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Analysis of Microbial Contamination of Drinking Water in Peshawar

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Abstract

Waterborne disease is a major public health problem caused by potentially lethal microorganisms which have serious health implications such as morbidity and death in severe cases. This study aimed to assess the microbiological quality of drinking water in thirteen different urban and rural areas of Peshawar, Pakistan. This cross-sectional study was approved by Khyber medical university Peshawar. A sterile water container was used to collect samples from tap water, distribution network, Tube Wells, and the hand pump by applying standard microbiological techniques. A multiple tube fermentation technique was used to analyze water samples. A total of 100 samples were collected from both urban and rural areas of Peshawar. Of these 22% were not contaminated whereas 78% were contaminated with fecal coliform and E. coli. The Prevalence of coliforms in contaminated water samples (n=78) for total coliforms, fecal coliforms, and E. coli was 34%, 26%, 18% respectively. The range of 2.2-240+/100ml confirmed E. coli count in urban and rural areas were 10% and 12% respectively. The prevalence of potentially deadly pathogens in the study setting indicates poor drinking water quality, which has serious health consequences. Serious attention needs to reduce the occurrence of water-borne diseases in such areas.

Keywords: Coliforms, Diseases, MPN, Waterborne, WASA

Introduction

Bacterial contamination, including Coliform, fecal coliform, and E. coli, is the most prevalent and widespread risk linked with drinking water. Fecal Coliforms are a subtype of total coliform bacteria; they are a group of species rather than a single bacterium. These are like total coliforms which can ferment lactose and produce gas by incubation at 44.5 °C for 24 hours. Typically, these bacteria were utilized as fecal indicators for water contamination. E.Coli belongs to the fecal coliform group and is a more precise indicator of fecal contamination. (Shoaib, Asad *et al.* 2016).

Human health is unfavorably affected by several agents like pathogens, bacteria, various minerals, and organic substances present in contaminated drinking water. A significant amount of the population in underdeveloped countries is suffering from health-related consequences due to unsafe drinking water and microbial contamination (Bacha, Durrani *et al.* 2010). Waterborne diseases frequently emerge due to the contamination of water with fecal matter, especially human feces containing infectious organisms. Consumption of water containing disease-causing microorganisms leads to the cause of many diseases like diarrhea, cholera, Enteric fever, hepatitis A, typhoid, paratyphoid, dermatitis, etc(Khan and Raza).

Waterborne diseases are estimated to affect 560,000 individuals in the United States each year, resulting in around 12000 deaths. According to WHO in their

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report on World in danger of missing Ahmad et al. 1365 sanitation targets have been reported that in both rural and urban regions, more than 1.1 billion people do not have access to clean drinking water, and approximately 2.6 billion do not have basic sanitation. (Ahmad, Shan *et al.* 2021). Another study by (WHO/UNICEF 2019) reported that about 4.2 billion people do not have access to basic sanitation, and 297,000 children under the age of five die due to inadequate hygiene, poor sanitation, and contaminated drinking water.

According to a recent study, 21 million people in Pakistan lack access to safe drinking water (Amin, Zaidi *et al.* 2019). Whereas in Pakistan the Poor water quality is leading to approximately 30% of morbidity and 40% of all mortality and other, waterborne disease such as Diarrhea is the main cause of mortality among infants and children in Pakistan. Every fifth individual suffers from disease and illness as a result of contaminated water. (Daud, Nafees *et al.* 2017).

However, in many urban and rural regions of Peshawar, Pakistan, literature is scarce on the microbiological quality of drinking water. Keeping in mind the potentially harmful effects of water-borne pathogens on human health, therefore this study was conducted to assess the bacteriological quality of drinking water contaminated with harmful bacteria in both urban and rural areas of Peshawar city.

Materials and Methods

Study Design and Duration

A cross-sectional approach was used for the current study and the study was conducted between April and August 2021.

