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RESEARCH ARTICLE

Water uses, treatment, and sanitation practices in rural areas of Chandigarh and its relation with waterborne diseases

Khaiwal Ravindra[1] · Suman Mor[2] · Venkatamaha Lakshmi Pinnaka[1]

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Abstract
Availability of clean water and adequate sanitation facilities are the principal measures for limiting various waterborne diseases. These basic amenities are critical for health and sustainable socio-economic development. This study attempted to assess the status of water and sanitation facilities and practices of the people living in rural areas of Chandigarh including awareness about the waterborne diseases. The community-based cross-sectional study design was adopted having 300 households across 12 villages of city Chandigarh. A standardized interview schedule was used to collect information related to water uses, storage, water treatment options, water conservation practices, personal hygiene, knowledge about waterborne diseases, and government schemes. The interview schedule was administered with the head of the family as a study approach during the door-to-door survey. Households in rural Chandigarh have municipal water supply for drinking as well as other domestic purposes. The mean per capita water usage was 67 ± 13.4 l. Most (68.6%) of the study participants reported that they do not treat water before drinking and store it in plastic bottles or bucket (58%). The survey shows that 97% of the household had functional toilets in their premises, remaining reported lack of finances, and space for construction as major barriers. Regarding personal hygiene, 83% of respondents wash hands with soap and rest used only water or ash. Observations made under the study highlighted the need to create awareness regarding the role of water and sanitation practices on health including knowledge about various government schemes to improve water quality, sanitation, and hygiene practices for better health.

Keywords Sanitation · Hygiene · Water treatment · Handwashing · Waterborne diseases

Introduction

Clean water and good sanitation practices are essential components of a sustainable, healthy life. These are the basic social development indicators that envisage health promotion and on a larger scale enhance national development. It is estimated that 5.2 billion people use safely managed drinking water service and 2.9 billion safely managed sanitation services (WHO and UNICEF 2017). Globally, remarkable progress has been made with regard to improved water and sanitation coverage during the last two decades (Cha et al. 2017; Ravindra and Smith 2018). Access to improved water sources has risen from 76% in 1990 to 91% in 2015. Similarly, over these years, the share of access to sanitation facilities has improved from 54–68% (Ritchie and Roser 2017).

Improved water and sanitation coverage is more in urban areas as compared to rural households. This differential improvement (distribution according to the type of households) has been reported across continents in most of the countries including India (Ritchie and Roser 2017). Rural drinking water programs with piped water facilities have almost doubled in the rural regions during the last decade. India tops the list of nations for reaching out for clean drinking water to most people. Still, 66% of the habitations do not have access to clean water and use contaminated water as the primary source (Water Aid 2018; Ministry of Drinking Water and Sanitation 2018; WHO 2013).

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✉ Khaiwal Ravindra
khaiwal@yahoo.com

[1] School of Public Health, Post Graduate Institute of Medical Education and Research (PGIMER), Sector 12, Chandigarh 160012, India

[2] Department of Environment Studies, Panjab University, Chandigarh, India

Similarly, there is only 30% increase in access to improved sanitation facilities (such as flush/pour flush, ventilated improved pit latrine, pit latrine with slab, and composting toilets) as reported in the joint monitoring program for Water Supply and Sanitation by WHO and UNICEF (2017). A recent WHO report suggests that > 50% of the rural population of the country still practices open defecation (WHO and UNICEF 2017). This suggests very slow progress in the sphere of sanitation.

Poor water and sanitation practices put a heavy burden of waterborne-related diseases with the largest share of diarrheal diseases (Ravindra and Mor 2013). Ali et al. (2018) reported that India tops the list among 15 countries that contribute to 75% of all diarrheal deaths globally. The situation is even serious in rural areas of the country with a prevalence of diarrhea reported to be 9.6% as against 8.2% in urban India (IIPS 2017). The reason is either an infrastructural dearth or deficient utilization concerning water and sanitation facilities/services.

Chandigarh was ranked among the top three cities in terms of sanitation (Ministry of Urban Development 2015; Ministry of Housing and Urban Affairs 2018). The city is known for its well-managed architecture and infrastructural design including water supply, electricity, and other sanitation facilities. Initially, until 1983, the main source of drinking water was underground water harnessed through tubewells. However, with development, over the years, not only have the numbers of tubewells increased but also the tapped surface water from the Bhakra Nagal main canal serves as a source for drinking water. Tap water served as the main source of drinking water in all the villages along with other sources such as well, hand pump, tubewell/borewell, and tank/pond/lake (Census 2011; Ravindra and Mor 2019). With regard to sanitation, the city has 100% toilet facility at the household level (as against 87.6% coverage as per Census 2011) along with a proper sewage disposal and treatment system (Ministry of Drinking Water and Sanitation, 2017a).

