AN APPRAISAL OF DRINKING WATER SOURCES AND WATERBORNE DISEASES AMONG CHILDREN IN NANKANA SAHIB CITY, PUNJAB

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ABSTRACT: Access to safe potable water supplies is a fundamental human right and essential for a healthy living. The present study was an attempt to assess the association of drinking water sources and resulting waterborne diseases among the children of Nankana Sahib city, Punjab, Pakistan. A total of 440 households from the study area were surveyed during July 2014 to October 2014. The collected data was analyzed by chi-square test to find out the relationship between waterborne diseases and sources of drinking water. The results showed that bore water (62.5 %) and public supply (22.05%) were the main drinking water sources. Diarrhea (40.4%) and Gastroenteritis (23.5%) were the most common diseases. 59.6% and 29.4% waterborne infections were found among those using water and public supply for drinking purpose. The results for chi-square revealed strong association between drinking water sources and waterborne infections. It was concluded that use of boiled water and improved sanitation conditions can reduce the prevalence and incidence of waterborne diseases among children.

INTRODUCTION

Water is the precious gift of nature for mankind and is the source of life on earth. It is the basic human right and an essential part of every living being. Unfortunately, this precious gift is inaccessible in many parts of the world. The growing population, increased water demand, unplanned urbanization and ill planned infrastructure have polluted many of the regional aquifers and contaminated drinking water sources are one of the major dilemma of the modern world. Waterborne diseases have always remained a major cause of morbidity and mortality particularly among the children over the globe.

The global spatial distribution of diseases shows that after Africa, Asia accounts for a large percentage of waterborne diseases (Lucas and Gilles, 2002). Drawing from the observations made by Snow (1894) to that of Swerdlow (1992), it is clear that the environmental factor "water" and the problem of waterborne diseases especially diarrheal diseases are linked up via two different mechanisms that are through the supply of contaminated water and or lack of water for personal hygiene. The un-hygienic practices maintained in everyday life (Willmott *et al.,* 2016) and the poor microbial quality found in the local aquifers can result in the outbreak of several waterborne epidemics (Pirsaheb *et al.,* 2017). Numerous waterborne diseases including diarrhea, dysentery, cholera, typhoid, hepatitis A, enteric fever, and several other infections are lasting health threats to human population particularly children and elderly people (Butt and Iqbal, 2007). About 17 million people globally get affected with typhoid fever and more than 600,000 deaths occur in a year. Likewise, cholera occurs in all age groups and causes 120,000 deaths globally in a year (Park, 2015). Diarrheal diseases share significant contribution in world disease burden because roughly 4 billion cases are reported in each year, out of them 1.9 million deaths occur only among children of ageing less than 5 years (Boschi 2008). Diarrhea is considered the second leading cause of mortality in infants and young children especially in South Asia and Africa (Ehsan *et al.,* 2019, Irfan *et al.,* 2017).

In a developing country like Pakistan, where water has a status of fundamental development issue due to its scarcity (World Bank, 2006). The deteriorated ground water quality is the major cause of waterborne infections among children. A child ageing below five years in Pakistan is expected to suffer from an average of five incidents of diarrhea every year (Biloo and Ahmed, 1997). According to a study Nanakana Sahib has one of the worst ground water qualities within Punjab province as only 36% of drinking water sources were reported to be bacteria free (Anonymous, 2007-08). The city has groundwater as the principal source for drinking purposes and other domestic uses and therefore faces great challenges of regular outbreaks of water related epidemics on regular basis. There is gap in previous literature regarding the pattern of waterborne diseases faced by children within the study area. Therefore, the present study is focused to find the interrelationship

between drinking water sources and resulting water related infections among children of Nankana Sahib.

MATERIALS AND METHODS

Nankana Sahib city is located in the center of the Tehsil Nankana Sahib and geographically located at 31° 42′ 52″ latitude to 73° 22′ 53″ longitude (Fig-1). It has altitude of 194 meters from the sea level. Climatic conditions of the Nankana Sahib city are generally very hot in summers and cold in winters. The absolute temperature in summers ranges between 113° to 122°F, while in winters the minimum temperature remains between 41° to 50°F. It is a city of nearly 110,000 inhabitants and famous for its religious status for Sikh community.

