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Original Research Article

Water quality and burden of jaundice with drinking water sources: a study from Haryana, India

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ABSTRACT

Background: Both anthropogenic and natural processes contribute to the contamination of freshwater sources. In developing countries like India, contaminated drinking water is a source of many diseases. Among anthropogenic factors, industries are an important contributing factor to water pollution. Hence, it is important to analyse water quality and investigate the prevalence of jaundice with different drinking water sources.
Methods: A cross-sectional health survey was conducted in Faridabad. A total of 688 people were randomly selected using convenient sampling, with consumers from all four types of water sources i.e., surface, hand pump, wells, and municipal water. Water samples were analysed for various physio-chemical parameters to understand water quality. The impact of this water pollution on the health of candidates was assessed using a pretested semi-structured questionnaire. The outcome variables like jaundice were considered to see if an association with the drinking water source was present.
Results: Most of the water parameters were within acceptable ranges set by WHO except total dissolved solids (TDS). Majority of subjects who reported jaundice were consuming water from municipal source. Jaundice was found to be statistically significant with $p<0.05$.
Conclusions: The results show that there is significant water pollution present in Faridabad. The possible explanation for the high prevalence of symptoms among those using municipal water is likely because of contamination with sewage lines. This may be the result of old, rusted pipelines lying close to sewer lines. This calls for an urgent intervention by the authorities.

Keywords: Drinking water, Jaundice, Total dissolved solids, Water quality

INTRODUCTION

Clean drinking water is a vital natural resource, which is essential for multiple purposes. It is an essential ingredient of animal and plant life. Its uses may include drinking and other domestic uses, industrial cooling, power generation, agriculture, transportation, and waste disposal. The growing population, accelerating pace of industrialization and intensification of agriculture, and also urbanization exerts heavy pressure on our vast but limited water resources. The presence of too much undesirable foreign substances in water is responsible for water pollution. Water pollution is one of the most serious problems faced by man today.[1]

According to WHO, 10.51 percent of the Indian population does not even get basic drinking water services.[2] Water is a contamination source for many communicable and non-communicable diseases worldwide. Contaminated water resource affects the well-

being and reduce the life span of the exposed population and increases the disease burden within the society. In such countries, risk factors like unsafe water supply, poor sanitation, and hygiene, undernutrition, and stunting are commonly found.[3] Worldwide one in three people don't have access to clean water and hence sustainable development goals of the UN aim at providing clean drinking water universally by 2030.[4] Both intermittent supply and storage of water for a long duration can pose a threat to microbial contamination and hence leading to various health shortcomings in the exposed population.[5] Water crisis includes both scarce water resources and water contamination and is governed by various factors like growing water demand per capita, ineffective water use crisis, widespread access to groundwater, climate-related hazards, and inappropriate sanitation facilities.[6]

The study was conducted in Faridabad district of Haryana, which has witnessed rapid industrialization and urbanization in the last few years. Previous studies have documented the role of industrialization in water pollution.[7]

Hence, the main objectives of this study were, (a) to analyse water quality parameters as per WHO guidelines, and (b) to investigate the prevalence of jaundice with drinking water sources i.e., handpump, municipal, well, and surface water.

METHODS

Study area, sample collection and analysis

The study was conducted in Faridabad, which is located in the Indian state of Haryana. It is the 9th biggest industrial town of India with a total population of 21,94,581 (11,93,063 males and 10,01,523 females) in 2001, covering an area of 2151 km^2.

