5-8.2	6.5-7.5	7.5	7.5	6.5-8.5
Temp (°C)	13-18	12-15	15-18	15-18	25
Iron (mg/l)	ND-0.3	0.3	0.3	0.3	0.3 - 3
Chlorine (mg/l)	ND	ND	ND	ND	0.2
Chloride (mg/l)	10-30	22-45	26-27	23-45	250
$N\text{-}NH_4$ (mg/l)	ND-0.2	0.2	0.2	0.2	0.04-0.4
$PO_4 - P$ (mg/l)	0.1	0.1	0.1	0.1	0.4-5.0
Coliform bacteria (WS)	+/-	+	+	+	-
Coliform bacteria (CW)	+				-
E. coli cfu/100 ml	10-131	3-20	48-200	58	0

Note: PVT TW = Private Tube Well, PB TW = Public Tube Well, S = Stone

The observation is that the factors responsible for contaminating drinking water at source points included the lack of protection and proper treatment of water, leakage in pipe distribution system, intermittent supply of water, poor drainage system and poor environment surroundings of water sources. The contamination at consumption point within house was due to lack of proper cleaning of water containers, personal habit, and lack of awareness of cleanliness. However, distance was not a factor of water contamination in the study region, as in other hill areas of Nepal where people normally have to travel longer distance for fetching water. All water sources lie within 200 meter, which is relatively easy proximity from the village localities. Incidence of water borne diseases including diarrhoea was one of the basic health problems in the study area. As the perception of the local communities towards water borne diseases analyzed in terms of relative proportion method, it was found that eating more food, eating stale food and eating in restaurant were important causes of diarrhoea (Table 2). Other causes included dirty surrounding, religious belief, polluted air and contaminated water. The traditional belief or religious reason found to be deeply rooted into the minds of the local people, which have made them belief in traditional causes of diarrhoeal disease.

Table 2: Communities' perception toward diarrhoeal disease

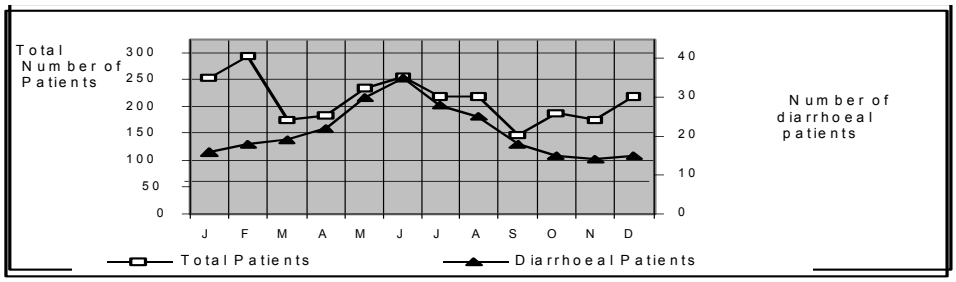
Reasons of diarrhoea disease	Illiterate (n = 46)	Literate (n = 24)	1-5 grade (n = 16)	6-10 grade (n = 24)	OF	MPF	CI (%)
Eating more food	73.9	62.5	87.5	83.3	83	110	75.5
Eating stale food	71.7	62.5	62.5	58.3	72	110	65.5
Eating in restaurant	56.5	62.5	87.5	62.5	70	110	63.6
Dirty surrounding	32.6	45.8	75.0	54.2	51	110	46.4
Religious belief	37.0	66.7	50.0	41.7	51	110	46.4
Polluted air	23.9	62.5	62.5	58.3	50	110	45.5
Contaminated water	10.9	33.3	68.8	54.2	37	110	33.6
Observed Frequency	141	95	79	99	414	770	53.8
Sample size (n)	46	24	16	24	110		
MP Frequency	322	168	112	168	770		
Cumulative Index	43.8	56.5	70.5	58.9	53.8		

Note: OF = Observed Frequency; MPF = Maximum Possible Frequency, CI = Cumulative Index.

Cleaning of the water sources by the local communities found to have done once a year. Eighty-eight sample households fell into this category. The practice of regular annual cleaning of the public water sources

found to be related to the religious functions or occasions, such as *Sithi nakha* of the Newar communities. The pattern of incidence of water borne diseases was varied remarkably during different months of a year. On the whole, there was a higher incidence of patients' visited during the month of rainy season. The diarrhoea disease patient's visit has also followed the same type of seasonal trend (Figure 2).

Figure 2



Bungamati's settlement localities were prone to different water borne and other diseases (Table 3). Skin disease was the most common disease in Bungamati VDC. Nearly one-fourth of the total patients were found to be affected by this disease. The second most important disease was found to be related to acute respiratory infection (ARI). The incidence of diarrhoeal disease, which was directly related to the consumption of contaminated water, occupied the third position among the total patients visit of the health post. Some other diseases belonged to top ten listed in the table were also indirectly related to water quality and quantity. The health post data as shown in table 3, the incidence of skin disease was found at the top. The incidence of diarrhoea was found to be highest and accounted 57 percent of the sampled households. The table 4 shows the multiple responses of the respondents about their perception of skin disease. The main emphasis has been given to the religious reason. Analysing the various responses given by the respondents as shown in table 4, it seemed that they were unaware with the real cause of skin problem.

