International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Assessing the impact of drinking water quality on public health: A case study of filter plants in a residential university

Nimra Riaz, Tayyaba Asim *, Imran Hashmi and Muhammad Fahad Akram

Institute of Environmental Sciences and Engineering, National University of Sciences and Technology, Islamabad, Pakistan.

International Journal of Science and Research Archive, 2026, 18(03), 1080-1086

Publication history: Received on 11 February 2026; revised on 17 March 2026; accepted on 20 March 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.18.3.0571

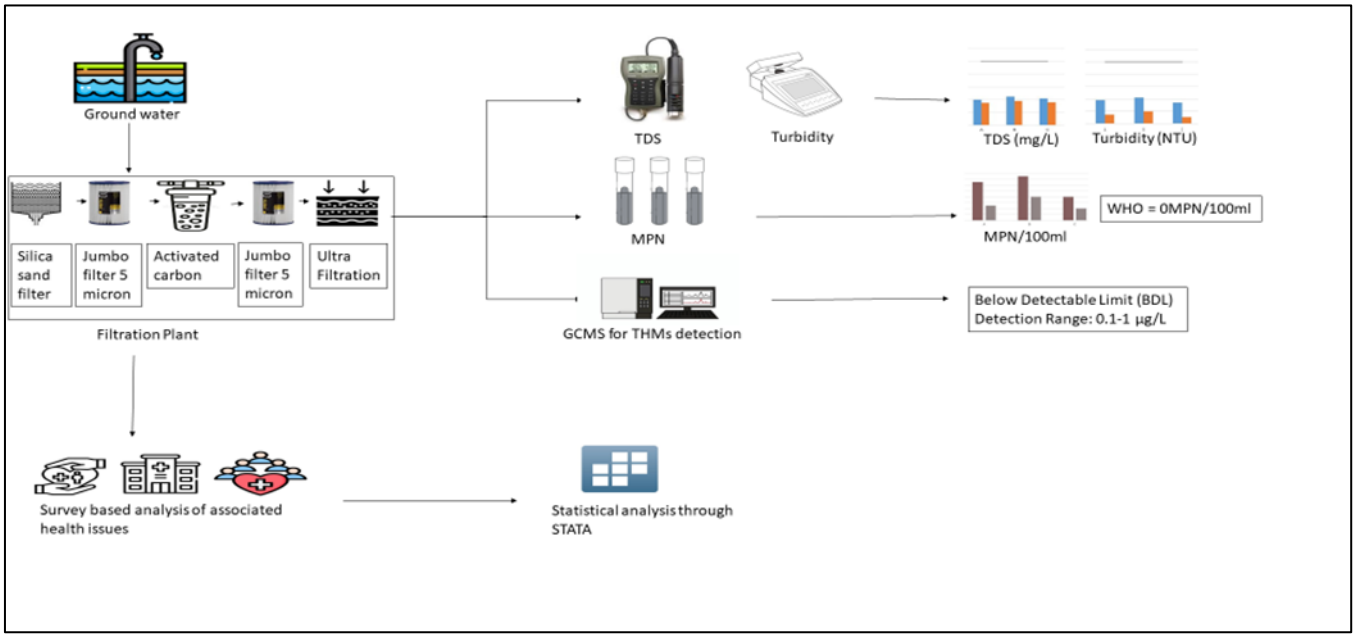
Abstract

This study focuses on the monitoring of drinking water quality and its impacts on public health. Physicochemical and microbial analysis (Most Probable Number) was performed to assess drinking water quality. A structured health survey was conducted among residents to assess the impact of water quality on community health and chi square test was applied to relate variables using STATA MP-17 software. T-test was applied on physicochemical and microbial parameters using Python. Physicochemical parameters were within Pakistan Standards for Drinking Water Quality limit except Chemical Oxygen Demand (74.6-266.6 mg/L) while concentration of *Escherichia coli* exceeded the recommended World Health Organization limits in all samples indicating risk to public health. It was observed that many respondents were facing health problems like skin dryness (82 %), stains on teeth (58 %) and eye irritation (56 %). Chi-square test revealed that duration of water consumption was significantly related to jaundice ($p < 0.05$) while amount of daily water consumption was significantly related to hepatitis ($p < 0.05$). The findings highlight the need for improved disinfection and maintenance practices in water treatment systems.