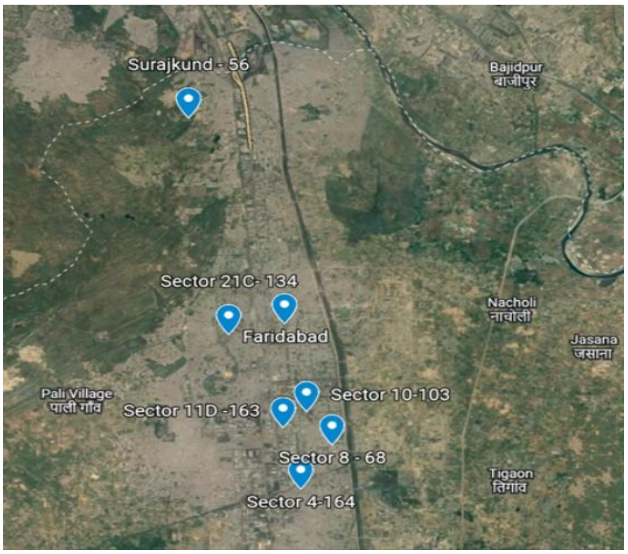

Figure 1: Study area and sample location.

Water samples were collected in 2.5-liter capacity polyethylene bottles (soaked overnight in 2% nitric acid and washed well in distilled water) from seven (7) locations to understand water quality (Figure 1). Samples were collected as per IS:3025 (part 1) methodology.[8] While collecting, preserving, and transporting all the necessary precautions were taken. Samples were analysed for pH, total dissolved solids (TDS), total hardness, alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand (COD).

The parameters like pH, temperature, and DO were measured on-site while collecting the samples. All the rest of the parameters were analyzed in the laboratory as per "standard methods for the examination of water and wastewater" APHA9 and "methods of sampling and test (physical and chemical) for water and wastewater" IS: 3025.[8]

Cross-sectional health survey

A cross-sectional health survey was conducted. A convenient sampling method was used to randomly select 688 subjects, with consumers from all four types of water sources i.e., surface water, hand pump, wells, and municipal water. The questionnaire included both open-ended and closed-ended questions. Age, monthly income, education, smoking habits, drinking water source, and employment data were collected and documented. Direct interviews were conducted by the researchers with all the survey respondents within the local communities in their native language.

The data collected from pretested semi-structured questionnaire was used to determine the prevalence of jaundice with different sources of drinking water, occupation, and age. It was done using the chi-square test.

RESULTS

Demographic overview

A total of 688 subjects were surveyed. Characteristics of the study population ae presented in Table 1. 55.3% of the participants were male. 55% of the participants had 10 years of formal education. 37% of the participants were of low socioeconomic status and only 13% were of higher socioeconomic status whose income was above 1,00,000 per month (According to Kuppuswamy Classification). 12.2% of participants were active smokers. Almost 40 percent of the study population was young, i.e., between 20-40 years of age. There were fewer children less than 10 years of age. Similarly, there were fewer old subjects above 60 years.

Out of 688 subjects, 75 people (10.9%) used hand pump water, 531 people (77.3%) used municipal water, 49 people (7.1%) used well water and 33 people (6.7%) used surface water as their source of drinking water (Table 1).

Table 1: Demographic overview of study population.

	Frequency	Percentage
Gender distribution		
Male	367	55.3
Female	321	46.7
Total	688	100.0
Age wise distribution (years)		
<10	73	10.6
11-20	114	16.6
21-30	148	21.5
31-40	140	20.4
41-50	76	11.0
51-60	57	8.3
>60	80	11.6
Sources of drinking water		
Hand pump	75	10.9
Municipal water	531	77.3
Well water	49	7.1
Surface water	33	6.7
Distribution according to educational status		
Primary	240	34.9
Matriculation	139	20.2
Intermediate	89	12.9
Bachelors	124	18.0
Masters	70	10.2
PhDs	4	0.6
Not answered	22	5.2
Smoking habits		
Current	84	12.2
Former	38	5.5
Never	547	79.2
Not answered	19	2.9

Water parameters

The results of water parameters are tabulated in Table 2. The water samples were observed to be neutral to slightly basic in nature with pH ranging from 7.5 to 7.8. TDS varied from a maximum of 2980 mg/l in sector 6 to a minimum in sector 10. The TDS values in sectors 6, 7, and 11 were higher than the prescribed levels by the World Health Organization (WHO) and the Bureau of Indian Standards (BIS).[7] Hardness in water was found maximum in sector 7 and minimum in sectors 10 and 21. The highest alkalinity was found in water samples of sector 6 and the lowest was found in water samples from sector 8. BOD was found to be lower than the prescribed limits set up by both WHO and BIS, the lowest was found to be zero (sectors 4,7, and 10) and the highest was found to be 1mg/lit (sector 8 and sector 21). As shown in figure 6, COD was found to be more than the prescribed WHO standards in all the sectors of Faridabad except sector 21 where it was found to be 2.0 mg/l.