For present research, following five residential localities (Fig-1) were selected as sample sites for the study:

- Canada Colony
- Shad Bagh Colony
- Housing Colony
- Railway road
- Purana Nankana

Data collection and analysis: A structured questionnaire was prepared that was consisted of 30 closed ended questions related to demographic information of the respondents, source of drinking water used at home, common diseases faced by children, etc. The mothers were taken as the target population and only those houses were visited where at least one child aging less than 14 years was found. The houses were selected randomly within the sample sites and 440 questionnaires were filled from mothers by interview method.

The geographical locations of the surveyed houses were taken through GPS device for the purpose of mapping. The questionnaire survey was conducted during July 2014 to October 2014. Afterwards, the collected data was tabulated in Microsoft Excel 2013 and SPPS version 20. For the preparation of maps, the shapefiles of Nankana Sahib city area were taken from the Punjab Municipal Development Fund Company (PMDFC) office Lahore. The shapefiles were imported in ArcGIS 10.1 and a base map was prepared which was further utilized for showing the disease pattern and the distribution of water sources used for drinking within the study area.
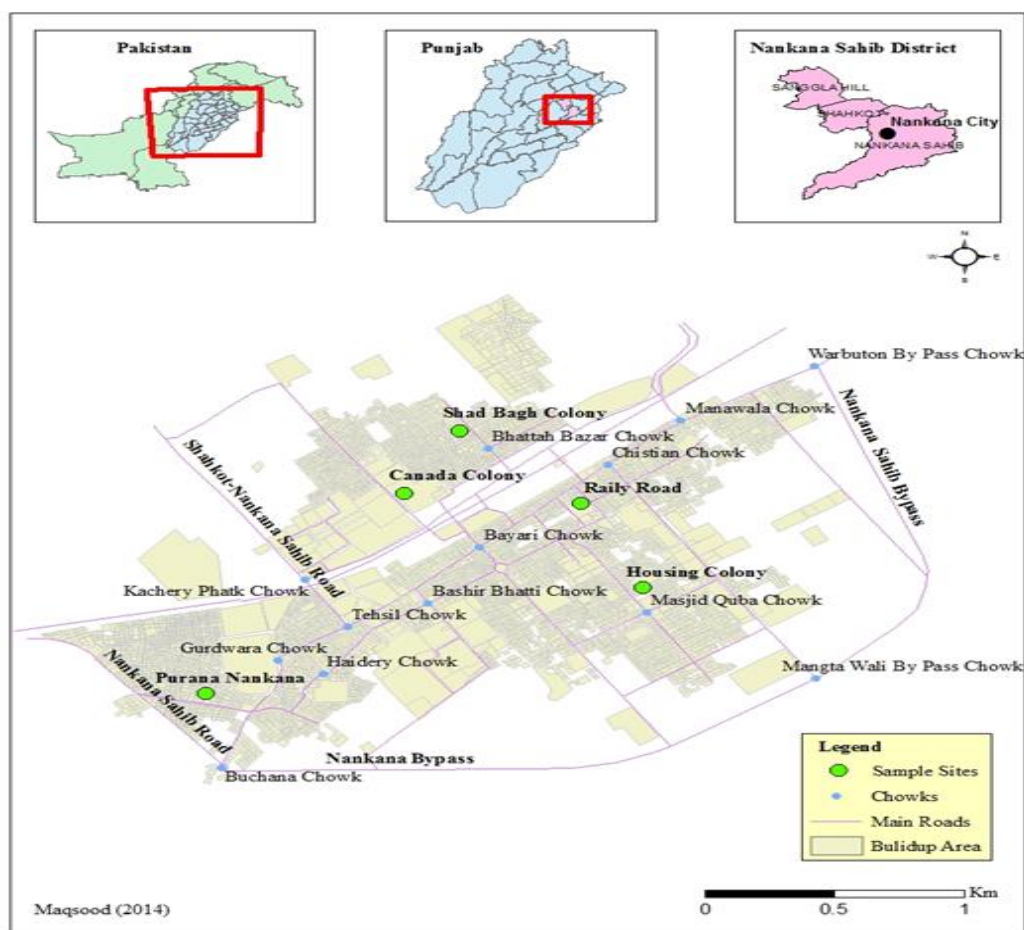

Figure-1. Nanakana Sahab city- The study area

The association between different drinking water sources and waterborne diseases was checked out by the statistical technique of chi square test of independence with the phi and creamer value.