Keywords: MPN; Public health; Statistical analysis; Survey; Water quality

* Corresponding author: Tayyaba Asim

Graphical Abstract



1. Introduction

Microbial contamination of drinking water poses greatest risk to safety of drinking water [1]. *Escherichia coli* is a harmful bacteria that may be present in drinking water and is a major source of waterborne diseases [2]. *E. coli* contaminated water may cause severe diarrhea, stomach cramps, vomiting and low grade fever. Therefore, water treatment is crucial for public health before it is used for drinking purpose. Several techniques are used for treatment of drinking water like filtration, sedimentation, disinfection, reverse osmosis and specifically disinfection by chlorine.

Chlorine is a disinfectant that kills microorganisms in water that can spread water borne diseases. It is used to improve the quality of drinking water. Chlorine is a widely used disinfectant because of its removal efficiency and cost effectiveness [3]. Chlorine dosage is an important parameter for improved water treatment. Excessive chlorine may react with Natural Organic Matter (NOM) already present in water and form several Disinfection Byproducts (DBPs). These DBPs include Total Trihalomethanes (TTHMs), Haloacetic acids (HAAs), Halogenated acetonitriles (HANs) etc. [4]. TTHMs and HAAs are more predominant in chlorinated water.

In Pakistan, drinking water quality is deteriorating as the population size is increasing [5]. Increase in water borne diseases like cholera, diarrhea etc. is observed with increase in water contamination. Common water borne diseases in Pakistan are malaria, typhoid, paratyphoid fever, hepatitis A&E, dysentery, ulcer, diarrhea, jaundice and cholera [6]. 100 million diarrheal cases are reported and 2.5 million people die in Pakistan due to diarrheal diseases every year [7].

2. Materials and Methods

2.1. Study area

The study was conducted in National University of Sciences and Technology (NUST), H-12 campus, Islamabad. Before and after filtration drinking water quality was monitored from 13 filtration plants located in different areas of NUST.

Figure 1 Sampling Locations

2.2. Physicochemical analysis

A monthly sampling frequency from representative sites was adopted from January to March 2025. Temperature, pH, total dissolved solids (TDS), dissolved oxygen (DO) and electrical conductivity (EC) were determined using Hanna Multiparameter Waterproof Meter (HI98194) manufactured in Romania. Chemical oxygen demand (COD) was analyzed using HACH COD Reactor, turbidity with a turbidimeter Type HACH-Model 2100P, nitrates and nitrites using UV Visible SPECORD 200 Plus Analytik Jena Double Beam Spectrophotometer while hardness and alkalinity were calculated using titration method. It showed all the parameters were within Pakistan Standards for Drinking Water Quality (PSDWQ) limits except COD. Residual chlorine concentrations were also within the PSDWQ limits (0.2-0.5 mg/L). T-test was applied to determine if there was a significant difference between two groups.

2.3. Microbial analysis

Samples were collected in 500 ml sterile glass bottles transported in an ice box immediately to laboratory and stored at 4°C in refrigerator. Microbial analysis was performed within 2 hours after sample collection to avoid post contamination as per APHA (American Public Health Association) 2017 guidelines. Most Probable Number (MPN) technique was performed for *E. coli* presence in drinking water samples. Lauryl Tryptose Broth (Oxoid, CM0451B), Brilliant Green Bile Lactose Broth (Oxoid, CM0031B) and *Escherichia coli* Broth (Oxoid, CM 0853) were prepared in distill water, autoclaved (K&K Scientific Supplier, Korea) and then sterility test was performed. LTB was inoculated with 10 mL of water sample and the tubes were then kept in incubator (Advantage Lab, Germany) for 24 hours at 37°C. As presumed positives, tubes exhibiting gas production and visible turbidity, were then inoculated into BGLB and incubated for an additional 24 hours at 37°C. Following the BGLB test, gas-positive tubes were carried to EC broth and incubated for 24 hours at 44.5°C. Based on the number of tubes exhibiting gas production during the three consecutive tests, the MPN was determined.

