

Drinking water and diarrheal characteristic cases in Darbandikhan city

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Abstract: *water pollution in Iraq has been extended disaster edge; this pollution is caused by wastes and sewages into soil and rivers, pollutant water sources influence the outbreak and serious epidemic status among the population.. The aim of this study is to determine the bacteriological quality of drinking water sources and characteristics of water-borne diseases especially diarrheal cases in Darbandikhan city. 166 water samples, collected from the different sources and areas, were tested for the presences of coliform bacteria as an indicator for pathogen contamination. Most probable number index was used for coliform enumeration. 161 diarrheal cases were taken as a sample from the patients were admitted to the general hospital in Darbandikhan district.. The questionnaire form was planned to view characteristics of diarrheal cases and patients were interviewed directly, the data was analyzed by STATA software application. 46% of the diarrheal cases used tap water for drinking. On the other hand, the reminder (54%) used other sources for the same purpose. All the risk factor such as type of water source, sufficiency of the water, duration of water storage and chlorination were associated with diarrhea. Almost half of the cases were children and three quarters were single. The data was analyzed by STATA version 13.1. This study indicated that the majority of drinking water sources in Darbandikhan city are not suitable for drinking, although net pipe system supplied chlorine significantly it has been proven that the tap water from the homes is not suitable for consumption.*

Keywords: Diarrhoeal cases, Drinking water, water sources, water pollution, Darbandikhan Lake.

1. INTRODUCTION

World health organization (WHO) and The United Nations Children's Fund (UNICEF) have recorded that 11% of the population in the world do not have access to safe water [1]. Contamination of natural water sources by pathogens is a worldwide public health problem, leading to waterborne outbreaks of gastroenteritis[1]. Still inadequate water supply and microbial contamination is a primary concern of developing countries[2]. Furthermore, the presence of heavy metals such as lead, cadmium, chromium, mercury, and arsenic in drinking water sources ;in most of the continents with different proportion; above normal ranges will have a detrimental effect on human health[3] [4]. Despite that few studies have been conducted for chemical contamination in developing countries due to high costs, lack of statics or other difficulties and challenges the study might have faced[5]. Water pollution in the north of Iraq has many reasons such as environmental pollution, human wastes, and external threats, the rivers are internally polluted by industrial waste [6] in addition, there are other challenges caused by neighborhood countries; Iran and Turkey for polluting and reducing water flow from their sources[7].

Darbandikhan damp accumulates water from two main sources, Sirwan River flows in from Iran alongside Halabja city and Tanjero from Sulaimani city, both sources have been affected by human wastes in past decades, the basis of tap water is Darbandikhan Lake. the

source of the darbandixan lake have been contaminated by heavy metals[8].

In Darbandikhan, the tap water supplies from the lake are not consumed by most residents directly for drinking because the colour, taste and odour of water changed and it not appear to be especially in summer. However, there are not many articles found about water pollution by heavy metals on Darbandikhan lake but, According to the study elevated bioaccumulation of heavy metals for water samples and fish muscles were observed especially in summer season, it was proved that the water of the lake, used for drinking by the citizens in the past, was contaminated [9]. Thus, the majority of citizens use commercial filter for tap water filtration. the tap water supplies by water pipe nets delivered to residents are not purified or filtered. Therefore, many of the residents of the city are using other sources for drinking water such as springs and wells water. But many residents could not reach the other sources Assessment of these other sources is a necessary task to be accomplished, yet there is no study related to other sources excluding tap water for drinking purpose. Furthermore, it is crucial to know to what extent the currently used water is safe. Water pollution in Kurdistan Regional Government (KRG) is taken into consideration by some researchers either biological or chemical pollution[5].

The aim of this study is to identify the characteristics of diarrheal patients who were admitted to hospitals and their relations with water sources. [10].

2. METHODOLOGY

2.1 Data collection:

The data was two parts: one is water samples collected by multi tube tests for water quality in various sources. The second part is questionnaire form established to identify the relation of diarrhoeal cases with drinking water consumption. 161 cases for both genders were taken in July and August relying on the bio-statistical unit at Darbandikhan Director of Health which says most cases of diarrhoea were registered in the summer season in the five previous years. The sample size was calculated by Epi info version 6.1 was used for calculation of the sample size .The convenience sampling was used for sampling.

All of the cases had an interview to demonstrate kind of drinking water they consumed. On the other hand, the water samples were collected by researcher staffs to determine the quality of drinking water from different sources such as storage reservoir, tap water, well, bottle, spring, domestic water tank and domestic filter.