Study Settings

The water samples were collected from urban and rural areas of Peshawar (Table 1) and the microbial analysis was performed at the microbiology section of Rehman Medical Institute Laboratory, Peshawar.

Table 1: Target Population of urban and rural area of Peshawar city

Sr No	Urban Areas	Sr No	Rural Areas
1	Hayatabad	1	Sheikh Mohammadi
2	Board Taj Abad	2	Jagra
3	Arbab road colony	3	Palosi
4	Tehkal	4	Bahadar kaly
5	Warsak road		
6	Sadder		
7	Khyber bazar		
8	Hajji Camp		
9	Gullbaher		

Sample Size

A total of 100 samples were collected by considering the 7% prevalence of waterborne disease with a margin of error of 5% and confidence interval of 95%.

Sample collection

Sterile glass bottles were used for sample collection and simple random sampling (SRS) was utilized for this study. The water sources in rural and urban areas were identified with the help of a local administrative body (water and sanitation

services Peshawar) in Peshawar. Specified code was applied to the data collection tools based on area and source of water. This study was included ten urban and four rural areas of Peshawar which were randomly selected and shown in Table: 1. A total of 100 drinking water samples were collected each sample with a volume of 100 ml was collected in sterile bottles according to WHO guidelines (1997). The sample selection process can be seen in Figure 1.

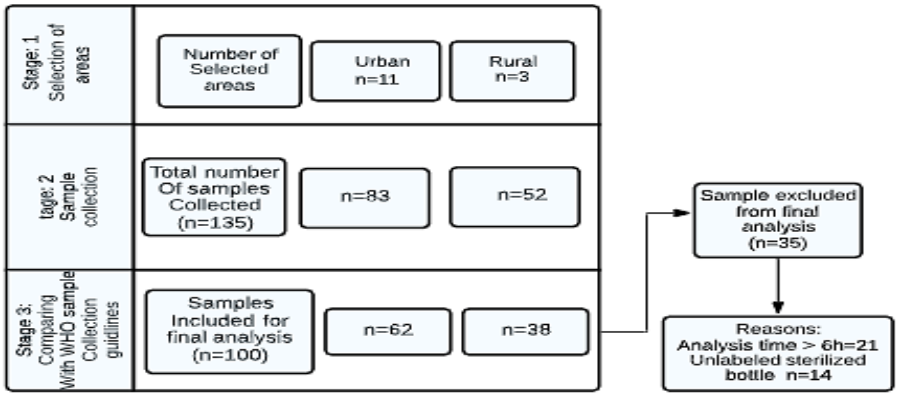

Figure 1: Sample selection process

Sample Preservation and Storage

The maximum storage duration for fecal coliform samples from wastewater is 6 hours, therefore the samples were transported to the laboratory within 2 hours at a temperature of 10°C or less according to Standard Methods for the Examination of Water and Wastewater, 23rd Edition (Baird 2017)

Inclusion Criteria

Only samples that were collected from specified areas and fulfill the data collection guidelines were included in the study for analysis.

Bacterial Tests

The confirmed count of coliforms was performed based on the approved method of the 23rd Edition of "Standard Methods for the Examination of Water and Wastewater" for the multiple tube fermentation (MPN) technique. For the detection of coliforms, MacConkey broth was employed. Fecal Coliforms were confirmed using Brilliant green lactose bile (BGLB) broth, while the completed test was done by using EMB agar whereas E. coli count was confirmed using Tryptone water medium (Baird 2017).

