Bacteriological Quality of Drinking Water Supplies in Different Areas of Lahore

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Abstract

Objective: The aim of this study was to assess the bacteriological quality of drinking water in different areas of Lahore.

Method: It was a cross-sectional study conducted from April 2021 to September 2021. A total of 150 water samples were collected from different localities of the Lahore city with different socio-economic conditions. The samples were collected in sterilized containers from water taps and filtration units and brought to the laboratory within two hours of collection. Membrane filtration technique was used to determine the presence of total coliforms and faecal coliforms.

Results: Tap water samples positive for bacterial contamination were 74 (86.0%) of the 86 samples tested and from the filtration unit, out of the 64 samples 38 (59.3%) tested positive for contamination with highly significant difference between contamination rates of tap water and water from filtration unit (p value <0.001). Bacterial contamination was highest in areas with low socioeconomic status, 91.9%, followed by 65.5% in intermediate socioeconomic status and 56.6% in areas with high socioeconomic status. The difference was statistically significant between areas with low and high socioeconomic status (p<0.001).

Conclusion: A considerable number of water samples in Lahore didn't meet the standard guidelines and thus highlights the importance of strict monitoring and control systems.

Keywords: Bacterial contamination, socioeconomic status, drinking water

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Introduction

Safe and readily available water is fundamental to human development and well-being. One of the most effective ways in promoting health and reducing poverty is by providing access to safe drinking water. In 2020, approximately one in four individuals did not have access to safe drinking water in their dwellings and nearly half the world's population had inadequate sanitation measures according to World Health Organization (WHO).[1] In Pakistan, increased population, rapid urbanization and conventional agricultural activities are leading to increased water contamination issues with time. The conventional knowledge and approaches cannot be used to overcome these issues.[2,3]

Poor sanitation and contaminated water supplies has been known to cause water borne diseases like cholera, typhoid, polio, diarrhea and dysentery. Inadequate sanitation facilities along with unsafe drinking water supplies not only take a toll on community's health but also puts an extra burden on health care. Insufficient management of industrial, agricultural and urban waste means the drinking-water of hundreds of millions of people is hazardously polluted.[4] It is estimated that each year, 829 000 people die from water borne diseases that result from consumption of contaminated drinking water, poor sanitary facilities, and lack of hand hygiene. However, this can easily be prevented and can save the lives of 297 000 children under the age of five each

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year.[5] The sources of water contamination are multiple, comprising of natural chemicals and minerals, land fill and waste disposal mechanisms, industrial activities, and sewer overspills or mixing of water supplies with sewage.[6,7]

Given the importance of clean drinking water, drinking water is routinely tested to assure its safety for consumption. As a result, normal intestinal organisms are utilized as a faecal contamination indicator. The presence of indicator bacteria means fecal pollution and thus posing greater threat of water borne diseases in the community.[8,9]

One of these indicators is the total coliforms. They are suitable indicators as these are easy to recognize and count in water. Coliforms are found abundantly in soil and decomposing vegetation, however, they can be associated with human or animal faecal pollution, so coliforms essentially do not provide indication of fecal contamination.[8] However, Escherichia coli is always indicated as a sign of direct or indirect faecal contamination.[9] It can be found in huge numbers in the flora of human intestines.[10] According to WHO, total coliforms and Escherichia coli, should not be detectable in any 100 mL of drinking water sample.[10-12] In Pakistan, only 20% of the total population has access to safe & reliable drinking water. The remaining 80% of population is compelled to use water that is unsafe for human consumption due to the paucity of safe and reliable water sources.[3] Therefore, it is imperative to conduct water surveillance studies frequently, so that adequate measures can be taken in order to prevent water borne diseases.

We undertook this study to assess the bacteriological quality of drinking water in different areas of Lahore.