Table 3: List of top ten diseases based on patient visit record, Bungamati VDC

Type of disease	Rank	Patients	
		Number	Per cent
Skin disease	I	624	24.4
ARI	II	336	13.2
Diarrhoeal disease	III	199	7.8
Intestine worms	IV	188	7.4
Gastritis	V	177	6.9
Toothache and other mouth complains	VI	132	5.2
Others	VII	80	3.1
Avitaminoses and other nutrition deficiency	VIII	75	2.9
Ear Infection	IX	67	2.6
Eye sore and complain	X	59	2.31
Total		1937	75.8

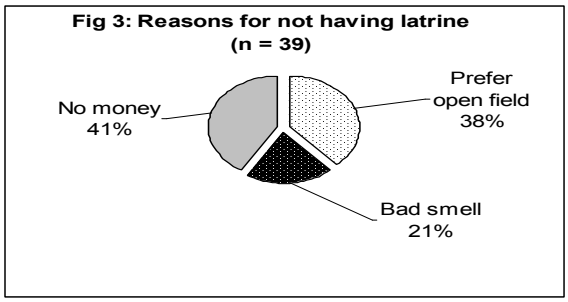
Source: Bungamati health post record 2002/2003.

Table 4: Communities' perception toward skin disease

Reasons of skin disease	% frequency by Locality			Total		
	Bungamati (n = 72)	Chundevi (n = 23)	Phasidol (n = 15)	OF	MPF	CI (%)
Religious belief (snake god)	55.6	87	93.3	74	110	67.3
Bathing by dirty water	55.6	60.9	40	60	110	54.5
Not regular bathing	41.7	43.5	86.7	53	110	48.2
Dirty surrounding	34.7	60.9	66.7	49	110	44.5
Playing in dust and dirt	27.8	65.2	80	47	110	42.7
Swimming in river	41.7	34.8	53.3	46	110	41.8
Not frequent changing clothes	13.9	78.3	-	28	110	25.5
Others Working in field in water	13.9	21.7	46.7	22	110	20
Drinking contaminated water	13.9	17.4	-	14	110	12.7
Bathing by well water	6.9	-	-	5	110	4.5
Observed Frequency (OF)	220	108	70	398		
Sample size (n)	72	23	15	110		-
Maximum possible frequency (MPF)	720	230	150	1100	1100	36.2
Cumulative index (CI)	30.6	47.0	46.7	36.2		-

Environmental sanitation is essential to promote health and prevent diseases. It is described in terms of personal hygiene, toilet facilities and surrounding environment. In the study area, 71 sample households (65%) had an access to latrine facilities such as pit and water seal. The sanitation maintenance of toilets could be related to the supply of water, housing density and space, practice, etc. The condition of toilets was not hygienic due to shortage of water. The members of the households without toilet were used to go to nearby open field for defecation.

The local communities' awareness toward sanitation was analyzed in terms of their practices. The reasons for not having toilets included preferred open field, bad smell of toilet and lack of money (Figure 3).



The first two reasons could be related to lack of awareness, whereas the last one to poverty. Nearby open field and riverbank were two major places used by the communities for defecation. Information was also sought on hand washing practices after defecation. There were four different hand-washing practices such as soap, ash, water and soil (Figure 4). It is encouraging to note that majority of the households (35%) used soap after defecation. Using ash after defecation was in second position, which is also encouraging.

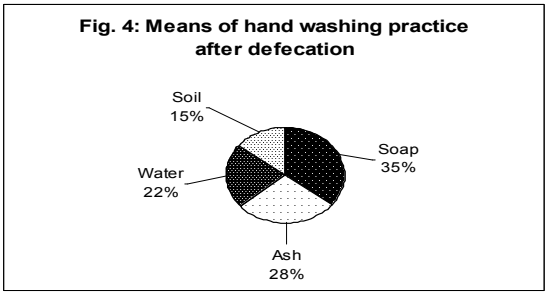


Table 5 indicated that the practice of using various means of washing varies with the localities. Bungamati locality has its major streets being paved with bricks and there were garbage collection baskets along major streets with the initiation of local effort. Being agricultural villages, collection and management of waste disposals were indeed not a serious problem, as the organic wastes have been used as manure in the farm fields.

Table 5: Means of hand washing practice after defecation

Means	Bungamati		Chundevi		Phasidol	
	No	%	No	%	No	%
Soap	36	50	2	8.7	1	6.7
Ash	12	16.7	16	69.6	3	20.0
Water	14	19.4	4	17.4	6	40.0
Soil	10	13.9	1	4.3	5	33.3
Total	72	100	23	100	15	100

Table 6 showed that 94 out of 110 households have used manure pit for the disposal of their wastes. The rest households used containers (particularly in Bungamati locality) and nearby open places for the wastes. There was no significant relationship between the households with different landholding sized and practice of waster disposal ($p<0.05$).