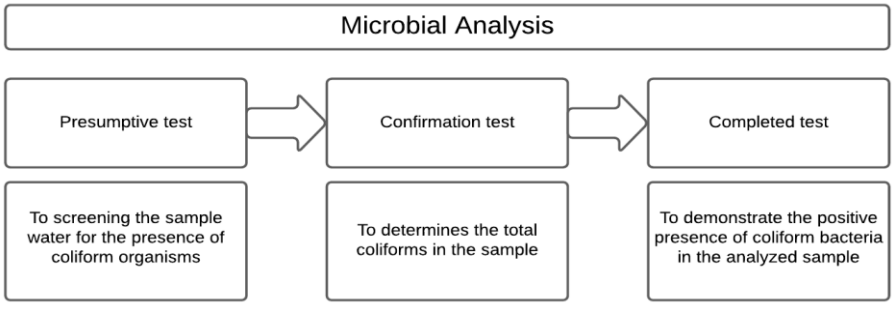

Figure 2: Steps of microbial analysis

MPN Presumptive test MacConkey Broth:

In this step, 3 tubes were taken containing MacConkey Broth for each water sample to be tested. Added 10 mL of water to the first tube containing 10 mL medium by using a sterile pipette. Similarly, added 1 mL of water to the second tube containing 10 mL medium and 0.1 mL water to the third tube containing 10 mL medium and kept the Durham tube in an inverted position in each tube. Incubate all the tubes at 37°C for 24 hrs. If no tubes appear positive re-incubate up to 48 hr (Figure 2).

Confirmatory Test for Fecal Coliform in Brilliant Green Broth

Gently rotate presumptive tubes that produced gas and showed growth and transferred one or more loof puls of culture by a sterile loop to all fermentation tubes containing BGLB broth. Incubated the tubes at 37°C for 24 hours (Figure 2).

Completed Test on Eosin Methylene Blue agar

Although some of the confirmatory test's positive results might be false, hence it is recommended to do completed tests. A loop full of a sample from each positive BGLB tube was streaked onto selective medium Eosin Methylene Blue agar and incubated at 37°C for 24 hours. Fecal coliforms and E.Coli produced green metallic sheen colonies. The overall microbial analysis is shown in figure 2).

Date Analysis

Results were analyzed by using SPSS (version22). Pie charts and Bar graphs were generated by using MS Excel 2007.

Results

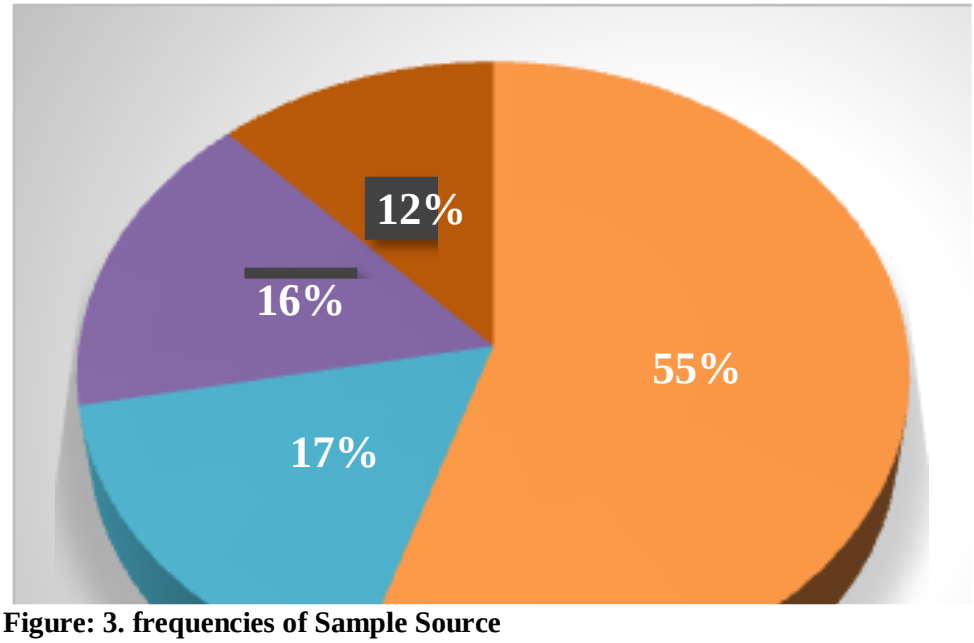

Figure: 3. frequencies of Sample Source

In a study population, samples for microbial analysis were collected from multiple sources. Mostly from Tap water 55%, followed by distribution network 17%, Tube well 16%, and hand pumps 12%. (Fig 3)