Table 2: Water sample characteristics.

Parameters	Sec 4	Sec 6	Sec 7	Sec 8	Sec 10	Sec 11	Sec 21	BIS standard	WHO standard
pH	7.7	7.5	7.6	7.6	7.8	7.6	7.7	6.5-8.5	6.5-9.2
TDS (mg/l)	1550	2980	2830	1970	590	2330	1080	2000	500
DO (mg/l)	7	5.6	5.3	5.3	6	5.8	7.2	-	-
COD (mg/l)	12	6	12	20	12	16	2	-	10
BOD (mg/l)	0	0.5	0	1	0	0.6	1	600	6
Total hardness (mg/l)	590	1010	1060	610	430	730	430	600	500
Alkalinity (mg/l)	276	316	96	70	102	122	282	600	200

Jaundice associated with drinking water

The outcome variables like Jaundice were considered to see if an association with the drinking water source was present. As can be observed from Figure 2, 4.5% of participants reported jaundice. Out of a total of 31 cases of jaundice, 19 (2.76%) cases were reported by the people who were consuming municipal water. Another 1.16% (8 cases) were reported by those consuming surface water. Only 2 cases (0.30%) were reported by those consuming handpumps and groundwater.

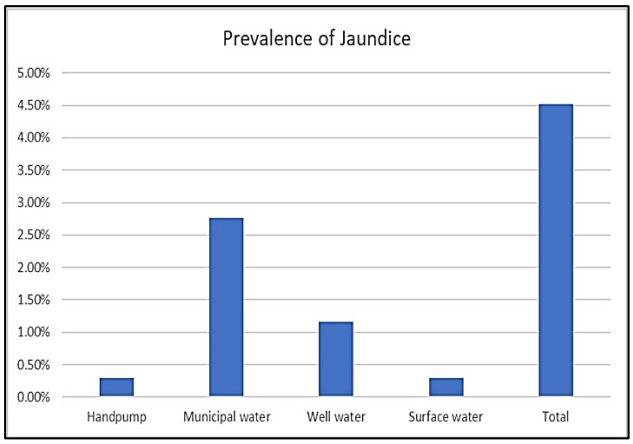

Figure 2: Source of drinking water and prevalence of jaundice.

Majority of those who reported jaundice were consuming water from municipal source. Both the factors were found to be statistically significant with $p<0.05$ which can be explained by the fact that "jaundice" is commonly caused by hepatitis-A virus and its transmission is through the oro-fecal route, i.e., when water gets contaminated by human excreta.[10] The possible explanation for the high prevalence of symptoms among those using municipal water is likely due to its contamination with sewage lines. This may be the result of old, rusted pipelines lying close to sewer lines.

Jaundice with occupation

As seen in Figure 3, the housewives constituted the largest group with 15 jaundice cases reported out of a total of 29 cases, and next was the retired group who reported 2 cases of jaundice.

Housewives spend a considerable amount of time in the house and drink water from the same water source. It could be one of the reasons for housewives showing the largest cases of jaundice due to exposure to polluted water in the greatest amount.

Age-wise distribution with jaundice

From Figure 4, it is observed that there was a steep fall in cases. The highest number of cases was reported in the age group of 30-49 years. Since the majority of the study population is young, i.e., between 20-40 years of age with fewer children less than 10 years and fewer old subjects above 60 years, this unsymmetric age-wise distribution with jaundice is observed.