Table 6: Places of wastes disposed by the household

Agriculture land (Ropani)	Waste disposal				Total	
	Manure pit		Other*			
	No.	%	No.	%	No.	%
< 5	42	87.5	6	12.5	48	43.6
5 - 10	29	93.5	2	6.5	31	28.2
> 10	23	74.2	8	25.8	31	28.2
Total	94	85.5	16	14.5	110	100

*Common place, near house and common container

The personal hygiene was explained in terms of frequency of bathing and washing cloths. It was noted above that not all local communities had potable water and private connection to pipe water. As majority of the households have to depend on the common sources for water, which were in few locations and the water supply from them was not sufficient all the year round, nearly 79 percent and 93 percent of the households found to have been practiced bathing and washing cloths once a week respectively. This meant the personal hygiene in terms of bathing and washing cloths was poor, which could be related to skin disease.

The findings of the study have been shared with the local communities in several small groups through meeting in order to make them aware about the quality of the drinking water they have used. Similarly sanitation condition of the surroundings has been shared in an interactive manner. Meanwhile, water disinfection

method such as solar disinfection (SODIS)[11,12,20] has also been demonstrated to the communities.

Discussion

Diarrhoeal disease occupied the second place among the top ten diseases in Nepal. This disease was directly related to the quality of water. However, it varied according to seasons. The patients of diarrhoeal disease visiting the hospitals were increasing every year. The patients' visits were recorded higher during the pre monsoon and rainy seasons than in the winter season[4,6,8,13]. This seasonal pattern of diarrhoeal disease remained unchanged since the last several years. Though the drinking water coverage was increasing every year, the quality of water supply was not safe mainly because of the bacteriological i.e. faecal coliform contamination. The situation was not improved since several years back[1,14,15]. The number of contaminated water samples was found higher during pre and rainy season than during the winter season[4,6,16]. Chlorination was one of the popular methods for water disinfection in developing countries but in Nepal its use in the drinking water was found fluctuated in its concentration[15,17,18]. In the present study the water analysis of free residual chlorine (FRC) was not detected in the water samples of both public and private taps which clearly indicated that the process of water disinfection was not reliable.

The factors responsible for contaminating drinking water at source points in Nepal included the lack of protection and proper treatment of water, leakage in pipe distribution system, intermittent supply of water, poor drainage system and poor environment surroundings of water sources[14,6,16]. Although there were numerous projects or activities related to diarrhoeal disease control program on the part of government, these attempts have remained to be ineffective. Because still majority of the rural communities in the study area were found to have a belief in traditional religious reason for the incidence of diarrhoeal disease[5,12].

The transmission of communicable disease was directly related to sanitary status of the place, as well as to the perception and behavior of the people. Different curative and preventive measures like regular de-worming; health education, toilet use etc. were being applied to control the disease integrating with other health package program, such as integrated family planning and parasite control project, school health program etc.[8]. The infective cyst or larva of the worm could survive for more than a year in the soil[18]. The worm infestation rate was remained at about 60 percent, which was very high[6]. Children in rural areas were more vulnerable, as open defecation system was widespread and there was poor personal hygiene such as poor hand washing practice among the rural children. The proper hand washing practice played a significant role to minimize water-related diseases[12]. The findings of the study showed that it varied with the type of localities and ethnic group.

On the whole, majority of the households in the country, i.e. 57.7 percent had no toilets and therefore they had to use open spaces including public places, roadside, riverbank, field etc. for defecation[1]. Although the number of toilets was increased, the number was not adequate. Hence, the open defecation was still a serious problem that could directly affect in the quality of water and sanitation in the country[6]. Some of the reasons responded by the households in the present study area regarding open defecation included lack of awareness, no habit of using toilet, foul smell from the toilet, lack of adequate water, limited space in house, un-affordability of the people and so on[19].

Conclusion

Incidence of diarrhoea appeared to be the most acute problem in rural region of Nepal. It was found more acute during the dry and rainy seasons. Yet, majorities of the households were not aware with the causes of water contamination. Inadequate supply and poor quality of drinking water were found to be major causes of poor personal hygiene and environmental sanitation. Open defecation at nearby field or on the riverbank was the only option available for the households with no toilets. The reasons for not having toilets included bad smell of toilet, lack of money, etc. Over one-third of the sample households had used hand-washing practice by water and soil after defecation, which might be a major cause of water borne diseases. Lack of awareness and poverty were considered for poor environmental sanitation and personal hygiene. Awareness program to the local communities particularly among the children was warranted for improving environmental sanitation and personal hygiene. Regular monitoring of water quality; increased use of toilet through making available affordable schemes to the poor, SODIS for water disinfection were also essentials for improving the health and sanitation conditions of the rural people in Nepal.

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