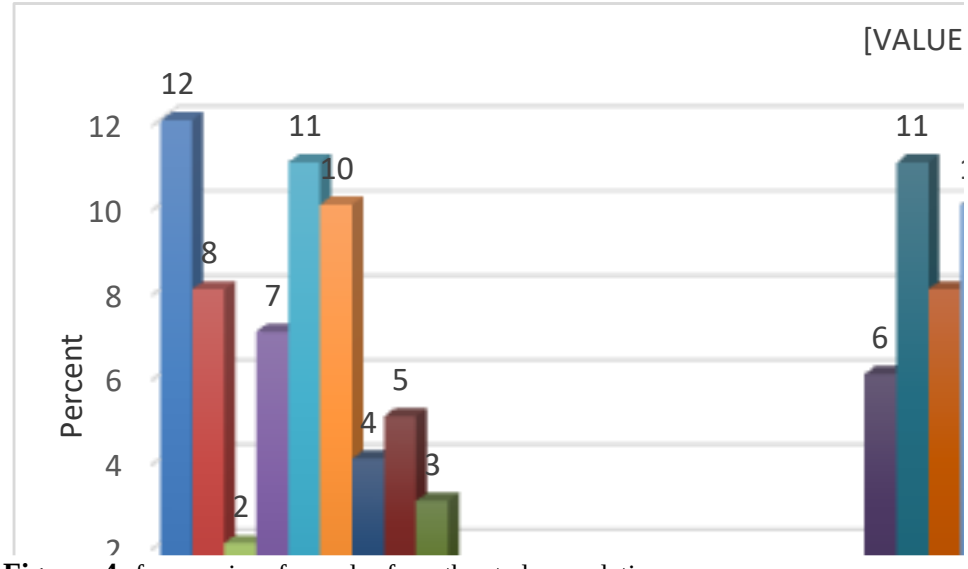

Figure: 4: frequencies of samples from the study population

Fig: 4 showed the frequency of collected samples in a study population from both urban and rural areas. All the collection points were randomly selected. The frequency of collected samples from the urban area were Hayatabad 12%, Board Taj Abad 8%, Arbab Road Colony 2%, Tehkal 7%, Warsak road 11%, Saddar 10%, Khyber Bazar area 4%, Haji Camp area 5%, and Gullbahar 3% whereas rural area was Bahadar kaly 6%, Sheikh Mohammadi 11%, Jagra 8%, and Palosi 10% respectively.

