Bacteriological Assessment of the Potable Water Quality in the Urban Informal Settlement Centers of District Bannu, Khyber Pakhtunkhwa

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Abstract
This research work aims at facilitating access to the safe drinking water for urban communities of informal settlement centers by analyzing the water samples in District Bannu Khyber Pakhtunkhwa - Pakistan. Particular emphasis is placed on the poor urban community where major constrains are already insufficient and unsafe water quality. Safe drinking water and hygienic sanitation are prerequisites for health, but these associations achieved greater importance when large numbers of displaced people from North Waziristan Agency (NWA) seek shelter in overcrowded settlement centers in Bannu where there are no established facilities to encourage hygiene and other barriers to prevent the transmission of disease. In this study, total one hundred water samples were collected from the Tube Wells, Water Storage Tanks, Consumer Taps and Household Utensils. The results revealed that 67% water samples were found unsafe for potable use owing to the bacteriological contamination either at Water Storage Tanks or at Consumer Taps or at Household utensils.
The conclusions drawn from the study are the lack of drinking-water quality monitoring and surveillance programs in the under study area, weak institutional arrangements and the absence of a legal framework for drinking-water quality issues have aggravated the situation. Above all the public awareness of the issue of water quality is dismally low. This research work is focused to highlight the prevailing situation regarding potable water quality.

Keywords
Water quality, Informal settlement centers and Bacteriological contamination

1. Introduction

Globally, an estimated 2,000 children under the age of five die every day from diarrhoeal diseases and of about 1,800 deaths are associated to water, sanitation and hygiene. Almost 90 per cent of child deaths

from diarrhoeal diseases are directly linked to contaminated water, lack of sanitation, or inadequate hygiene. Despite a burgeoning global population, these deaths have come down significantly over the last decade, from 1.2 million per year in 2000 to about 760,000 a year in 2011 (UNICEF, 2013).

The mortality rate for children under five in Pakistan is among the highest in the world, with 101 deaths per 1000 children. Water and sanitation-related diseases are responsible for 60% of the country's disease burden in children under five, and it is estimated that diarrheal disease kills more than 200,000 children under the age of five each year (WHO -UNICEF, 2000).

Inadequate water supply and impact of urbanization in the urban informal settlement centers poses health risks to the consumers because of its poor quality. Faecally-contaminated water is a major contributor to waterborne diseases. According to the community health report, in Pakistan, almost 30% of all the diseases and 40% of deaths are related to the water-borne diseases (Akhter, 1981).

Numerous research studies about water quality contamination have been carried out in different parts of Khyber Pakhtunkhwa province and across the Pakistan. Afed *et al.,* (2013) evaluated the potable water quality characteristics of District Bannu that 85% of potable water samples were found contaminated. Ahmad and Ahmad *et al.,* (2012) carried out research on the potable water quality characteristics of the rural areas of District Hangu and concluded that 63% water samples were contaminated bacteriologically. These studies concluded that most of water in these area were contaminated at household level and were not suitable for potable pupose.

The prime objective of the said research work was to know the bacteriological water quality of the poor urban informal settlement centers where the major constraints are already insufficient and unsafe water quality. Safe drinking water and hygienic sanitation are prerequisites for health, but these associations achieved greater importance when large numbers of displaced people from North Waziristan Agency (NWA) seek shelter in overcrowded settlement centers in Bannu where there are no established facilities to encourage hygiene and other barriers to prevent the transmission of disease.

The water quality test results were compared with the World Health Organization (WHO) standards, in order to ascertain the water cycle i.e., Tube Well, Water Storage Tank, Consumer Tap and Household Utensil quality.

2. Materials and Method

2.1 Sampling Area

Informal settlement centers in district Bannu were selected as a test case for evaluation of water quality parameters of the potable water specifically bacteriological one. These centers were developed haphazardly which mainly consists of private houses and government buildings. Informal settlement centers were Lakki Gate Chowk, Tehsil Bazar, Chai Bazar, Gilani Mosque Area and Mild Park Area. Two Tube Wells, Three Household Connections i.e., Consumer Taps of each tube well, Two Water Storage Tank and Tewelve water samples from household utensils in each informal settlement centers were collected for the assessment of bacteriological parameter of the under study area. As per the WHO guide values, one sample per 5000 individuls should be collected from the distribution network (WHO Guidelines, 2006). Since all these informal settelemnt population varies in the range of 7,000 to 11,000 so for giving an accuarte picture three samples were collected from the Household Connetions in the service area of each tube well for analysis.