2.2 Study population:

All 161 diarrhoeal cases were taken in Shaheed Tofiq Bag Hospital (STBH) during July and August. Each of the cases admitted to the hospital differed in their period of stay, the questionnaire forms were filled by researchers and registration files for the cases were taken to complete medical necessary information. the patient's views regarding water sources. The study staffs attempted to take all cases

who had admitted to STBH. During the period of this research which was approximately two months, this study excluded all cases that had not admitted to STBH or visited private centres for treatment.

Ethically, the study was granted permission from Darbandikhan health director and all cases had the right to be contributed or rejected. Those cases which had disallowed participation for the study did not use medical records as well; fortunately, most cases decided to involve in the research.

2.3 Drinking water tests:

Darbandikhan is divided into fourteen zones. From all regions, 166 water samples were collected to investigate the quality of bacteriological water throughout the city for various drinking water sources. Samples were tested by professional laboratory staff from the Preventive Health Center of the Directorate of Health in Darbandikhan by using multiple tube tests. Samples were collected for two weeks and tested within one hour of collection. *Escherichia coli* (E. coli), hermotolerant (or faecal) coliform and total coliform bacteria were used as indicators of faecal contamination in drinking water. Total coliform count in the water samples were analyzed by using standard protocol of multiple tubes technique of the most probable number (MPN) test.

2.4 Data analysis

Statistical analysis was performed using STATA version 13.1. General characteristics of the patients were presented in terms of frequency and percentage. The chi-square test was used to examine the relationship between diarrhoea and water related covariates. A p value of ≤ 0.05 was considered statistically significant.

3. RESULTS

3.1. Bacteriological quality of different drinking water sources in Darbandikhan city:

One-third of three main water storage reservoirs not suitable for drinking which was equal to one half of the number of samples. Less than one third of the pipes water to dwellings were safe for human consumption. All the 31 samples that were taken from the different well in depth and places where not supplied with piped water project failed in laboratory and were contaminated with coliform bacteria. On the contrary, All the 14 samples of bottled water in the three various volumes that available in the market were free of harmful pathogen. Unfortunately, the 38 samples which were taken from the spring around the city, and still some people rely on them, were not proper for drinking and bacteriologically polluted. About four fifths and one fifth of taken water from domestic water tank and filter (respectively) were safe successful in the laboratory analysis. Non evidence was found of the presence of *vibrio cholerae*(V.C.) in the all mentioned samples and places.

Regarding the chlorination of the drinking water, only one quarter (41 samples out of the total 166 samples) were at optimum residual chlorine levels which is in the range of 0.2 to 0.5mg/l according to WHO Guideline for drinking-water quality [11]. Almost all chlorinated water came from examples where piped water systems were supplied. While, approximately two third of the drinking water was below the optimal limit (107 samples) and just above one tenth (18 samples) were over the upper limit of normal range. Table (1)

Table 1 Bacteriological aspects of drinking water in Darbandikhan

drinking water sources	No of samples * (Districts)	chlorine			E. Coli		Thermo T. Coliform		T.Coliform		Safe to drink	
		<0.2	0.2-0.5	>0.5	N.G	>2.2	N.G	>2.2	N.G	>2.2	yes	no
Water storage reservoirs	8 (3)	0	6	2	4	4	4	4	4	4	4	4
Tap water	36 (14)	1	23	12	34	2	29	7	22	14	25	11
Well	31 (14)	31	0	0	12	19	9	22	0	31	0	31
Bottle	14 (3)	14	0	0	14	0	14	0	14	0	14	0
Spring	38 (7)	38	0	0	28	10	28	10	0	38	0	38
Domestic water	23 (8)	7	12	4	23	0	23	0	11	12	19	4
Domestic filter	16 (4)	16	0	0	16	0	16	0	3	13	3	13

*each number of sample represents five real samples take for testing

3.2 Water-related characteristics of the cases and their association with diarrhea

The most used water source by diarrhoeal patients was tap water. About one-third of them (32.92%)

had drunk from pipe water. Followed by the water of well which was the second most frequently used source of drinking water (30.42%). Whereas, those who had used more than one source for drinking, including the sources mentioned above or others

consisted of (17.39 %) cases, moreover about one third (33.54%) of the patients added chlorine to water in their homes. Regarding water storage, (90.68%) of the houses that suffered from diarrhoea, stored the water for three days or less before they refilled, reused or changed the water. As a protective measure for diarrhoea (82.61%) of the patients installed domestic filters in their houses. Only, (4.35%) of the patients were not convinced that their water supplies were sufficient enough. Table (2). The association of diarrhea with these potential risk factors is shown in the same table. Most of the risk factors were related to diarrhea with the exception of using domestic filter.