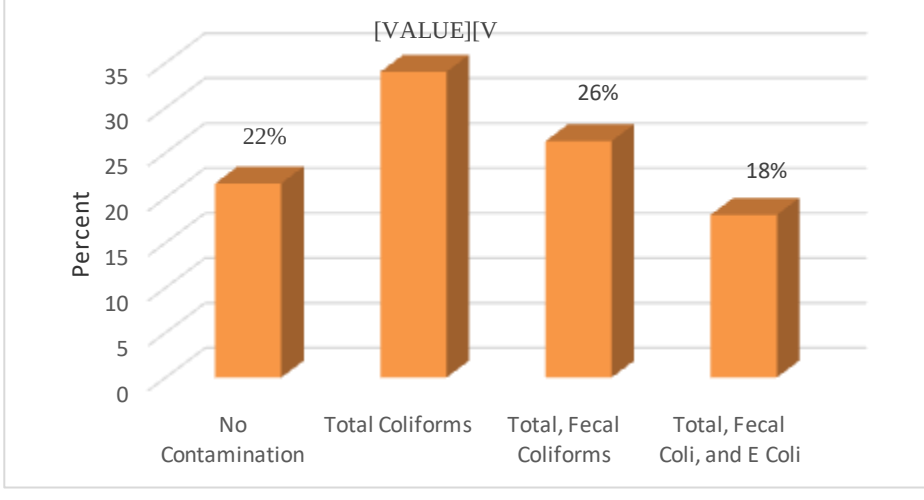

Figure 5: Prevalence of Microorganisms (Coliforms) n=100

Figure 5 shows that 22 percent of the sample size (N=100 were not contaminated, whereas 78 percent were contaminated with fecal materials including various proportions of total coliforms, fecal coliforms, and E. coli. Total coliforms were found in 34% of cases, total coliforms, and fecal coliforms in 26% of cases, whereas total, fecal coliforms and E. Coli in 18% of cases.

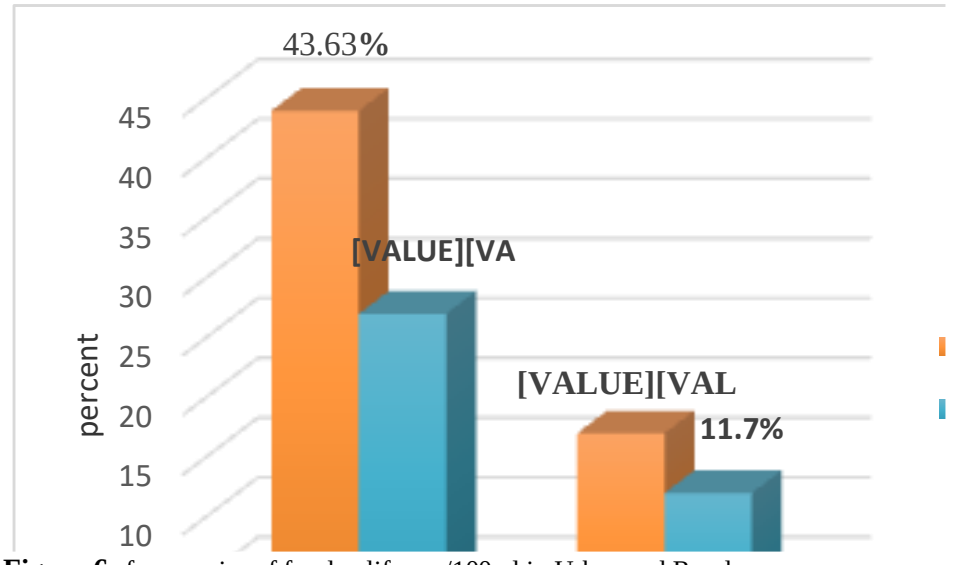

Figure 6: frequencies of fecal coliforms/100ml in Urban and Rural area

Figure 6 clearly showed that maximum ranges of confirmed fecal coliforms count were determined in urban areas. Confirmed fecal coliforms count ranges from 2.2-240+/100ml (MPN/100) in both urban and rural areas were calculated 27.1%, and 11.7% respectively.