RESULTS

During the survey, it was found that 54% of the mothers aged between 36- 42 years. In terms of educational attainment, 21% mothers were illiterate, 44% mothers were matriculate, 24% were graduate, 8% were master degree holders and less than 1% mothers were M.Phil. degree holders. Only 3.5% mothers were working women serving as teachers, lady health visitors etc. The average family size was found between 6 to 10 persons with monthly income rupees 25,000 to 40,000. The main drinking water sources used at home by the respondents in the study area were bore water, public supply water, Filtration plant, Canal water, Personally Filtered and mineral water (Table-1).

Table-1. Sources of drinking water used at Nankana Sahib City.

Sr. No.	Water source	No.	Percentage
1	Bore water	275	62.50
2	Public Supply water	97	22.05
3	Filtration Plant	23	5.23
4	Canal Water	18	4.09
5	Personally Filtered	15	3.41
6	Mineral Water	12	2.73
	Total	440	100.00

Source: Field survey (2014)

As the table-1 shows, bore water was the most common source of water used by respondents at home for drinking purpose. Moreover 22.05% mothers reported that they used the public supply water for drinking purpose, while 5.23% were bringing drinking water from filtration plants installed by the municipal authority at various points within the study area. However, very few mothers *i.e.* 3.41% reported that they used personally filtered water and only 2.73% mothers were using mineral water for drinking at home (Fig-2).
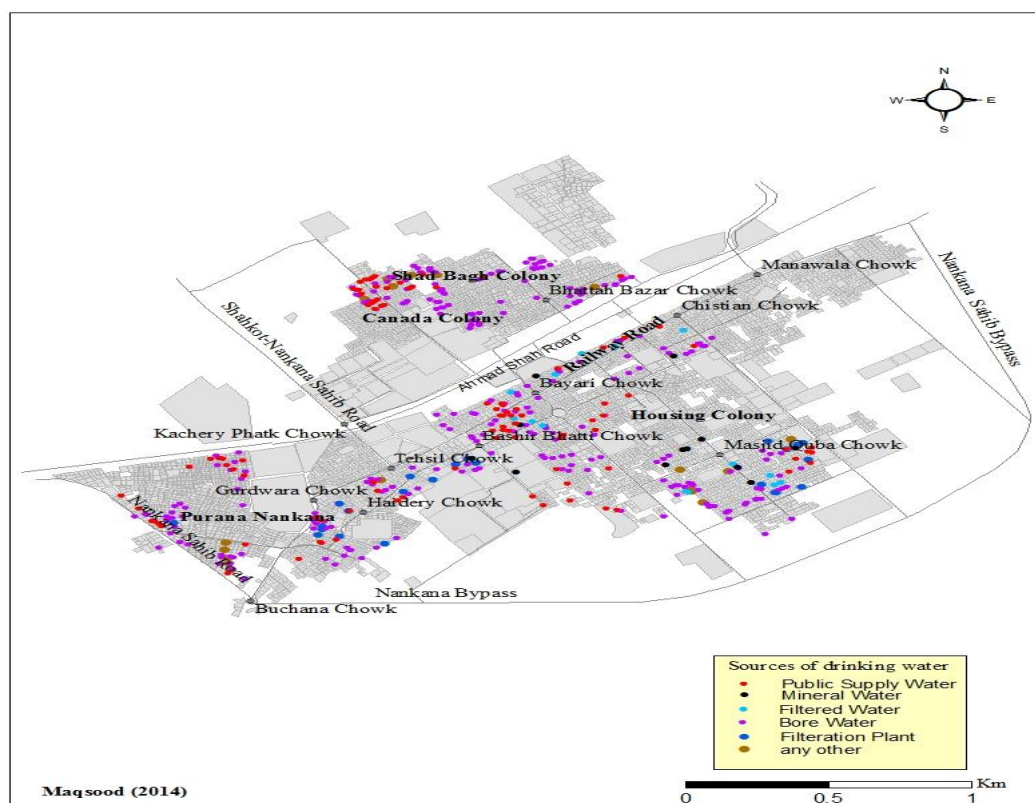

Figure-2. Drinking water sources at Nankana Sahib City

The mothers were also investigated about the various types of waterborne infections faced by their children during the past one year. As per their responses, 06 different types of waterborne infections were reported by mother that were Diarrhea/Dysentery, Gastroenteritis, Enteric fever, Cholera, Hepatitis A and Worm infestation (Table-2).