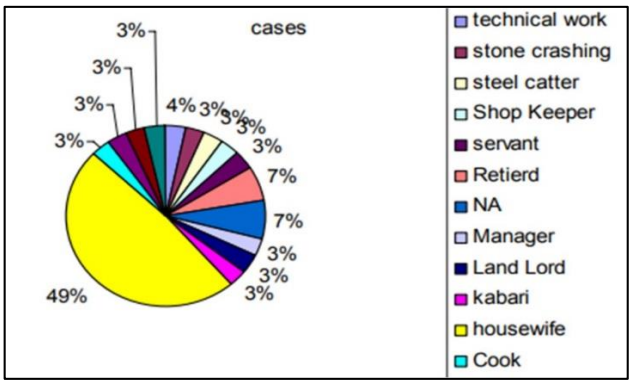

Figure 3: Distribution of occupation in jaundice cases.

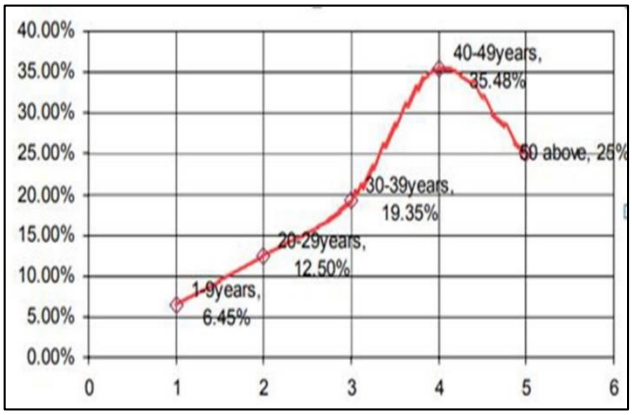

Figure 4: Age wise distribution with jaundice cases.

DISCUSSION

In our study, we assessed the quality of drinking water using various physio-chemical parameters as well as explored its impact on the health of the subjects who consume the same water. Most of the water parameters were within the acceptable ranges except TDS. TDS comprises a variety of salts, including those of Ca, Mg, Na, K, and other elements, as well as carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates. TDS occurs in drinking water well below its toxic levels hence, WHO has not defined its health-based limit in drinking water. However, a TDS level of less than 500 mg/l is considered to be good. Water becomes progressively unpalatable at TDS levels greater than 1000 mg/l. Consumers may find TDS beyond 1200 mg/l undesirable, and it may affect people who need to restrict their daily salt intake, e.g., diabetic, severely hypertensive, and dialysis patients.[11] In sectors 4, 6, 7, 8, and 11, TDS was found above 1200 mg/l.

The majority of subjects do have access to municipal water which is supposed to be treated and tested before being supplied for drinking. However, our analysis revealed that one of the dreaded impacts of contaminated water which is water-borne hepatitis-A did occur in numbers, which we regard as unacceptable.[10] Almost 4.5% of participants reported having jaundice and the majority of them consumed water from municipal source. This was statistically significant with $p<0.05$ which can be explained by the fact that "jaundice" is commonly caused by hepatitis-A virus and its transmission is through the oro-fecal route.[10,12]

There is also a significant correlation present between age and the incidence of jaundice. It was observed that there was a gradual increase in the number of cases with increasing age. After 50 years there is a steep fall in cases. The highest number of cases was reported in the age group of 30-49 years. The unsymmetrical distribution of cases in the age wise distribution is because of the predominance of the young population in the study sample i.e., between 20-40 years of age with fewer children less than 10 years and fewer old subjects above 60 years.

Limitations of the study include the listed factors. First, the sampling was done by a convenient sampling method and hence might not be representative of the entire city of Faridabad. Second, the participants were assessed using a pretested semi-structured questionnaire which might include recall bias, interviewer bias, and performance bias.

CONCLUSION

The findings in our study suggest that water quality monitoring needs further emphasis and an improvement in the total dissolved solids and other physio-chemical parameters of the water are needed. Since consumers of municipal water supply reported cases of jaundice (2.76%), it is advisable that the people residing in the area should consume water either after boiling it followed by cooling it down or using a reverse osmosis machine (RO). Moreover, it is recommended that regular monitoring of drinking water should be enforced and appropriate actions should be taken to decrease the burden of diseases in the community.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of Maulana Azad Medical College

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