2.2 Parameter Tested

Three water quality parameters; two physical and one bacteriological parameters were examined for the collected samples in the under study area. pH and turbidity were the physical parameters that were tested due to the importance in the process of chlorination of the potable water. In this study the bacteriological parameter was faecal coliform bacteria. This parameter indicates the presence and absence possibility of pathogenic bacteria in the potable water.

2.3 Sampling and Analysis

Hundred water samples were collected in 120 ml sterilized sample bags from the water cycle i.e., Tube Wells, Water Storage Tanks, Consumer Taps and Household Utensiles within the study area. The water samples were collected from the major urban informal settlement centers i.e., Lakki Gate Chowk, Tehsil Bazar, Chai bazar, Gilani Mosque Area and Mild Park area in the District Bannu. The sample collection, preservations, transportaation and analysis were conducted according to the standard methods for water quality testing and proper procedure and precautionary measures were followed while collecting samples from the under study area (AWWA, WEF and APHA, 1995). During the collection of water samples sanitary score survey was carried out owing to obseve the general cleanness and sanitation condition in the urban informal settlement centers. Wagtech Kit was used for the determination of pH, Turbidity and Faecal coliform bacteria.

3. Results and Discussion

3.1 pH

All the water samples that were collected from the urban informal settlement centers and were found within WHO standards (6.5-8.5). No health base guide values were propsed by the WHO for the pH of potable water. Higher values of pH, above than 8.5 of the potable water is not suitable for effective chlorination process while lesser values, less than 6.5 augment the corrosion in the water supply network and household plumbing system.

3.2 Turbidity

Turbidity of all the water samples were found to be within WHO limits i.e., Less than 5 Nephelometric Turbidity Units (NTU). Values of the determination of pH and turbidity of all the water samples were evaluted owing to suggest the effective chlorination process.

3.3 Faecal Coliform (F.C)

The test results revealed that 67% water samples were unsafe for potable use owing to the faecal contamination and has been shown in Figure 1. Major water quality faecal contaminations were observed at the Consumer Taps and at Household Utensils.

Table 1: Details of Bacteriological Water Quality Test Results

S.No	Sampling Site	Total samples tested for faecal coliform bacteria	% matching WHO guide value
1	Tube Wells	10	100
2	Water Storage Tanks	10	70
3	Consumers Taps	30	27
4	Household Utensils	50	16

It is evident from the Figure 2 that tube well water samples were found free from faecal contamination. The high degree of faecal contamination was observed at the Household Utensils as only 16% of samples were within WHO limits as shown in Table 1.

In some of the informal settelement urban centers the water supply lines were laid side by side or in the close proximity with main drain without giving any proper prime consideration of adequate safe distance between the two.