Despite the progress made over the years, there are some villages and rural areas in Chandigarh that lie close to the municipal waste dumping ground or the industrial site; this may contaminate water (Negi et al. 2018; Mor et al. 2013a) as detailed in supplementary Figure S1 and S2. There is research evidence focusing on the physio-chemical parameters and microbiological quality of water in Chandigarh (Sharma 2015; Ravindra et al. 2015; Singh et al. 2014). Coliform contamination of drinking water in Chandigarh was also reported by Goel et al. (2015). In addition, cases of gastroenteritis because of contaminated and stinking water supply were reported in January 2017 (Mahajan 2017). Puri et al. (2014) reported another outbreak of waterborne disease in Chandigarh during July 2012. This study identified mixing of drinking water with sewage due to leakage of pipes as a cause of the outbreak, despite the supply of drinking water through the tap. The outbreak of waterborne diseases, especially acute diarrheal diseases, has increased over the last 2 years in Chandigarh. The number of cases in these outbreaks during the last 10 years are summarized in Table 1 (National Centre for Disease Control 2019) but most of the waterborne remain under-reported. Further, there is a dearth of studies that ascertain the water, sanitation, and hygiene practices being followed by the residents.

Drinking water and sanitation are the two most crucial pre-requisites for progress, social equity, and human dignity to improve the quality of life of people. Hence, the study was conducted to understand the impact of socio-cultural factors with the help of knowledge, perception, and practice survey on water handling and usage, sanitation, and defecation practices in rural areas of Chandigarh. The study will help to understand the factors associated with poor sanitation and hygiene to plan culturally acceptable interventions to reduce the burden of waterborne diseases. This will further aid to achieve sustainable development goal six, which aim to achieve adequate and equitable access to clean water and sanitation for all.

Methodology

Study area and study design

The study was carried out in the rural areas of Union Territory, Chandigarh, which is located near the foothills of the Shivalik range of the Himalayas in northwest India. It covers an area of approximately 114 km^2 and shares its borders with the states of Haryana and Punjab. Chandigarh lies on the geographical coordinates of 30° 44′ 13″ N, 76° 47′ 13″ E. It has an average elevation of 321 m.

Chandigarh administration has notified 12 villages as shown in Fig. 1. Khuda Ali Sher and Kaimbala villages lie in the Northern Periphery of Chandigarh; Dhanas, Khuda Lahora, Khuda Jassu, Sarangpur, Maloya, and Dadu Majara villages are located in the Western Periphery of Chandigarh; Kishangarh, Daria, Mauli Jagran, Makhan Majra, Raipur Kalan, and Raipur Khurd villages are located in the Eastern Periphery of the city. A cross-sectional survey was conducted in 2014 during the post-monsoon season.

Sampling and sample size

The study area covered a rural population of 28,991 with 17,150 males and 11,841 females. The sampling units were households, and the sample size was calculated based on the standard formula

$$n = z^2pq/d^2$$

wherein n = sample size; z = 1.96, (at 95% confidence levels); p = 78.5 (access to drinking water); q (1-p) = 21.5;

Table 1 Trend of the number of cases reported during waterborne outbreaks in Chandigarh, India

Year	Acute diarrhoeal disease	Cholera	Food poisoning	Hepatitis A	Hepatitis E	Enteric fever
2018	172	0	0	0	17	0
2017	310	3	0	0	0	0
2016	0	0	0	0	0	0
2015	0	20	0	0	0	0
2014	0	0	0	0	0	0
2013	0	0	0	0	0	0
2012	0	0	23	67	0	0
2011	0	10	0	0	0	0
2010	0	0	0	0	0	36
2009	0	0	0	0	0	0

Data source: Integrated Disease Surveillance Programme Portal (IDSP 2019)

and absolute precision "*d*" was taken at 5% = 0.05. Using the above formula, the sample size was calculated to be 270. Accounting 10% non-response, the sample size was finalized to be 300 households. Proportionate random sampling was done to select the respondents from all the 12 villages viz. Dadu Majra (25); Malloya (26); Kaimbala (26); Burail (24); Dhanas (25); Kishangarh (25); Moli Jagran (25); Khuda Jassu (24); Khuda Ali (26); Raipur Khurd (25); Raipur Kalan (25); and Sarangpur (24).