2.4. Survey

A survey was conducted among the residents of selected university about water quality and health impacts they may face by drinking contaminated water. Sample size was calculated using formula for finite population size given in equation (1).

$$n = \frac{Z^2.p(1-p)}{e^2}.\frac{N}{N-1+\frac{z^2.p(1-p)}{e^2}} \qquad (1)$$

Where,
n = required sample size
N = total population size
Z= confidence level (95 %)
p = estimated proportion of the population (0.5)

e = margin of error (0.05)

Simple random sampling methodology was adopted to obtain responses. Questionnaire was designed and responses were collected through Google forms. 69 responses were collected and results of responses were organized using StataMP-17 software. Chi-square test was applied to relate a few parameters.

3. Results and Discussion

3.1. Physicochemical analysis

Results of physicochemical parameters were found satisfying as all the parameter ranges of all samples were within the safe limit except COD (74.6-266.6 mg/L) and nitrate levels (15.6-51.2 mg/L). T-test was applied on physicochemical parameters using Python. Significant difference was observed among turbidity and total dissolved solids.

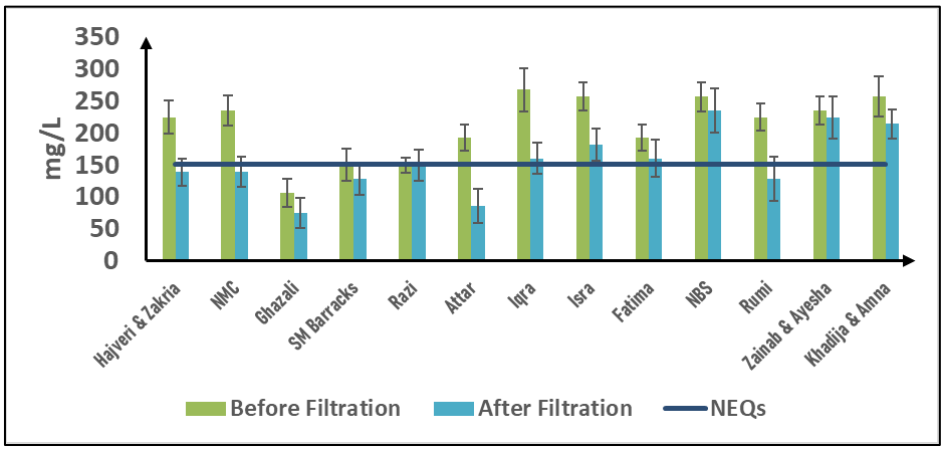


Figure 2 COD of samples before and after filtration

3.2. Microbial analysis

All samples before and after filtration were found microbiologically contaminated. It was observed that *E. coli* was present abundantly in all the samples (4.2->23 MPN/100ml). According to WHO MPN/100ml safe limit is 0/100ml, while all the samples were exceeding WHO limits. In conclusion, water from filtration plants was not found fit for drinking purpose even after filtration. T-test results showed p-value 0.17 and t-statistic 1.45.

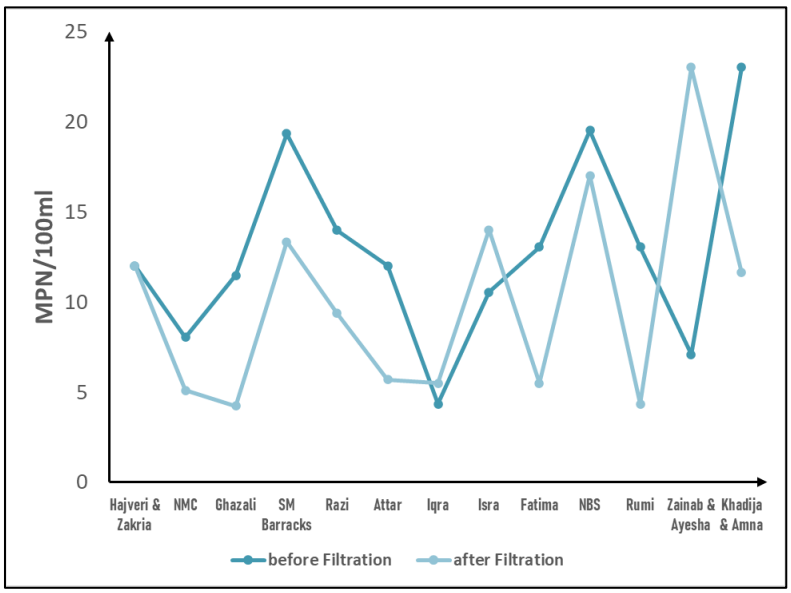


Figure 3 Microbial contamination in samples before and after filtration

It was observed that microbial contamination was increased after filtration in some samples, it may be because of several reasons, including inadequate disinfection, post filtration contamination and ineffective filter performance. Fouling from bacteria from pipes and pumps may also be a reason [8].

