

Surveillance of Waterborne Disease and Water Quality Assessment in Saharanpur District of Uttar Pradesh, India

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ABSTRACT

Water contamination remains a major public-health concern, particularly during the monsoon season when groundwater sources become vulnerable to microbial pollution. The present study investigated the seasonal prevalence of typhoid fever and assessed drinking-water quality in selected areas of Saharanpur district, Uttar Pradesh, India. Hospital-based surveillance data were collected from CHC Punwarka, Civil Hospital Saharanpur, and Horora Hospital from April to August 2026, while handpump water samples from Dehradun Chauk, Punwarka, and Harora were analysed using BIS IS 10500:2012 and APHA standard methods. The results showed a seasonal rise in typhoid fever cases during the monsoon months, with the highest prevalence recorded at CHC Punwarka in July 2026 (19.61%) and at Horora Hospital in August 2026 (21.42%). Water-quality analysis revealed that turbidity levels at all sampling sites exceeded the acceptable BIS limit, with the highest value observed at Harora (6.61 NTU), indicating possible microbial contamination. The results suggest a relationship between poor drinking-water quality and increased typhoid prevalence in the study area. The study emphasizes the importance of regular water-quality monitoring, improved sanitation, chlorination, and continuous disease surveillance for the prevention and control of waterborne diseases.

Keywords- Waterborne disease, Typhoid fever, *Salmonella Typhi*, Water quality, Surveillance, Turbidity, Saharanpur.

I. INTRODUCTION

Water is essential for human survival and public health; however, contamination of drinking water remains a major global challenge. According to the World Health Organization, nearly 2 billion people consume faecally contaminated water, contributing significantly to diarrhoeal and other waterborne diseases worldwide (WHO, 2019; UNICEF/WHO, 2021). Poor sanitation, unsafe water supplies, flooding, and inadequate hygiene practices are major factors responsible for the spread of waterborne infections (APHA, 2017; Jain et al., 2016).

Waterborne diseases such as cholera, typhoid fever, dysentery, hepatitis A, and gastroenteritis are caused by pathogenic microorganisms transmitted through contaminated water (WHO, 2019). Among these, typhoid fever caused by *Salmonella enterica*

serovar Typhi (*Salmonella Typhi*) remains a serious public-health problem in India and other South Asian countries (Parry et al., 2002). The emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) typhoid strains has further increased disease severity and treatment difficulty (Crump et al., 2015).

India reports a high burden of typhoid cases due to rapid urbanization, poor sanitation, and dependence on untreated groundwater sources such as handpumps and shallow wells (Kumar & Singh, 2020). Previous outbreak investigations have linked contaminated drinking water with increased typhoid incidence, particularly during the monsoon season (Srikantiah et al., 2007; Jain et al., 2016).

Assessment of drinking-water quality through physico-chemical parameters including pH, turbidity, TDS, hardness, alkalinity, chloride, calcium, and

magnesium is important for evaluating water safety (BIS, 2012; APHA, 2017). Elevated turbidity often indicates possible microbial contamination and reduced disinfection efficiency (WHO, 2019).

Saharanpur district of Uttar Pradesh experiences heavy monsoon rainfall and widespread use of handpump water, increasing the risk of groundwater contamination. Therefore, the present study was undertaken to conduct surveillance of typhoid fever and evaluate drinking-water quality in selected areas of Saharanpur district, Uttar Pradesh.

II. MATERIALS AND METHODS

2.1 Study Area

The present study was conducted in Saharanpur, located in the north-western region of Uttar Pradesh, India (28.37°N, 77.55°E). The district lies near the foothills of the Shivalik range and experiences a humid subtropical climate with heavy monsoon rainfall during July–September. Three sampling sites representing different settlement types were selected: Dehradun Chauk (urban), Punwarka MS University Campus (peri-urban), and Harora (rural).

2.2 Hospital Surveillance

Monthly surveillance data of confirmed and suspected typhoid fever cases were collected from three healthcare centres: CHC Punwarka, Civil Hospital Saharanpur, and Horora Hospital. Data collection was carried out from April 2026 to August 2026, covering both pre-monsoon and monsoon periods. Total OPD attendance and typhoid-positive cases were recorded monthly. Typhoid prevalence was calculated using the following formula:

$$\text{Prevalence (\%)} = \frac{\text{Number of Typhoid Cases}}{\text{Total OPD Population}} \times 100$$

2.3 Water Sample Collection

Drinking-water samples were collected on 20 April 2026 from three handpump sources using sterile 1-L polyethylene bottles. Samples were collected from Dehradun Chauk, Maa Shakumbhari University Campus (Punwarka), and Harora locality. All samples were labelled, preserved at 4 °C, and transported to the laboratory within 24 hours for analysis.