Study tool

A semi-structured interview schedule consisting of 78 questions was used as the study tool. It was divided into five different sections, and the first section consisted of the general information. This incorporates the socio-demographic profiles of the households including a number of family members residing in the house, age, gender, education, occupation, income, and suffering from any

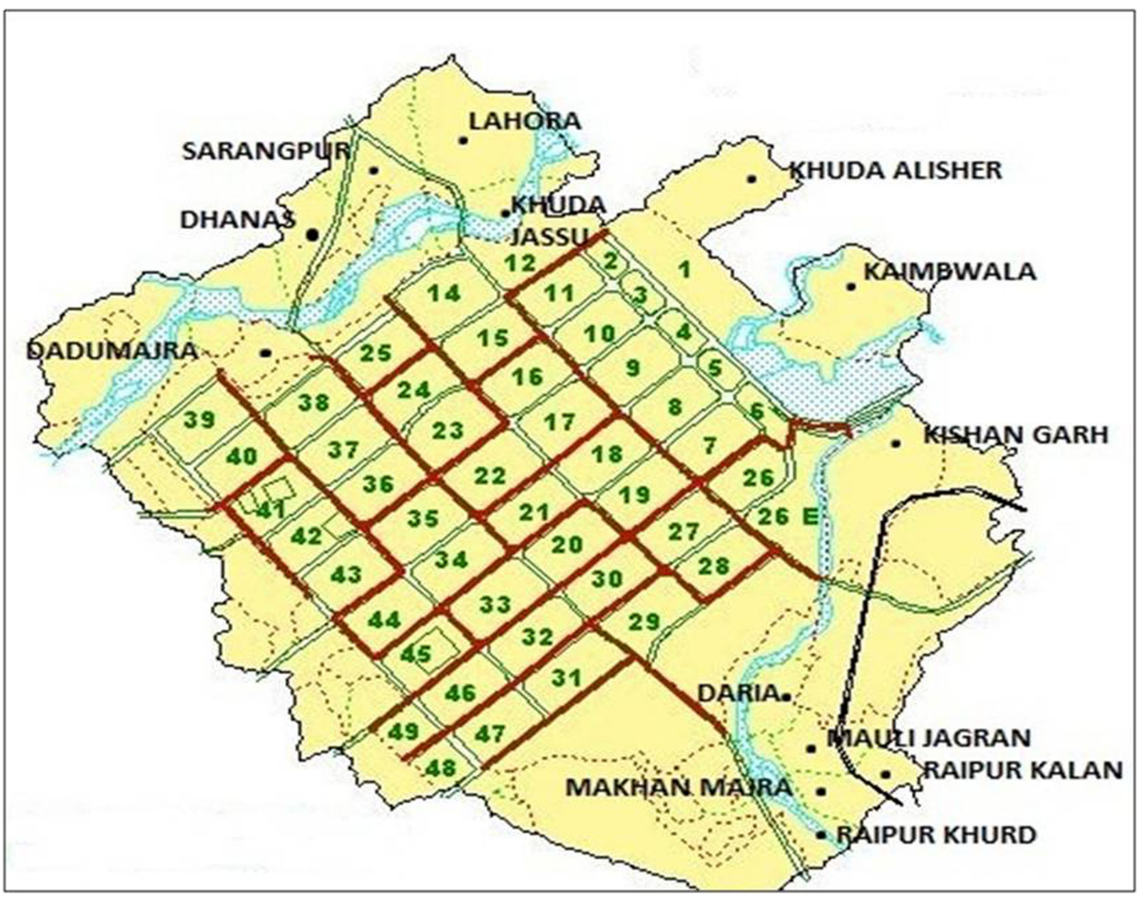

Fig. 1 Map showing villages of Chandigarh, India

illness in the past year. Section 2 aimed to determine the main source of drinking water for each household (i.e., the water source that caters to most of the household drinking water needs), its storage, and usage. Water treatment awareness and options were assessed in section three. This segment ascertained the various water treatment practices prevalent among the residents of the villages. Section four seeks information regarding the prevalent health and sanitation practices among village residents of Chandigarh. The last section of the questionnaire focused on the awareness level of the residents regarding various government schemes related to health and sanitation.

The head of the household usually the female head was interviewed. However, in their absence, another member of the household was contacted. During the survey, the queries of the participants were also considered, and appropriate advice was given. The study was conducted in accordance with the approved ethical guidelines and written informed consent was obtained from the participants.