Table 2 Water related characteristics of diarrhoeal cases

	Frequency (%)	χ^2 value	<i>P</i> value
Water sources		13.731	0.017
Tap	53 (32.9)		
Well	48 (29.8)		
Spring	21 (13)		
Tanker	1 (0.6)		
Bottle	10 (6.2)		
Mix	28 (17.4)		
Chlorination		6.851	0.009
Yes	54 (33.5)		
No	107 (66.5)		
Water storage		15.359	0.000
3 days or <	146 (90.7)		
> 3 days	15 (9.3)		
Domestic Filter		1.368	0.242
Used	133 (82.6)		
Not Used	28 (17.4)		
Sufficiency		12.677	0.000
Yes	154 (95.7)		
No	7 (4.3)		
Total	161		

3.2. Demographic characteristics of diarrhoeal cases:

There was not much difference between the genders of admitted patients to the hospital due to diarrhoea. Males were compromised 49% of the cases while the other individuals were females (51%). However, most of the diarrhoeal conditions occurred among children. 77 cases out of the 161 hospitalized patients were children which accounted for (47.83%) of the overall percentage. Then, students were the second occupational category (status) with diarrhoea (18%). Housewives who have the most contact with water admitted to hospital only by (14.29%). The median age of the cases was 10 years (IQR 3 – 25 years). Nearly three fifths (60%) of the illness happened in

the families that were crowded (had more than 5 members). Table (3)

Table 3 Socio-demographical characteristics of the studied group.

	Frequency	Percentage
Gender		
Male	79	49
Female	82	51
Occupation		
Children	77	47.83
Student	29	18.01
Housewife	23	14.29
Others	32	19.87
Marital status		
Single	120	74.53
Married	41	25.47
Age (Median)	10	(3 – 25) *
Family Size		
<5 members	96	59.63
=>5 members	65	40.37
Total	161	

*IQR: Inter Quarter Range

3.3. Medical characteristics of diarrhoeal cases:

Six of the cases (3.73) were outpatient treated which did not need to stay at the hospital. Most of the ill persons stayed one night in the hospital (70.8%). However, those who needed to be admitted to hospital 2 days or 3 days and more were 20.5% and 4.97%, respectively. Regarding travelling to other places a week before getting the disease, 30 cases (18.63%) had travelled. And about one-fifth of the patients (20.5%) ate outside their home where they were prone to get the infection with the disease. Among 156 cases that stayed at hospital none of them had used medications before. Therefore, the side-effect of medication was abandoned as a cause of the infection. Diarrhoea continued in 62 cases (38.5%) more than 2 days, those who had diarrhoea for one day or less were (32.3%) of the study group. In addition, those who had it for 3 days or 4 days and more composed 16.77% and 44.72%, correspondingly. Table (4)

Table 4 Distribution of the medical and some other characteristics of the studied group

	frequency	Percentage
Travel		
Yes	30	18.63
No	131	81.37
Eat outside		
Yes	33	20.50
No	128	79.50
Hospital admission & medication		

Yes	156	96.89
No	5	3.11
How long stayed in hospital		
Admitted at the same day	6	3.73
One day	114	70.80
Two days	33	20.50
≥ 3 days	8	4.97
Duration of diarrhoea / day		
One	52	32.30
Two	62	38.51
Three	27	16.77
≥ 4	20	44.72
Other Signs & symptoms		
Abdominal pain	0	0.00
Fever	0	0.00
Total	161	

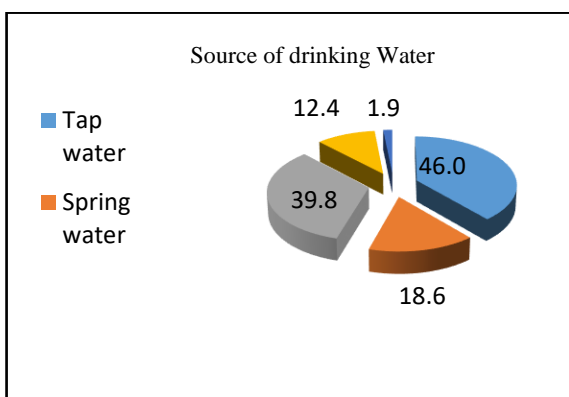


Figure 1: percentage of diarrheal patients according to their usage of water source

It was found that drinking of tap water was the highest prevalence of the disease 46.0%, well water comes in the second highest prevalence of the illness 39.8, while tanker water was the lowest prevalent.