2.4 Water Quality Analysis

Physico-chemical analysis was carried out at the District Level Water Analysis Laboratory, UP Jal Nigam (Rural), Saharanpur, a NABL-accredited laboratory (Certificate No. TC-14290). Water samples were analysed according to BIS IS 10500:2012 and APHA standard methods. Parameters analysed included pH, turbidity, total dissolved solids (TDS), chloride, total alkalinity, total hardness, calcium, and magnesium. Standard analytical procedures such as IS 3025 methods and APHA 24th Edition protocols were followed during analysis. Temperature and relative humidity during

testing were maintained at 25±3 °C and 50±15 %, respectively.

III. RESULTS

3.1 Hospital Surveillance Data

Monthly surveillance of typhoid fever cases was carried out at three healthcare facilities in Saharanpur district from April to August 2026. The prevalence of typhoid fever showed noticeable monthly variation across all hospitals, with a marked increase during the monsoon period.

At CHC Punwarka, the highest prevalence of typhoid fever was recorded in July 2026 (19.61%), corresponding to 354 cases out of 1805 OPD patients. The lowest prevalence was observed in May (10.10%). Overall, CHC Punwarka recorded the highest number of typhoid cases during the study period.

At Civil Hospital Saharanpur, typhoid prevalence ranged from 2.85% in July to 10.58% in August. A comparatively lower prevalence was observed during July, whereas August recorded the highest disease burden.

Horora Hospital exhibited comparatively smaller patient numbers; however, the prevalence remained consistently high. The highest prevalence was recorded in August 2026 (21.42%), indicating a possible localized outbreak associated with contaminated drinking-water sources in the rural area.

3.2 Graphical Representation of Typhoid Prevalence

The monthly prevalence trends of typhoid fever at CHC Punwarka, Civil Hospital Saharanpur, and Horora Hospital are presented in **Figures 1-3**. Comparative distribution of typhoid cases among all three hospitals during the study period is illustrated in **Figure 4**.

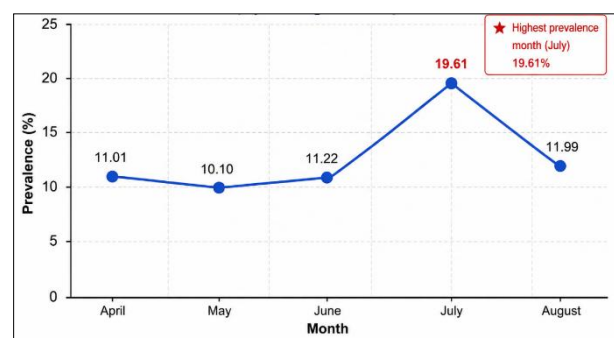


Figure 1. Monthly typhoid prevalence at CHC Punwarka (April-August 2026)

Figure 1 The prevalence remained around 10-11% during April–June, increased sharply to the highest level in July (19.61%) during the monsoon season, and declined again in August (11.99%).

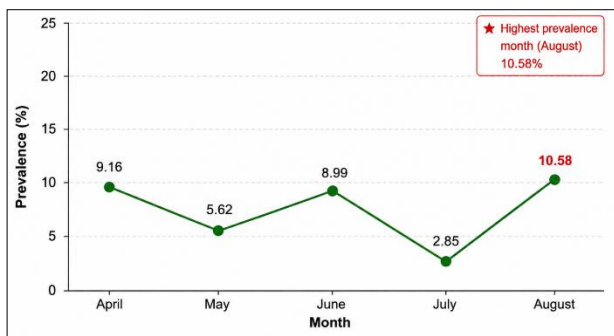


Figure 2. Monthly typhoid prevalence at Civil Hospital Saharanpur (April-August 2026)

Figure 2 The prevalence showed fluctuations throughout the study period, with the lowest prevalence recorded in July (2.85%) and the highest prevalence observed in August (10.58%).

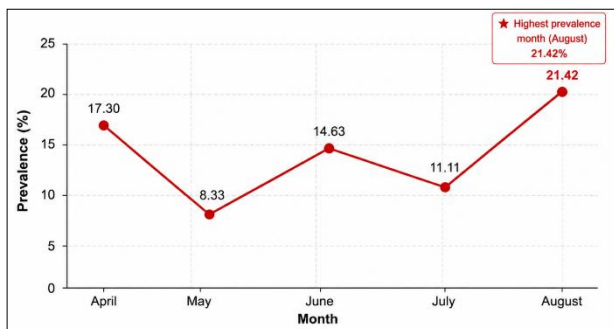


Figure 3. Monthly typhoid prevalence at Horora Hospital (April-August 2026)

Figure 3 The prevalence remained comparatively high throughout the study period and reached the maximum level in August (21.42%), indicating an increased risk of waterborne disease during the monsoon season.