Statistical analysis

Data was entered and analyzed using Microsoft Excel and SPSS version 19. Frequency and percentage were calculated in terms of household water supply and storage; water treatment practices and beliefs about water; handwashing practices; toilet facility; and knowledge level regarding waterborne diseases as well as about various government schemes available related to health and sanitation. Moreover, the mean and standard deviation was assessed for per capita usage of water by the households.

Results and discussion

The socio-demographic characteristics of households are shown in Table 2. More than three-fourths of the respondents were literate. No particular occupation was found predominant among the participants. However, majority, i.e., 30.6%, was engaged in private sector jobs, and only a few (5.6%) were involved in agriculture. Majority of the families had a single earning member with a monthly income of less than $137.9

India has achieved the MDG target by increasing the share of access to improved drinking and sanitation facilities from 54 to 68% (WHO 2015). However, significant efforts are needed to attain the SDG target of safe drinking water by 2030. Until safe, drinking water is available to household interim measures such as household water treatment and safe storage practices are helping to reduce the burden of waterborne diseases.

Water supply, availability, and adequacy

One of the primary public health concerns in rural India is the availability, adequacy, and provision of safe water (Ministry of Drinking Water and Sanitation 2017b; Dahnn et al. 2017; Kang et al. 2001; Bilas and Singh 1981). In the present study, 299 (99.6%) households, obtained water from the government piped supply. However, the issue of seasonal variation concerning the availability of water was also mentioned by the respondents. Some houses had an additional personal bore well. These findings corroborate with studies by Banda et al. 2007; Edokpayi et al. 2018; Verma et al. 2017. Other primary sources of water such as manually operated hand pump; wells or spring water reservoirs; and boreholes have also been reported (Bhadra et al. 2018; Nastiti et al. 2017; Mkwate et al. 2016).

As a corollary, it was also estimated during the study that majority (66.6%) of the families were using the respective source of water supply for 4 years. All the households were satisfied with the adequacy, but water supply was intermittent (fixed hours supply during morning and evening). The per capita mean water usage was 69.3 ± 13.2 l in villages near the dumping ground; 65.5 ± 12.04 l for villages near the industrial area, and 65.7 ± 12.9 in other remaining villages. This was in agreement with adequate water supply in the household as reported by over half of the households in Adilabad, India (Lalitha and Suchirithadevi 2018) and Botswana (Ramolefhe et al. 2017).

Water usage and storage

The concept of safe water in a community depends on the quality of water source as well as its storage and handling in domestic settings. Believing that the government supplied water is safe may increase the prevalence of preventable water-related morbidities and mortality. Due to intermittent water supply, communities store water for many hours or even for days, which increases the probability of waterborne contamination despite having a safe drinking water supply. Users especially children can contaminate water as they might put their unclean hands or utensils into the household water container (Jensen et al. 2002). Hence, the appraisal of water storage, handling, and treatment practices prevalent among communities help to plan suitable and effective interventions.

The survey shows that piped supply was mainly used for drinking as well as other routine domestic purposes in all the households. Similar results, concerning piped water supply, were also observed by Bermedo-Carrasco et al. (2018) and Pachori et al. (Pachori 2016). Contrarily, the use of bottled water for drinking was reported by Harris et al. (Harris 2017) in Thailand and by Nastiti et al. (2017)

Table 2 Socio-demographic distribution of the respondents in Chandigarh, India ($N = 300$)

Socio-demographic variable		No. of respondents *n* (%)
Education	None	67 (22.3)
	Primary/secondary school (completed 7th std.)	70 (23.3)
	High school (completed up to 10th std.)	87 (29)
	Higher secondary school (completed higher than 12th std.)	50 (16.6)
	College/university (graduated/post graduate)	26 (8.66)
Occupation	Self-employed	72 (24)
	Government employ	61 (20.3)
	On daily wages	56 (18.6)
	Agriculture	17 (5.6)
	Private sector	92 (30.6)
Earning members in the family	1	196 (65.3)
	2	69 (23.0)
	3	24 (8)
	> 3	11 (3.6)
Monthly income	Less than Rs 5000	54 (18)
	Between Rs 5000–10,000	126 (42)
	More than Rs 10,000–20,000	81 (27)
	More than Rs 20,000	37 (12.3)

in Indonesia, whereas Juran and Lahiri-Dutt (2017) highlighted the use of hand pump water for drinking and cooking purposes in Kolkata, India.