3.3. Survey

Survey had been depicted overall health scenarios of the selected study area and its attribution to contamination of water. Only 20.29 % respondents were satisfied with the quality of drinking water.

Several health impacts were observed by consumers due to the water quality of filtration plants located in hostels.

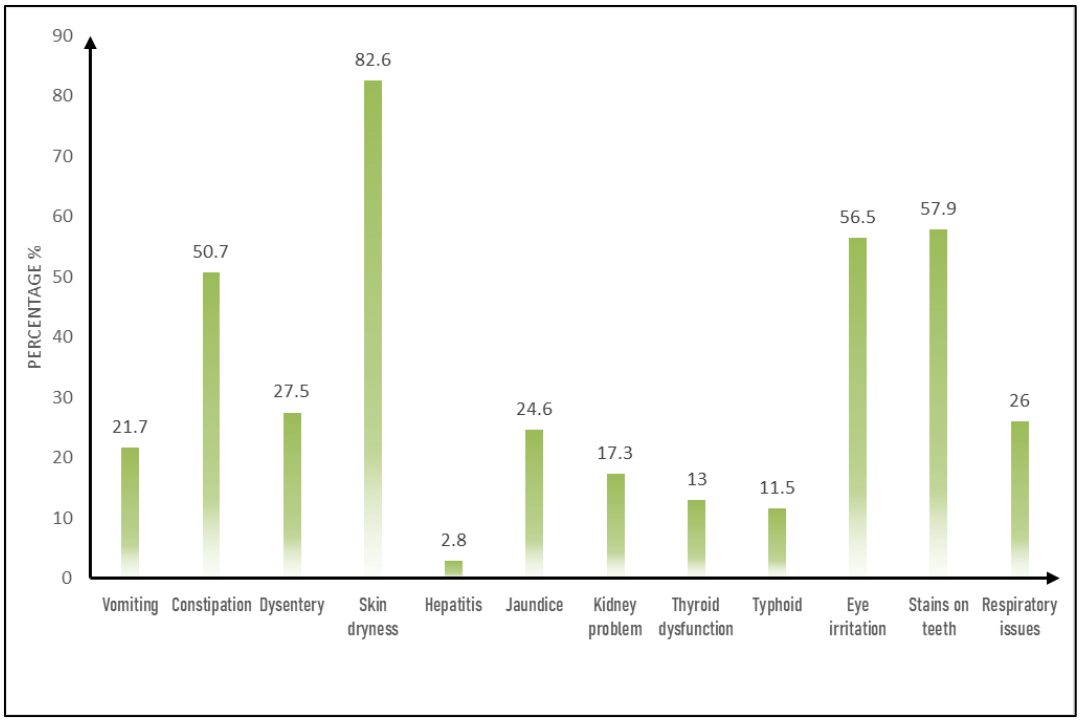


Figure 4 Public health problems faced by respondents

3.4. Chi-square Test

Chi-square test was applied in data sets to determine relationship between two categorical variables. It was observed that a few health problems were significantly related with the duration of using this water as their p-value was less than 0.05.

Table 1 Relationship of health problems with the time range

Duration (Less than 2 years)	Health problem	p-value
	Kidney Problem	0.026
	Jaundice	0.002
	Typhoid	0.000

Gobalarajah in 2020 [9] related Kidney problems with TDS and Hardness in water while Jenkins in 2019 [10] related Typhoid fever with unsafe water sources. It was observed that dosage of water is significantly related to Hepatitis with p-value 0.007. Kadri in 2018 [11] related Hepatitis outbreak with contaminated municipal supply. Some respondents observed stains on teeth ($p < 0.05$) and fading of clothes color after washing ($p < 0.05$).