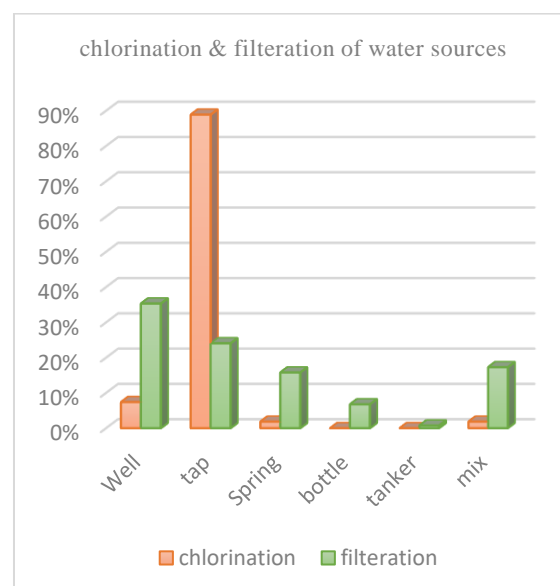


Figure 2: Percentage of chlorination & filtration of water sources

Chlorination and domestic filtration for all sources, the tap water had the highest level of chlorine, but mostly well consumer used filtrations.

4. DISCUSSION

The bacteriological examination of water sources is used globally to evaluate and monitor the quality and safety of various water sources, many potential pathogens might be associated with water consumption, the screening of drinking water samples are essential, in addition, various indicator organisms (bioindicators) used to assess the risk of most diseases, waterborne diseases are related to polluted water sources, some microbial pathogens are highly indicated to water contamination such as *E Coli* and coliform?? [10]. According to WHO guideline for water quality, the water sources do not exist pathogens, it means total coliform bacteria should not exist in 100ml of water samples. The tap water (net distribution system) was poorly treated [1] (see table 1). The study shows that if water sources such as well and springs untreated the water samples unfit for drinking purpose [11]. According to the previous study demonstrated that the various water sources unsuitable for drinking such us spring and well [12]. In this article the well and spring positively contaminated by coliform bacteria (see table 1).

Both genders were chosen randomly in this study and there were no significant differences between male and female, however, the median of age in years was 9.5 and the IQR was 3 to 25, it means cases admitted to the hospital were mostly children[12]. In addition, there were no noticeable differences for both eating outside and traveling out of Darbandikhan (see table 3).

The sources of drinking water had been significantly different for causing diarrhoeal cases, such as patients consuming tap water were at the highest

level (see table 2). As the chlorination of water system from the storage tank and water distribution were not good and leakage might have happened in the net pipe distribution throughout the city, furthermore, in some areas the net of the pipes are too old and the leakage may not appear this could cause mix with sewerage system[13]. The contamination of the storage tanks for the houses upon the rooftops could be another reason for diarrhoea because water distributed 2 to 3 times per week and the families are obliged to store it for more than three days[14].

The second cause of diarrhoea was well water; alternatively, there are many families who are obliged to bring water from springs near and around the city (see table 2). The underground and surface water are not safe too because there is evidence of underground and surface water being contaminated by chemicals and biological substances[15]. Those families who were obliged to bring water for one or two weeks without using any chlorination, they could save a small amount of water for a long time for drinking and cooking purposes this process leads to diarrhoea because of contamination [16].

Globally Consumption of bottled water has highly increased, therefore bottles are prepared by water factories and these types of water were purified but, consuming this type was low according to the data acquired in this study because of economic status most of the families are not able to buy water for drinking and cooking purposes (see table 2). Other diarrheal cases might have happened due to causes such as food poisoning or mixed usage of bottled water with unhealthy water [14].

Some remote areas of the city which are not provided with water pipe systems water is supplied to them through tankers, the cases which were admitted to the hospital from these districts were very low, because only one or two districts were not supplied water by net pipes so the usage of tanker water is low (see figure 1). There was not any evidence that these tankers added chlorine to their water. Over past decades it was proved that chlorination could potentially be harmful but it is still used as a disinfectant especially in developing countries[15]. Finally, tap water consumers had fewer diarrhoea cases in comparison with all types of other water source consumers because the tap water had the system for chlorination, observed and monitored by water director in Darbandikhan city (see figure 2).

5. CONCLUSION AND RECOMMENDATIONS

In this study, it was demonstrated that causes of diarrhoea significantly differ by consuming different sources of drinking water. Correspondingly majority of the cases consumed tap, well and spring water. Although supported piped water supplied the city and chlorination process is performed regularly, the household drinkg water sources are not safe for consumption.

Other studies could be valuable for investigating physical and chemical characteristics of all water sources used in Darbandikhan and chemical pollution should also be deliberated on by researchers.

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