Infrequent availability, particularly due to seasonal variation, generates the need to store water for drinking, food preparation, cleaning, washing, and bathing. Water storage is also influenced by interrupted water supply. It was observed that most (80.3%) households stored drinking water separately from water used for other domestic purposes such as cleaning the house, washing utensils, cooking, and for toilet purposes. Interrupted water supply may sometimes force the household to use water for drinking purposes, which was stored for other domestic purposes. This highlighted the need for proper treatment before its consumption for drinking purposes. Household storage has been found to be associated with contamination of drinking water. The level of contamination depends on various factors such as the site of storage, type of container, and handling practices (Clasen 2015; UNICEF 2009; Mintz et al. 1995). Storing water in plastic containers or bottles aids the accumulation of biofilms and escalates microbial growth leading to deterioration of water quality (Ramolefhe et al. 2017; Machdar et al. 2013). It was observed that rural Chandigarh also stored drinking water mainly in plastic bottles or bucket (57.6%) which may contaminate water during storage. The use of plastic containers has also been reported in other studies (Edokpayi et al. 2018). However, people in the villages of South India preferred the use of brass and steel vessels for water storage (Banda et al. 2007; Lalitha and Suchirithadevi 2018). The use of plastic material for storage of drinking water may also contaminate it with microplastic particles, which may be toxic for human consumption (Evandri et al. 2000; Leivadara et al. 2008; Yang et al. 2011; Bach et al. 2012; Fan et al. 2014)

Length of storage time is another important factor that contributes to the contamination of stored water (Packiyam et al. 2016; Subbaraman et al. 2013). Brick et al. (2004) reported that 67% of water samples showed increased contamination with an increase in sampling duration and is also affected by the container materials. Water storage for long periods facilitates stagnation of drinking water including dissipation of disinfectant residuals, which could lead to the deterioration of water quality (Nogueira et al. 2003). Freshwater was not collected every day in rural Chandigarh. This increases the chances of contamination of stored water proportionately with the storage time. Mohmhad and Malik (Mohd and Malik 2017) also reported that water was stored in 20-l capacity cans and subsequently used it for at least 2 days in Bangalore, India. Therefore, the practice of collecting fresh water for everyday use needs to be inculcated among rural households and communities. However, contrary results were reported by Reshma et al. (Reshma and Mamatha 2016) where they observed the daily change of water in storage vessels in Udupi, India. Hence, it could be concluded that both storage time and the type of container accentuate the contamination of stored drinking water.

Perception about the quality of water

Long et al. (2018) highlighted that ensuring access to drinking water may not increase water consumption if there are negative perceptions about tap water safety or taste. Perception about safe water is a crucial determinant of community acceptance of public water. It is affected by many factors such as organoleptic properties and perceived level of risks associated with water sources as reported by de Franca et al. (de Doria et al. 2009) and de Franca (2010).

Clean drinking water was considered an important aspect of everyday life by most (92.6%) of the respondents in rural Chandigarh. Despite a major proportion (78.6%) of the study respondent attested that available water is safe for drinking, but some households (21.4%) expressed certain organoleptic barriers concerning drinking water quality as depicted in Table 3. The most commonly reported barrier by the studied households was the taste of drinking water (75%). Similar observations were also reported by Ramolefhe et al. (2017) (> 50%), Harris et al. (Harris 2017) (≃ 50%); Dupont et al. (2014) (31%); and Mkwate et al. (2016) (51%). Foul odor from drinking water was also reported by some of the studied households in Chandigarh. This may be linked to chlorination of water, with free chlorine residual beyond the breakpoint (Bruchet and Duguet 2004; Cees et al. 1974)

Water treatment practices

Perceptions about water quality are endogenous (Bontemps and Nauges 2016; Lloyd-Smith et al. 2018; Vásquez et al. 2015). This contributes to the participant's decision to treat drinking water or not. In India, more than 70% of the rural population does not use any method of water disinfection (Verma et al. 2017; IIPS 2007). This elaborates the study findings of the current study as 68.6% respondents do not treat water before its use. This instigates to be a source of infection for waterborne diseases. These findings are in agreement with Bhattacharya et al. (2011), Joshi et al. (2014), and Badiya et al. (Baidya et al. 2018) wherein 72%, 75%, and 56% households respectively do not treat water and used it directly for drinking. However, contrary results were found by Pachori et al. (Pachori 2016) in Salem, India, and Kuberan et al. (2015) in Chennai, India, where most households treated water before use for drinking purposes.