Material and Methods

Our study was a cross-sectional descriptive study carried out in the Pathology Department of CMH Lahore Medical College, Lahore from April 2021 to September 2021. The study was approved by the ethical committee of CMH Lahore Medical College IRB no. 544/ERC/CMH/LMC. A total of 150 samples were collected from different areas of Lahore. These areas were divided into High, Intermediate and Low based on the socioeconomic conditions (SEC). High SEC areas included Faisal Town, Wapda town, Model town, Bahria town, Askari X, Askari V, Iqbal town, Cavalry ground and Garden town. Intermediate SEC areas included Bedia Road, Ichra, Firdous Market, Berni Road, Thokar Niaz Baig, Malik Park, Rizwan block, Hassan town, Azam Garden, Sabzazar, Sadar Bazar, Press club, Margzaar colony, Rana town, Awan town, Mansoora bazar, Shaam Nagar, R.A bazar, Guldasht town and Garhi Shahu. Low SEC areas included Badami bagh, Shadbagh, Farooq Ganj, Wasan pura, Usman Ganj, Singh Pura, Anarkali, Mochi gate, Mayo hospital, Saanda, Shahdara, Baghbanpura, Begumpura, Singhpura, Delhi gate, Mohni Road, Lohari gate, Peer Maqi, Mozang Chungi, Tajpura.

From each site, water samples were aseptically collected in 200 ml capacity sterile screw capped bottles. The water samples were collected from the water taps and filtration units. The samples were transported to the Pathology Laboratory of CMH Lahore within 2 hours of collection. In the laboratory all the samples were processed within 24 hours of collection. Aseptic techniques were practiced during the analysis process to avoid sample contamination. Membrane filtration technique was performed for bacteriological analysis of water samples according to the guidelines of American Public Health Association (APHA).[13] The analysis involved passing water samples through sterile 0.45µm filters. The membrane filters were then placed on Chromogenic coliform agar (Bio life) plates and incubated at 35°C for 24 hours. Number of cell growth was expressed as colony-forming units per 100 milliliters (CFU/100ml). The results were interpreted according to the manufacturer's instructions (Bio Life). All pink to red colonies were considered as presumptive coliform bacteria but not E. coli. All dark-blue to violet colonies were considered as E. coli. The total coliform count was the sum of both pink/red colonies plus dark-blue/violet colonies that were oxidase negative (Fig-1). The data was analyzed by computer software program SPSS 22.0. Frequencies and percentages were calculated. Chi square test was used to estimate statistical significance.

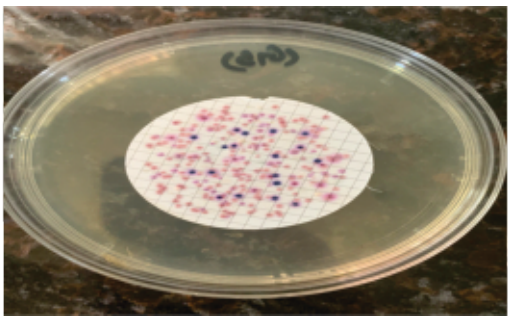

Fig-1: *Chromogenic coliform agar showing pink colonies (coliforms) and blue colonies (E. coli)*

Table 1: *Breakup of results of Bacteriological testing of drinking water system of Lahore (n= 150)*

Parameters		No. of tests	No. (%) of samples unfit for drinking (as per WHO 1993)
Types of water samples			
	Tap water	86	74 (86.0%)
	Filter water	64	38 (59.3%)
Socioeconomic status			
	High	30	17 (56.6%)
	Intermediate	58	38 (65.5%)
	Low	62	57 (91.9%)

Table 2: *Frequency of Total coliforms and E. coli in drinking water samples from Lahore (n= 150)*

Parameters		No. of Samples	No. (%) of samples positive for Total coliforms	No. (%) of samples positive for E. coli
Types of water samples				
	Tap water	86	74 (86.0%)	34(39.5%)
	Filter water	64	38 (59.3%)	18 (28.1%)
Socioeconomic status				
	High	30	17 (56.6%)	9 (30.0%)
	Intermediate	58	38 (65.5%)	12 (20.6%)
	Low	62	57 (91.9%)	31 (50%)

Results

In the present study, a total of 150 water samples were tested from the tap water and filtration unit. Tap water samples positive for bacterial contamination were 74 (86.0%) of the 86 samples tested. From the filtration unit, out of the 64 samples 38 (59.3%) tested positive for contamination as shown in Table 1. There is highly significant difference between contamination rates of tap water and water from filtration unit (p value <0.001). The number of samples positive for E. coli were 34 (39.5%0 from tap water and 18(28.1%) from filtration unit as shown in Table 2. No significant difference was found between numbers of E. coli in tap water and filtration unit water samples (p-value >0.05). The water samples collected from different localities of Lahore were divided into areas with high, intermediate, and low socioeconomic status. Bacteriological contamination was highest in areas with Low SEC 91.9%, followed by 65.5% in Intermediate SEC and 56.6% in areas with High SEC as shown in Table 1. The difference was statistically highly significant between areas with Low SEC and High SEC (p<0.001) and non-significant between areas with Low SEC and Intermediate SEC (p> 0.05) as well as between Intermediate SEC and high SEC (p>0.05). E. coli positive samples from areas of different SEC were highest (50%) in Lower socioeconomic status areas. Significant difference was found between Intermediate and Low SEC areas for E. coli positivity.