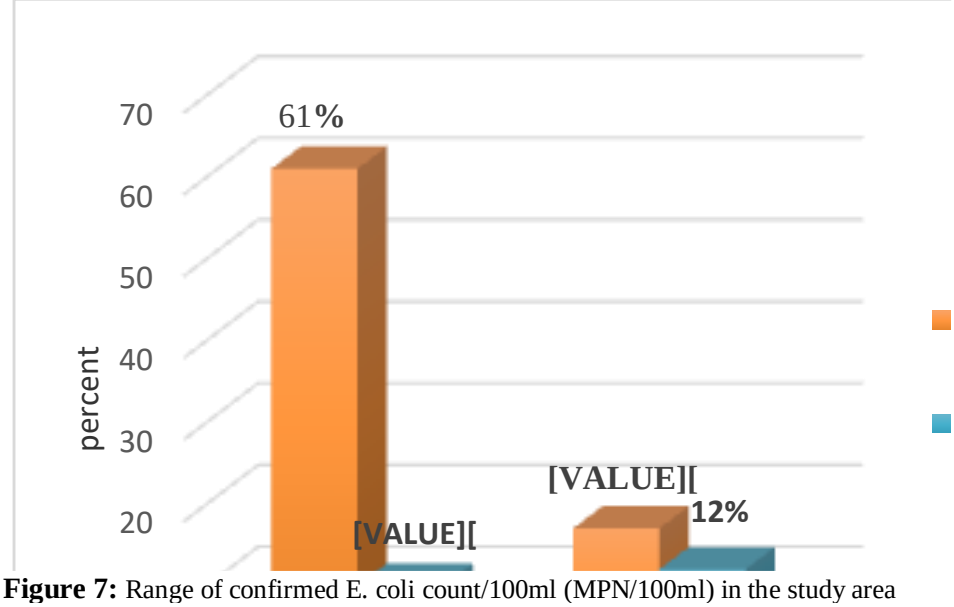

Figure 7: Range of confirmed E. coli count/100ml (MPN/100ml) in the study area

Maximum ranges of confirmed E. coli count were determined in rural areas, as sh own in Figure 7 Confirmed E. coli count ranges from 2.2-240+/100ml (MPN/100) in urban and rural areas were calculated 10%, 12% respectively.

Discussion

Pathogenic microorganisms have posed a significant public health threat. Drinking of unsafe water is the leading cause of waterborne diseases. The

microbiological quality of drinking is determined by water quality guidelines. Or standards of the Department of Water Affairs and Forestry (DWAF, 1996). The current study's findings revealed that the water source examined was of inadequate microbiological purity, based on such drinking water quality guidelines.

In comparison to chemical contaminants, poor microbiological quality of water has negative health consequences on single consumption, as it can cause serious health problems such as diarrhea.(Nabeela, Azizullah *et al.* 2014)

Our study revealed that 22% of the water samples were satisfactory for human consumption, whereas the remaining samples had microbial contamination and were unsafe to drink. These findings indicated that 20-25 percent of the population has access to safe drinking water, as WASA and CDA supplies are the primary sources of water supply.

Similar findings were found in a previous study, indicating that drinking water quality is poor. Shoaib et al. conducted another study in Rawalpindi and Islamabad, Pakistan, and observed a significant frequency of water-borne pathogens, with a percentage of 37.2 %, As Lahore is also an industrialized and densely populated location which creates an ideal environment rapidly spread of water-borne pathogens like E. coli [8]. A study carried out by Shoaib et al. and reported 56.1% contamination which is consistent with our findings (Shoaib, Asad *et al.* 2016).

In our study, the prevalence of fecal coliforms and E. coli were 26%, and 18% in the samples collected from both urban and rural areas of Peshawar. A similar study was conducted by Din M et. al. from Quetta Pakistan and collected a total of 125 water samples. Of these 110 water samples were highly contaminated with fecal coliforms and E.coli(Din, Ahmad *et al.* 2014). Another study conducted by Ahmad et al. and reported 11% of E. coli which is quite similar to our study. (Ahmad, Shan *et al.* 2021)

Conclusion

The major conclusions drawn from these findings are that three major bacteria cause water-borne diseases in the urban and rural areas of Peshawar city. The problem is mostly caused by an old system of water distribution, pipeline leaks, poor sanitary conditions, and inadequate waste management in Peshawar city because old pipes and leaks in pipelines and other pollutants alter the quality of drinking water which is mainly associated with health problems as Sufaid Deri's cholera epidemic in 1998 is a well-known example. The findings show that drinking water is highly prone to bacterial contamination. Water contamination can occur as a result of broken pipes, wastewater cross-contamination, a poorly constructed wellhead, a short distance between the water supply network and the wastewater supply lines, or the construction of septic tanks near tube wells and drinking water supply lines.

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