Table 3 Self-reported barriers in consumption of available water for drinking in Chandigarh, India (*N* = 64; multiple responses)

Barriers	No. of respondents *n* (%)
Taste	48 (75)
Color	30 (46.9)
Smell	22 (34.4)
Other (fine dust particles, dirt, etc.)	8 (12.5)

The quality of water in Chandigarh was evidenced to be acceptable in terms of various physio-chemical parameters (Sharma 2015). The same study suggested that to avoid possible adverse health effects, water should be treated properly before drinking minimize contamination. Puri et al. (2014) investigated a waterborne outbreak in Chandigarh and identified leakage in water pipes and its subsequent mixing with drainage as its cause. This signifies that though water is acceptable in terms of physio-chemical parameters, it always remains prone to microbial contamination as in many cities including Chandigarh, drainage and drinking water pipes are laid down together at certain locations. A similar situation of contamination of groundwater sources with fecal coliforms from the adjacent on-site sanitation system has been reported in Chennai (Jangam and Pujari 2019). Thus, treatment of water before consumption is suggested to prevent and reduce the burden of waterborne diseases (Ravindra and Garg 2006; 2007; Mor et al 2018).

The government's attention towards water treatment remains poor at rural locations, and hence, these communities need to adopt averting behaviors such as boiling, filtration, or bottled water. Moreover, with little information available regarding the quality of water, households follow a mix of averting behaviors based on their perception (Aksan and Vasquez 2018). In the present study, 31.3% of participants treated water before drinking, and the use of domestic filters was observed as a popular practice followed by boiling as shown in Fig. 2. With regard to methods used for filtration, most of the participants used reverse osmosis (RO)-based water purifier, and only some of the participants were using RO filters with UV system.

Similar findings with adopting filtration devices such as reverse osmosis systems, charcoal, and multimedia filters were seen in 100% of households in Kolkatta, India (Juran and Lahiri-Dutt 2017). Filtering using cloth or sieve, though not discovered in our study, is one of the most popular traditional method still prevalent in certain areas as reported by Claassen et al. (2015) and Badiya et al. (Baidya et al. 2018). Boiling was the second preferred method as emphasized in the current study area but have disadvantages such as cost, time consumption, and further, it remains prone to recontamination if not stored properly as reported by Hazarika (2015).

Rooftop water tanks are used for storing water for routine purposes in rural Chandigarh, and these water tanks were cleaned once a month by the majority (77.6%) of the households but without any disinfectant. Despite regular cleaning of rooftop water tanks, 48.3% of households reported algae, sand, or silt deposits in the storage tank. This suggests that cleaning is not done regularly and

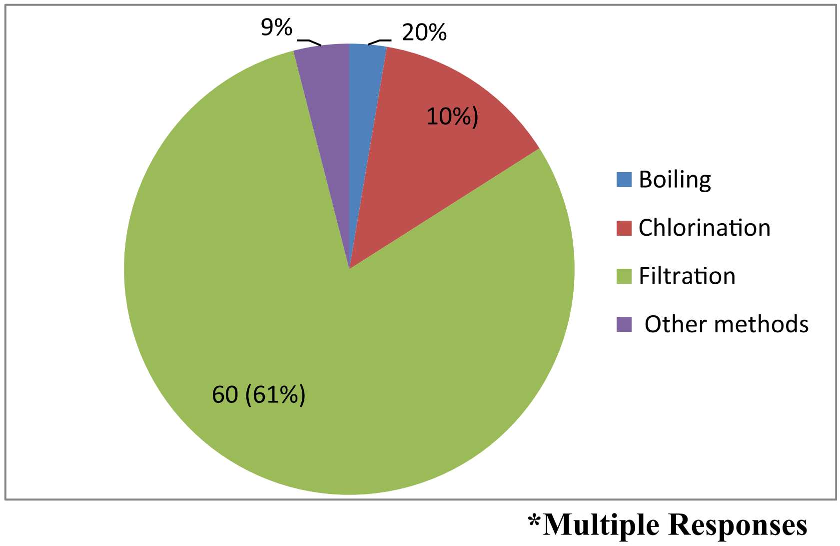

Fig. 2 Water treatment processes adopted by the respondents in rural, Chandigarh, India ($N = 94$; multiple responses)

properly with the application of disinfectant. Similar results of contamination of overhead water tanks, despite fortnight cleaning, were reported by Gopal et al. (2009) in Tamil Nadu, India. Though, the reason for contamination was different and was attributed to the insufficient quantity of the bleaching powder used for cleaning of water tanks.