Table 2. Waterborne diseases among children by drinking source

Sr.	Diseases	Public supply	Mineral water	Personally filtered	Bore water	Filtration plant	Canal water	Total
1	Diarrhea	50	2	3	124	6	8	194
2	Gastroenteritis	35	0	0	70	6	4	114
3	Enteric fever	22	0	2	46	7	4	81
4	Cholera	13	1	2	21	4	0	41
5	Hepatitis-A	13	1	1	16	0	0	31
6	Worm Infestation	8	1	0	9	1	0	19
	Total	141	5	8	286	24	16	480

Source: Field survey (2014)

A total of 480 cases of waterborne diseases were reported by mothers. Diarrhea was found the most common type of infection affecting maximum number of children within the study area with 194 children found to be infected by it. Similarly, gastroenteritis was the second most commonly reported waterborne illness affecting 114 children of Nankana Sahib. Enteric fever had infected 81 children, 31 cases of cholera were reported, while as hepatitis A was found in 31 kids and only 19 cases of worm infestation were mentioned by the mothers. Furthermore, another noticeable thing was that the maximum number of waterborne infections *i.e.* 286 (59.6 %) and 141(29.4%) cases were reported by those mother who used bore water and public supply for drinking purpose at home. Hence, very few diseases were reported by those mothers who used mineral water or personally filtered water, which were only five and eight cases of waterborne infections respectively. Surprisingly, the ratio of infections was found higher among those who fetched water from filtration plants for drinking purpose and so on (Fig-3). A similar pattern was observed among the reported waterborne diseases and sources of drinking water that majority of the infections were mainly caused by using either bore water or public supply water, which clearly tells that the local aquifers of the study area were highly contaminated with fecal pathogens due to leakage of old pipelines of public water supply, and the bore water was coming from less depth underneath the ground and thus that water got infected by bacterial contamination of human feces. In addition to this filtered water was also found unfit due to the expired and old filters installed within the study area.
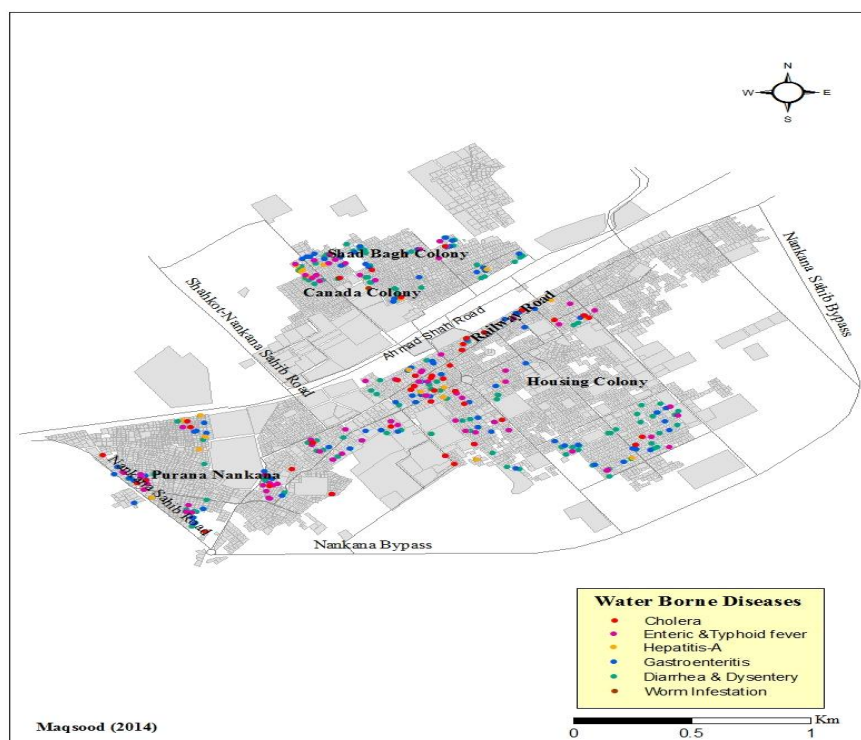

Figure-3. Distribution of waterborne diseases in Nankana Sahib

DISCUSSION

In order to understand the nature of relationship between drinking water sources and waterborne diseases, Chi square test with the phi and creamer value was performed. The obtained results are mentioned in Table-3.