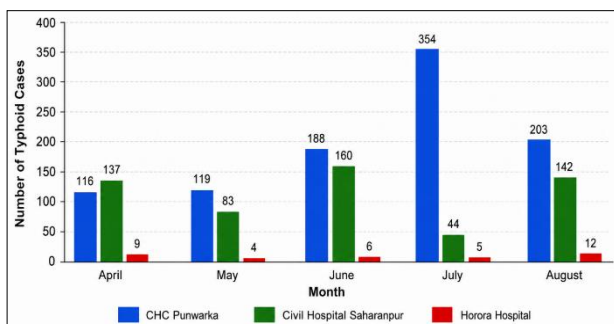


Figure 4. Comparative monthly distribution of typhoid cases across all hospitals

Figure 4 compares the monthly distribution of typhoid cases among CHC Punwarka, Civil Hospital Saharanpur, and Horora Hospital during April-August 2026. CHC Punwarka recorded the highest number of cases with a peak in July (354 cases), whereas Horora

Hospital showed fewer total cases but relatively higher prevalence, indicating localized disease transmission

3.3. Water Quality Analysis

Table 1. Physico-chemical Analysis of Handpump Water Samples Collected from Dehradun Chauk, Punwarka, and Harora in Saharanpur District Compared with BIS IS 10500:2012 Drinking Water Standards

Paramete	U	IS	IS	Sampl	Sa	Samp
pH	—	6.5–	No	7.36	7.20	7.50
Turbidit	N	1.00	200	3.01*	2.91*	6.61*
TDS	m	500	100	262	279	396
Chloride	m	250	100	20	25	30
Total	m	200	600	220	248	290
Total	m	200	600	240	268	310
Calcium	m	75	200	60	68	78
Magnesi	m	30	100	43.2	48	55.68

* Values exceeding IS 10500:2012 acceptable limit

Table 1 presents the physico-chemical characteristics of drinking-water samples collected from three handpump locations: Dehradun Chauk (Sample 01), Punwarka (Sample 02), and Harora (Sample 03) and compares them with the drinking-water standards prescribed under BIS IS 10500:2012.

The pH values of all three samples ranged between 7.20 and 7.50, indicating that the water samples were neutral to slightly alkaline and remained within the acceptable BIS limit (6.5–8.5). This suggests that the water was chemically suitable for drinking with respect to acidity and alkalinity.

Turbidity values in all samples exceeded the acceptable limit of 1 NTU. Sample 03 from Harora recorded the highest turbidity (6.61 NTU), followed by Sample 01 (3.01 NTU) and Sample 02 (2.91 NTU). Elevated turbidity indicates the presence of suspended particles and possible microbial contamination, which may increase the risk of waterborne diseases such as typhoid fever.

Total Dissolved Solids (TDS) values ranged from 262 to 396 mg/L, remaining within the permissible BIS limit of 1000 mg/L. This indicates that the dissolved mineral content of the water samples was within acceptable levels for drinking purposes.

Chloride concentration in all samples varied between 20 and 30 mg/L, which was considerably below the permissible limit of 1000 mg/L. Low chloride levels suggest minimal saline contamination in the groundwater sources.

Total alkalinity values ranged from 220 to 290 mg/L. Although slightly higher than the acceptable limit of 200 mg/L, the values remained within the permissible limit of 600 mg/L, indicating moderate buffering capacity of the groundwater.

Total hardness values were recorded between 240 and 310 mg/L. Sample 03 (Harora) showed the highest hardness value (310 mg/L), exceeding the

acceptable limit of 200 mg/L but remaining within the permissible limit of 600 mg/L. Increased hardness may be associated with elevated calcium and magnesium salts in groundwater.

Calcium concentrations ranged from 60 to 78 mg/L, while magnesium concentrations ranged from 43.2 to 55.68 mg/L. Magnesium values in all samples exceeded the acceptable limit of 30 mg/L but remained within permissible levels. Elevated magnesium and hardness values indicate mineral-rich groundwater conditions.

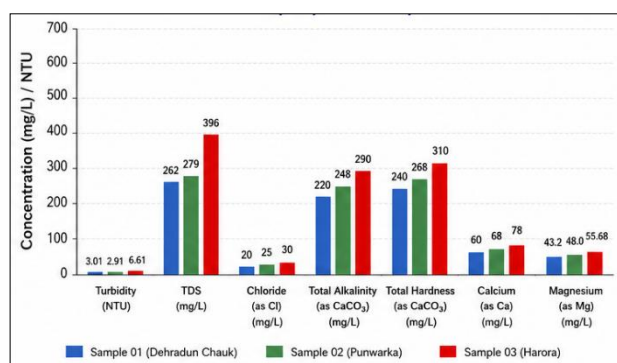


Figure 5. Comparative Physico-chemical Analysis of Handpump Water Samples from Dehradun Chauk, Punwarka, and Harora, Saharanpur District

Figure 5 presents the comparative physico-chemical characteristics of handpump water samples collected from Dehradun Chauk, Punwarka, and Harora. Among all samples, Harora showed comparatively higher values of turbidity, TDS, alkalinity, hardness, calcium, and magnesium, indicating relatively poorer water quality. Elevated turbidity and hardness levels suggest possible groundwater contamination and may increase the risk of waterborne diseases in the study area.