Toilet availability and usage

Globally, one out of eight people still defecate in the open, and the situation is even worse in low- and middle-income countries (Ravindra and Mor 2018). India is no different where only moderate progress has been observed in the use of sanitation facilities from 1950 to 2015. However, significant efforts are being made since 2014 under the Clean India Mission known as Swachh Bharat Abhiyaan (SBA) to wipe out open defecation by 2019 (Ministry of Drinking Water and Sanitation 2016). Ravindra and Smith (2018) mentioned that 44% of Indian population defecate in the open with 10% belonging to urban and 61% to the rural population.

In the light of the SBA national program, out of total houses visited, 97% had functional toilets with flush systems in their premises. The remaining 3% went to open fields or used common toilet facilities. The main reason for not having a toilet in the household was reported to be lack of finances and space for the construction of the toilet. Concerning the drainage system, 96.3% of households had sewer lines followed by closed pipes (2%) and open drainage (1.6%). This suggests appropriate sanitation facilities in rural areas of Chandigarh, but financial support is still needed to build toilets to achieve 100% open defecation free status.

The results of our study corroborate with the study conducted by Swain et al. (Swain and Pathela 2016) wherein 81% of the households in Districts of Ghaziabad and Jabalpur, India, had toilets. Though, these toilets were underutilized in these two districts due to lack of proper sewer drainage system. However, the proportion of toilet availability within the household premises of Thandalam village in Chennai, India, was observed to be lower, i.e., 75% (Kuberan et al. 2015). This indicates that due to lack of proper toilet facility in India, people still either defecate in the open or use community toilets or share toilets with other households. The practice of open defecation may increase the incidence of various waterborne and infectious diseases (Mor et al. 2013b). This poses a great challenge to achieve the sixth goal of SDG, which focuses to ensure availability and sustainable management of water and sanitation for all by 2030. Hence, there is a need to address the issue of open defecation with greater focus in rural areas of India.

Handwashing practices

Hand washing forms the basis of hygienic practices, and in rural Chandigarh, 97% of respondents reported that they follow proper handwashing practices. These results were contrary to the study conducted in Uttar Pradesh and Madhya Pradesh states of India, where the practice of hand washing was observed to be very low by Swain and Pathela (2016).

Among the different materials used for handwashing, soap was most commonly used (83.3%) followed by only water (9.3%), and other materials such as ash (7.33%). Badiya et al. (Baidya et al. 2018) and Kuberan et al. (2015) reported similar observation for Salyan, Nepal, and Chennai, India, where 96.3% and 83% respondents used soap for handwashing. However, this figure of usage of soap was found to be low (57.7%) in Bangalore, India (Mohd and Malik 2017). It is suggested that about one-third of episodes of waterborne diseases can be reduced by handwashing (Ejemot-Nwadiaro et al. 2008)

Knowledge about diarrhea and other waterborne diseases

Diarrhea is still one of the leading causes of deaths in India (Ravindra and Smith 2018). It is estimated that poor water, sanitation, and hygiene practices contribute to approximately 50% of the total premature deaths in children < 5 years (Verma et al. 2017; Manna et al. 2013) and 10% of premature deaths in age < 5 years as reported by Ravindra and Smith (2018). Though the rate of premature mortality has declined in India during the last decade, considerable efforts are needed to promote adequate hygiene.

Most of the study participants from rural Chandigarh were found to be well aware of the causative factors associated with diarrhea and other waterborne diseases. They perceived either contaminated food (23%) or contamination of water and food together (21%) as the main cause of diarrhea. As shown in Fig. 3, similar findings were established by Bharadwaj et al. (2011) and Bhattacharya et al. (2011) wherein 34.7% and 20% respondents respectively reported contaminated food and water as the major causes of diarrhea and other waterborne diseases. Thus, it is critical to ensure routine awareness program on waterborne diseases, their causation, transmission, and health implications for improving the water, sanitation, and hygiene practices and for reducing associated morbidities.

Awareness regarding available government schemes related to sanitation

About 61.3% of study participants knew the location of rural sanitary marts which provide basic material for the construction of toilets in the villages. This suggests that the rural communities are well aware of the latest sanitation schemes under SBA. Kishore et al. (2018) also reported a high awareness level (62%) about SBA in Telangana. Similarly, the majority (57%) of the nursing students in Nellore had heard about the mission (Paramjyothi et al. 2017).