The nature of relationship was determined as if the value of phi and creamer's is 0.00 means no relationship , if value falls 0.00-.15 means very weak, if value falls in 0.15 to 0.20 means weak, if falls in 0.20 to 0.25 means moderate, if value falls in 0.25 to 0.30 means moderately strong. If value falls in between 0.30 to 0.35 means strong, if value falls 0.35 to 0.40 means very strong, if value falls in 0.40 to 0.50 means worrisomely strong. Moreover, if value falls in 0.50 to 0.99 means redundant relationship and if value falls become 1 it means there is a perfect relationship.

Table-3. Association between drinking water sources and waterborne diseases.

Waterborne diseases	Public Supply Water	Mineral Water	Personally Filtered	Bore Water	Filtration plant	Canal Water
Cholera	0.328	0.285	0.360	0.173	0.408	0.00
Enteric fever	0.431	0.00	0.360	0.265	0.541	0.464
Hepatitis-A	0.328	0.285	0.254	0.150	0.00	0.00
Gastroenteritis	0.553	0.360	0.00	0.324	0.501	0.464
Diarrhea	0.673	0.285	0.441	0.485	0.501	0.659
Worm infestation	0.256	0.112	0.00	0.285	0.203	0.00

Source: Field Survey (2014)

According to the test results, cholera showed strong association with filtration plant. Enteric fever showed strong association with filtration plant and public supply water. While as hepatitis A was found strongly associated with public supply water. Gastroenteritis was found most strongly associated with public supply water and filtration plant. Most interestingly, diarrhea had strong association with every drinking water source except mineral water. While as worm infestation was strongly associated with bore water only (Fig-4).
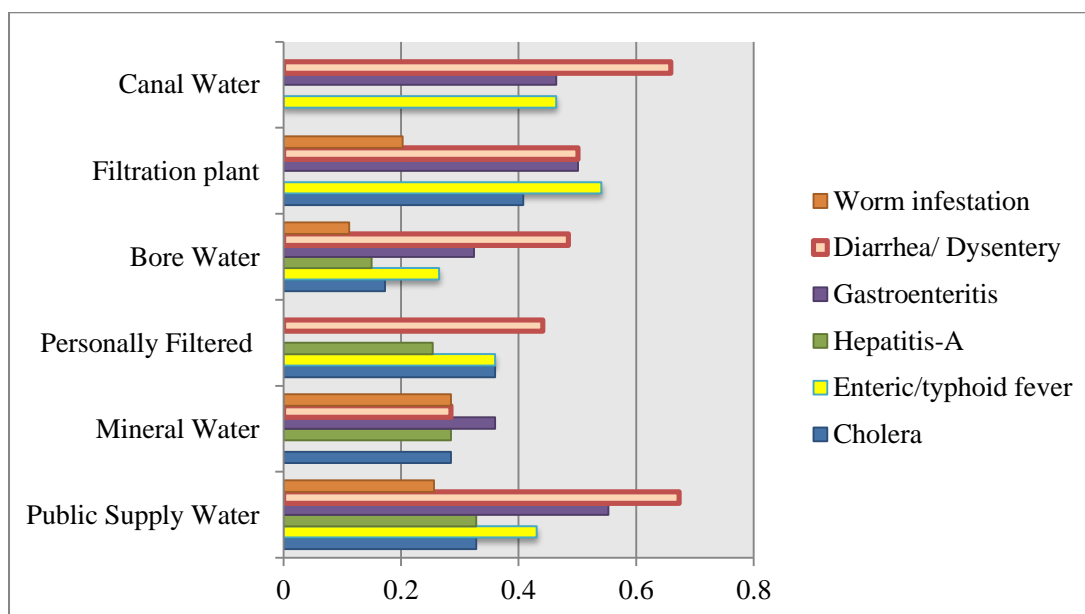

Figure-4. Results by symmetric measures of chi square test

Conclusion: The study concluded that due to poor management and fecal contamination, the local bore water and public supply water were responsible for prevalence of waterborne diseases among the children. Use of boiled water and improved sanitation conditions can reduce the prevalence and incidence of waterborne diseases in NankanaSahib.

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