4. Conclusion and Discussion

Contaminated drinking water results in several waterborne diseases and a serious environmental problem. Present study was designed to monitor the physical, chemical and microbial quality of drinking water in a residential university and discover health issues related to water quality. The concentrations of some physical and chemical parameters (pH, temperature, DO, TDS, EC, nitrites, alkalinity, hardness and UV-254) of drinking water samples met the permissible limits recommended by PSDWQ. COD and nitrate levels exceeded the permissible limits recommended by WHO in some samples. *E. coli* was present in all the samples exceeding recommended limits by WHO. It was observed that only a few consumers were satisfied with the quality of drinking water. Respondents experienced skin dryness, stains on teeth, eye irritation, constipation, dysentery, respiratory issues, jaundice, vomiting, kidney problems, thyroid dysfunction, typhoid and hepatitis. Chi-square test revealed that duration of using this water was significantly related to kidney problem, jaundice and typhoid while amount of daily water consumption was significantly related to hepatitis.

Compliance with Ethical Standards

Acknowledgments

The authors are extremely thankful to Environmental Microbiology Teaching Lab, Institute of Environmental Sciences and Engineering (IESE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad.

Disclosure of conflict of interest

The authors declare that no conflict of interest exists.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] WHO (2022). World Health Statistics 2022. Www.who.int.https://www.who.int/news/item/20-05-2022-world-health-statistics-2022

[2] Odonkor ST, Mahami T. *Escherichia coli* as a Tool for Disease Risk Assessment of Drinking Water Sources. International Journal of Microbiology. 2020; (1): 1–7. https://doi.org/10.1155/2020/2534130

[3] Srivastav AL, Patel N, Chaudhary VK. Disinfection by-products in drinking water: Occurrence, toxicity and abatement. Environmental Pollution. 2020; 267: 115474. https://doi.org/10.1016/j.envpol.2020.115474

[4] Mazhar MA, Khan NA, Ahmed S, Khan AH, Hussain A, Rahisuddin, Changani F, Yousefi M, Ahmadi S, Vambol V. Chlorination disinfection by-products in Municipal drinking water – A review. Journal of Cleaner Production. 2020; 273. https://doi.org/10.1016/j.jclepro.2020.123159

[5] Atif M, Ayub G, Shakoor F, Farooq M, Iqbal M, Zaman Q, Ilyas M. Evolution of waterborne diseases: A case study of Khyber Pakhtunkhwa, Pakistan. SAGE Open Medicine, 2024; 12. https://doi.org/10.1177/20503121241263032

[6] Perveen S. Spread of water-borne diseases in Pakistan. Pakistan Journal of Health Sciences. 2022; 3 (04): 02–02. https://doi.org/10.54393/pjhs.v3i04.298

[7] Qamar K, Nchasi G, Mirha HT, Siddiqui JA, Jahangir K, Shaeen SK, Islam Z, Essar MY. Water sanitation problem in Pakistan: A review on disease prevalence, strategies for treatment and prevention. Annals of Medicine and Surgery. 2022; 82: 104709. https://doi.org/10.1016/j.amsu.2022.104709

[8] Woźniak P, Gryta M. Bacterial contamination of ultrafiltration installation applied to carwash wastewater treatment. Membranes. 2025; 15(3): 71–71. https://doi.org/10.3390/membranes1503007

[9] Gobalarajah K, Subramaniam P, Jayawardena UA, Rasiah G, Rajendra S, Prabagar J. Impact of water quality on Chronic Kidney Disease of unknown etiology (CKDu) in Thunukkai Division in Mullaitivu District, Sri Lanka. BMC Nephrology. 2020; 21 (1). https://doi.org/10.1186/s12882-020-02157-1

[10] Jenkins AP, Jupiter SD, Jenney A, Rosa V, Naucukidi A, Prasad N, Vosaki G, Mulholland K, Strugnell R, Kama M, Crump JA, Horwitz P. Environmental Foundations of Typhoid Fever in the Fijian Residential Setting. International Journal of Environmental Research and Public Health. 2019; 16 (13): 2407. https://doi.org/10.3390/ijerph16132407

[11] Kadri SM, Rehman S, Rehana K, Benetou DR, Ahmad DF, Abdullah A, Chattu VK. Hepatitis A and E Outbreak Surveillance during 2015–2017 in Kashmir, India: Is the Water to Blame? Journal of Epidemiology and Global Health. 2018; 8 (3-4): 203. https://doi.org/10.2991/j.jegh.2018.04.101