However, on the contrary, only 24% of respondents were aware of SBA in the states of Uttar Pradesh and Madhya Pradesh as reported by Swain et al. (Swain and Pathela 2016). Despite the variation in the knowledge level regarding SBA across different states of India, the communities are well aware of these initiatives taken by the government to reduce open defecation, accelerate rural sanitation coverage and improve waste management. Still, concrete efforts are needed to bridge the gap between knowledge and practice through appropriate and effective behavior change interventions.

The way forward

Based on the observations made in the current study, various initiatives as listed below could be taken at government, community, and individual levels to reduce the burden of poor water, sanitation, and hygiene practices.

Government

There is a need to ensure proper maintenance of the water distribution system in accordance with the laid down rules and regulations. The measures need to be taken to regularly monitor the condition of the water supply pipelines, etc. to keep a check of the contamination of water during the supply process. Routine monitoring of water should be done to ensure the availability of safe drinking water as per the drinking water quality standards.

Community level

Although government agencies have provided infrastructural support to improve access to clean water and proper sanitation

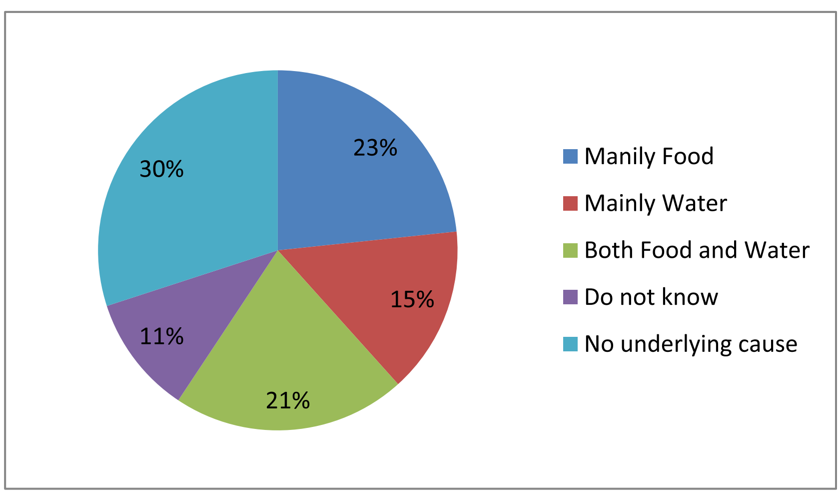

Fig. 3 Perceived causes of Diarrhea in rural Chandigarh, India ($N = 300$)

facilities through various programs such as the SBA and Nation Rural Drinking Water Programme (NRDWP), communities are aware of such schemes, but their implementation on the field is still lacking. Thus, mass media, local politicians including community leaders need to be engaged in the loop to mobilize the public regarding the benefits of government schemes that improve water quality and sanitation facilities. The role of local NGOs and front line workers also needs to be impressed upon.

Individual level

There is a need to promote personal hygiene and sanitary education having a focus on water and sanitation practices to minimize the waterborne diseases. Individuals need to be educated about various techniques and process available for safe water treatment and storage. Adoption of hygienic practices not only help individuals to remain healthy but endorse action towards a health-promoting society.

Research related

There is a need to focus research on hygiene and sanitation practices in rural and urban areas and effective interventions need to identify. Expansion of the current study ascertaining the causal relationship of water, sanitation practices with the prevalent waterborne morbidities also need to be established.

Conclusion

Almost all households in Rural Chandigarh had piped water supply and utilize it for drinking and other domestic purposes. Rural residents perceive the available water supply to be safe and adequate, with some seasonal complaints. Rural communities store water due to the intermittent water supply. Water is mainly stored in plastic bottles or buckets for drinking purposes and in overhead water tanks for other domestic needs. A greater understanding among the participants is required that though the piped water supply is treated, there are chances of water getting contaminated during distribution. Thus, the residents should be made aware of the cost-effective measures to treat water at the point of use, i.e., at the household level including knowledge about safe storage and handling practices. The lack of knowledge about safe water, proper sanitation, and hygienic practices including handwashing is need to be improved. However, while planning intervention cultural practices should be taken in the account, this will help communities to adopt improved sanitation practices for better health.

Limitations of the study

Since only one member from each household was selected, the status of hygiene practices cannot be generalized for other members of the family. Further, the study reports water, sanitation and hygiene practices of rural household in the urban settlement.

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Compliance with ethical standards

Ethics approval and informed consent Written informed consent was also obtained from the participants enrolled for the study. All data has been kept confidential.

Conflict of interest The authors declare that they have no conflict of interest.

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