IV. DISCUSSIONS

The present study demonstrated a clear seasonal variation in typhoid fever prevalence across the selected healthcare facilities of Saharanpur district, with a noticeable increase during the monsoon months of July and August 2026. Similar seasonal trends of waterborne diseases have been widely reported in India and other developing countries, where heavy rainfall and flooding contribute to contamination of groundwater and drinking-water sources through sewage overflow and surface runoff (WHO, 2019; Jain et al., 2016). The sharp rise in typhoid prevalence at CHC Punwarka during July (19.61%) may therefore be associated with increased microbial contamination during the peak monsoon period.

The comparatively higher prevalence observed at Horora Hospital (21.42% in August) despite a smaller patient population suggests localized transmission linked to unsafe drinking-water conditions in rural areas. Rural

communities relying on untreated handpump water are particularly vulnerable to waterborne infections because shallow groundwater aquifers are easily contaminated by domestic sewage, animal waste, and agricultural runoff (Kumar & Singh, 2020). Similar findings were reported by Srikantiah et al. (2007), who associated a typhoid outbreak among rural schoolchildren with contaminated community water supplies.

Typhoid fever remains a significant public-health problem in South Asia due to inadequate sanitation, poor hygiene, and limited access to safe drinking water (Parry et al., 2002). The persistence of the disease in the present study area further supports earlier epidemiological observations that regions with insufficient water-treatment and sanitation infrastructure experience a higher burden of enteric fever (Crump et al., 2015). Moreover, the emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) *Salmonella Typhi* strains increases the public-health significance of disease surveillance and preventive water-quality management (Crump et al., 2015).

The physico-chemical analysis of hand pump water samples revealed that turbidity exceeded the acceptable BIS limit (1 NTU) at all three sampling locations. Elevated turbidity is considered an important indicator of suspended organic matter and possible microbial contamination, which may reduce the efficiency of chlorination and disinfection processes (APHA, 2017). Among the three sites, Harora recorded the highest turbidity value (6.61 NTU), corresponding with the highest typhoid prevalence observed during the surveillance period. This association suggests that poor drinking-water quality may have contributed to the increased occurrence of waterborne diseases in the area.

Although parameters such as pH, TDS, chloride, calcium, and magnesium remained within permissible BIS limits, total hardness and alkalinity were comparatively higher in Harora water samples. Increased groundwater hardness and mineral concentration may result from geological composition, agricultural runoff, and anthropogenic contamination (Kumar & Singh, 2020). Similar groundwater-quality deterioration has been reported in several districts of Uttar Pradesh due to rapid urbanization, sewage leakage, and poor waste-management systems (Kumar & Singh, 2020).

The present study indicate a possible relationship between deteriorating drinking-water quality and increased typhoid prevalence during the monsoon season in Saharanpur district. Continuous monitoring of water quality and hospital-based disease surveillance are therefore essential for identifying high-risk areas and implementing timely public-health interventions. Preventive measures such as chlorination of drinking water, improvement of sanitation infrastructure, regular cleaning of hand pump surroundings, and public awareness regarding safe-water practices may significantly reduce the burden of waterborne diseases in the region (WHO, 2019; UNICEF/WHO, 2021).

V. CONCLUSIONS

The present study revealed a seasonal increase in typhoid fever cases in Saharanpur district, with the highest prevalence observed during the monsoon months of July and August 2026. CHC Punwarka recorded the highest number of typhoid cases, while Horora Hospital showed comparatively higher prevalence rates, indicating localized transmission associated with rural water sources. Physico-chemical analysis of handpump water samples showed elevated turbidity levels at all sampling sites, particularly in Harora, suggesting possible microbial contamination of drinking water. The observed relationship between poor water quality and increased typhoid prevalence indicates that contaminated groundwater may play an important role in disease transmission. In the study showed the importance of regular water-quality monitoring, improved sanitation, chlorination of drinking-water sources, and continuous disease surveillance for the prevention and control of waterborne diseases in Saharanpur district.

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Author's Contributions:

PK and MC conceptualized, designed, and supervised the study, and contributed to data interpretation and statistical analysis. SG conducted the sample collected and compiled the data, performed laboratory coordination, and prepared the manuscript. SK assisted in methodology development, data analysis, and manuscript editing. All authors reviewed, revised, and approved the final version of the manuscript.

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