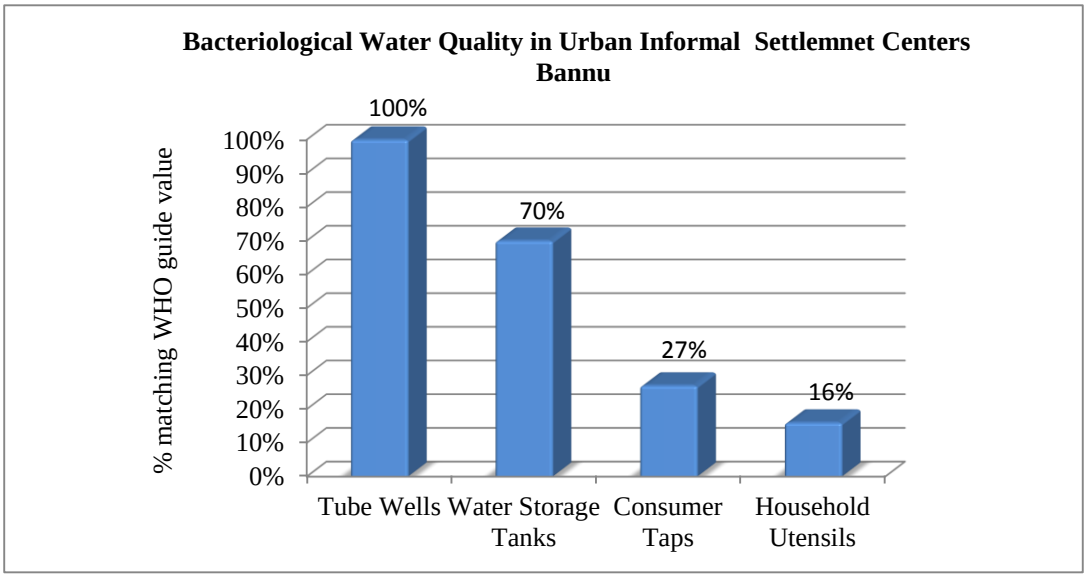

Figure 1: Percentage of Water Samples Results Matching with WHO guide value

The results of sanitary score survey showed that there were no proper storage and handling practices as most of the water containers have no lid cover that may eventually increase the chances of water contamination during handling practices.

Table 2: Summary of Bacteriological Water Samples Test Results

S. No.	Microbial Fit Water Samples	Microbial Unfit Water Samples	Total Samples
1	33	67	100

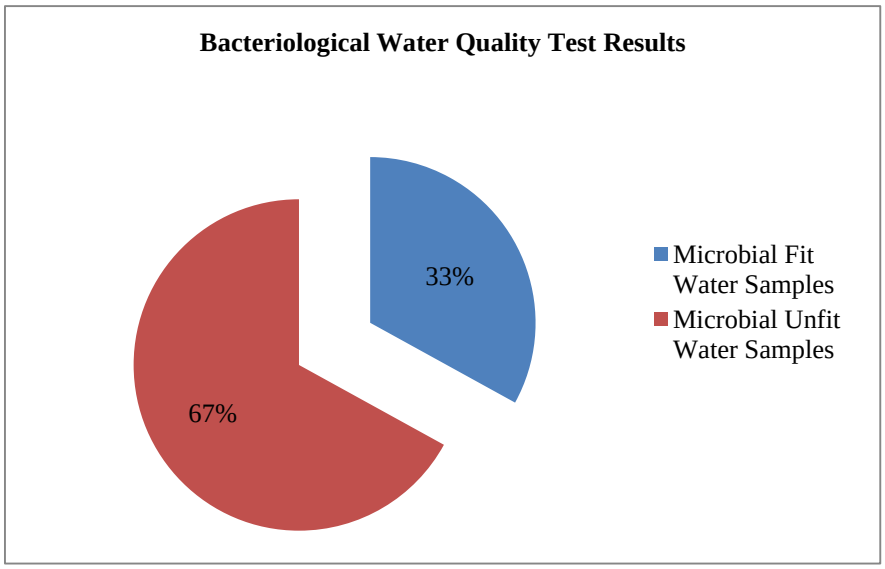

Figure 2: Percentage of Microbial Fit and Unfit Water Samples

It was observed that pounding of rain water owing to the lack of drainage system in certain centers may be the one cause of potable water contamination.

4. Conclusions and Recommendations

1. Bacteriological contamination of 67% water samples collected at the house hold utensils and water taps were found unsafe. Various causes of bacteriological contamination included improper storage and handling practices, lack of drainage system, old rusted water supply pipes, laying of water supply pipes closely to the main drains, lack of drinking-water quality monitoring and surveillance programs in the under study area, weak institutional arrangements and the absence of a legal framework for drinking-water quality issues have aggravated the situation.
2. The physical (pH and Turbidity) and Bacteriological (F.C) parameter of the water samples collected from tube wells were found within the WHO guide values. Therefore, it can be concluded that the tube well water is safe for potable use.
3. The physical parameters of all the collected water samples were within the limits defined by the WHO guidelines.
4. Water supply lines should be laid opposite side of the drains to maintain safe distance between them.
5. Pounding of water in the urban informal centers should be avoided through the storm drainage system.
6. Old and leak pipes should be replaced to avoid bacteriological contamination.
7. Mechanical chlorinator should be installed at the Tube well sources and proper training should be imparted to the tube well operator regarding the maintenance and proper dosage of chlorine disinfection.

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