Discussion

Due to its immense significance, access to safe drinking water was included in both the Millennium Development Goals and the Sustainable Development Goals introduced for the period 2016-2030. Quality of drinking water is directly related to disease outbreaks especially diarrheal diseases.[14] According to an estimate, 1.8 billion of the total population worldwide utilize a source of drinking water which is fecally contaminated.[15] Every year, 1.5 million people die from diarrheal diseases, including 360,000 children under the age of 5, predominantly in low-income nations. Unsafe water supplies, poor sanitary conditions and inadequate hygiene are responsible for approximately 58% of diarrheal diseases.[14]

The current study undertook the assessment of the bacteriological quality of drinking water in different areas of Lahore. Presence of both Escherichia coli and total coliforms in water sources were considered as sufficient proof of exposure to faecal contamination. In the present study, a total of 112 (74.67%) samples out of 150 samples were positive for faecal contamination. In a similar study conducted in Karachi by Fatima et al. 313 (64.66%) samples out of 484 were positive for faecal contamination.[16] In another study conducted in Nepal, out of a total sample of 243, 160 (66%) samples had faecal contamination.[17] Whereas, another study conducted in the area of Saggiyan, Lahore showed 95% of the water samples were polluted with fecal coliforms.[18]

In the current study, 74% of samples from tap water and 38% from filter water were contaminated with faecal coliforms whereas 34% of samples from tap water and 18% samples from filter water showed the presence of E. Coli. These results are similar to a study conducted in Bangladesh, in which, 73.96% samples were contaminated with faecal coliforms and 34.7% with E. coli.[19] In another study conducted in Lahore, 51% of the filtered and 93% of the unfiltered water samples were found to be fecally contaminated and unsuitable for consumption.[20] Another study which compared the

coliforms existence in filtered and boiled water found 16.67% faecal coliform contamination of filtered water.[21]

The present study also correlated the quality of drinking water samples with the socioeconomic status of the people. Accordingly, samples were collected from different localities designated as areas with high, intermediate, and low socioeconomic conditions. Bacterial contamination was highest in areas with low socioeconomic conditions 91.9%, followed by 65.5% in intermediate and 56.6% in areas with high socioeconomic conditions. These results concurred with a similar study conducted in Rawalpindi and Islamabad which concluded that people living in poor socioeconomic conditions were more prone to waterborne diseases as there was a strong association between hygienic status and waterborne diseases.[22] Contamination of drinking water creates a significant burden on public health in countries like Pakistan with poor socioeconomic conditions, due to water-related diseases. This study highlights the importance of water surveillance studies, so that preemptive measures can be taken in order to prevent water borne diseases.

Conclusion

A considerable number of the samples that were obtained did not meet the quality standards which poses an issue concerning the microbiological quality of drinking water and emphasizes the significance of rigorous monitoring and regulatory mechanisms. Since the total viable count in the majority of the tested samples was much higher than the permitted range defined according to the national and international requirements, further preventative measures must be seriously considered in order to enhance the quality of drinking water.

Conflict of interest *None*

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References

1. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. Progress on Sanitation and Drinking Water: 2020 Update. Geneva, Switzerland: World Health Organization; 2020.
2. American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington, DC: APHA; 2017.
3. Daud MK, Nafees M, Ali S, Rizwan M, Bajwa RA, Shakoor MB, Arshad MU, Chatha SA, Deeba F, Murad W, Malook I. Drinking water quality status and contamination in Pakistan. BioMed research international. 2017 Aug 14; 2017.
4. Benedict KM, Reses H, Vigar M, Roth DM, Roberts VA, Mattioli M, Cooley LA, Hilborn ED, Wade TJ, Fullerton KE, Yoder JS, Hill VR. Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2013–2014. MMWR Morb Mortal Wkly Rep. 2017;66 (44):1216-21.
5. Prüss-Ustün A, Wolf J, Bartram J, Clasen T, et al. Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: an updated analysis with a focus on low-and middle-income countries. International journal of hygiene and environmental health. 2019 Jun 1; 222(5):765-77.
6. Centers for Disease Control and Prevention (CDC). Water-related diseases and contaminants in public water systems. 2019.
7. Wahdini S, Putra VP, Sungkar S. The Prevalence of Intestinal Protozoan Infections among Children in Southwest Sumba Based on the Type of Water Sources. Infection & Chemotherapy. 2021 Sep; 53(3):519.
8. Invik J, Barkema HW, Massolo A, Neumann NF, Checkley S. Total coliform and Escherichia coli contamination in rural well water: analysis for passive surveillance. Journal of Water and Health. 2017 Oct;15(5):729-40.
9. [9] Odonkor ST, Ampofo JK. Escherichia coli as an indicator of bacteriological quality of water: an overview. Microbiology research. 2013 Apr; 4(1):5-11.
10. World Health Organization. Guidelines for Drinking-water Quality. World Health Organization; 1993.
11. Price RG, Wildeboer D. E. coli as an indicator of contamination and health risk in environmental waters. Escherichia coli-Recent Advances on Physiology, Pathogenesis and Biotechnological Applications. 2017 Jul 12:13.
12. Gwimbi P, George M, Ramphalile M. Bacterial contamination of drinking water sources in rural villages of Mohale Basin, Lesotho: exposures through neighbourhood sanitation and hygiene practices. Environmental health and preventive medicine. 2019 Dec;24(1):1-7.
13. Forster B, Pinedo CA. Bacteriological Examination of Waters: Membrane Filtration Protocol. American Society for Microbiology. 2015 Jun 23.
14. Weststrate J, Dijkstra G, Eshuis J, Gianoli A, Rusca M. The sustainable development goal on water and sanitation: learning from the millennium development goals. Social Indicators Research. 2019 Jun; 143(2): 795-810.

15. R. Bain, R. Cronk, R. Hossain, S. Bonjour, K. Onda, J. Wright, H. Yang, T. Slaymaker, P. Hunter, A. Prüss-Ustün, J. Bartram. Global assessment of exposure to faecal contamination through drinking water based on a systematic review. Tropical Med. Int. Health, 19 (2014), pp. 917-927.
16. Fatima A, Urooj S, Mirani ZA, Abbas A, Khan MN. Fecal Coliform Contamination of Drinking Water in Karachi, Pakistan. PSM Microbiol. 2021 Jun; 6(2): 42-48.
17. Maharjan S, Joshi TP, Shrestha SM. Poor quality of treated water in Kathmandu: comparison with Nepal Drinking Water Quality Standards. Tribhuvan University Journal of Microbiology. 2018 Sep;5:83-8.
18. Javed M, Aslam MU, Nadeem S, Aftab H, Hussain S, Arif M, Raza H, Haroon SM, Khan MA. Microbial Contamination in Drinking Water of Saggiyan-Lahore, Pakistan. International Journal of Economic and Environmental Geology. 2021 Jun;12(1):76-80.
19. Mahmud ZH, Islam MS, Imran KM, Hakim SA, Worth M, Ahmed A, Hossan S, Haider M, Islam MR, Hossain F, Johnston D. Occurrence of Escherichia coli and faecal coliforms in drinking water at source and household point-of-use in Rohingya camps, Bangladesh. Gut pathogens. 2019 Dec;11(1):1-11.
20. Khan I, Mohsin S. Microbiological Analysis of Drinking Water from Different Areas of Lahore. International Journal of Economic and Environmental Geology. 2021 Nov;12(3):44-7.
21. Khan SA, Lubna MA, Razeeb SR, Acharjee M. A proportional study on the existence of coliform and fecal coliform in the post-treatment (filtered and boiled) water samples. International Journal of Science Reports. 2021 Apr;7(4):215-20.
22. Shoaib M, Asad MJ, Aziz S, Usman M, Rehman A, Zafar MM, Ilyas M. Prevalence of pathogenic microorganisms in drinking water of Rawalpindi and Islamabad. World Journal of Fish and Marine Sciences. 2016; 8(1): 14-21.

Authors Contribution

MSA: Conceptualization of Project
KHC, FH, MR : Data Collection
FH, MR: Literature Search
FH, KHC: Statistical Analysis
AS, AS: Drafting, Revision
FH, KHC: Writing of Manuscript