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Water, Sanitation, and Hygiene (WASH) Conditions and Their Association with Selected Diseases in Urban India

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Abstract

In urban India, water, sanitation, and hygiene (WASH) practices are a significant public health concern because the urban resident has more adverse exposure to WASH practices and there is a severe crisis of demand and supply. This study aims to explore WASH conditions and their association with selected diseases in urban households in India. WASH conditions and the prevalence rates of stomach problems, malaria, skin diseases, and fever due to diseases other than malaria were calculated using the National Sample Survey Organization (NSSO)'s 69th round data. Logistic regression was carried out to examine the association of WASH conditions with selected diseases. About 95% of households studied had access to improved sources of drinking water, 77% had water sources within their premises, and 90% had improved latrine facilities. 52% were covered by municipalities' garbage collection facilities, 60% were connected with improved drainage, whereas 97% had problems with flies and mosquitos. Unimproved sources of drinking water were significantly associated with stomach problems and skin diseases. The quality of drinking water, the non-availability of latrine facilities, and the absence of garbage collections were significantly associated with stomach problems and fever other than malaria. Improved WASH conditions are crucial to achieving better health and development in urban India, and the results suggest the need for effective policy and program interventions in waste management along with awareness generation on hygienic environment.

Keywords

Water; sanitation and hygiene; diseases; urban households; India

Introduction

Clean water along with adequate sanitation facilities and hygiene practices is essential for good health (Mara, Lane, Scott & Trouba, 2010). Sanitation refers to the provision of adequate facilities and services for the safe disposal of human urine and faeces as well as for solid waste management. It also relates to the state of indoor, outdoor, and neighborhood environmental conditions, such as sewerage systems, methods of garbage disposal, and the availability of ventilation and open space (Bartlett, 2003). The World Health Organization (WHO) considers water, sanitation, and hygiene (WASH) practices to be the most basic needs for overall development. About 2.6 billion (40%) of the world's population lacks some access to sanitation facilities for the appropriate disposal of human excreta, whereas 1.2 billion have no such facilities at all (UNICEF, 2012). Estimates from a study in 2002 showed that issues with WASH caused 4% of all deaths and 5.7% of total disability-adjusted life years (Prüss, Kay, Fewtrell & Bartram, 2002). In Low and Middle-Income Countries (LMICs), 842,000 people die due to inadequate WASH conditions each year; and of these deaths, 280,000 are caused by poor sanitation (WHO, 2018a).

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Many developing countries besides India struggle with inadequate (WASH) facilities. A WHO (2018b) study has estimated that, worldwide, there are 219 million cases and 435,000 deaths due to malaria (WHO, 2018b). Half of the cases mentioned in the study occurred in five countries (Nigeria 25%, the Democratic Republic of the Congo 11%, Mozambique 5%, India 4%, and Uganda 4%). Malaria has been continuously declining, but there were still 0.84 million disease cases in 2017 in India (Dhiman, Veer & Dev, 2018). Skin diseases and fevers other than malaria are widely associated with WASH conditions. Due to rapid urbanization in India, cities are facing severe problems related to a lack of drinking water, inadequate toilets, poor wastewater management, and unhygienic practices (Chaplin, 1999). The population of India has increased more than threefold from 1950 to 2018 (382.4 million to 1.35 billion), and the level of urbanization has nearly doubled, with the urban population reaching 461 million in 2018 and projected to double by 2050 (United Nations, 2018). The National Family Health Survey – 4, shows that nearly 12% of households do not have access to toilet facilities, and 9% of households do not have access to an improved source of drinking water in urban India (IIPS & ICF, 2017).

Literature Review

Several studies have recognized the link between sanitation conditions and human health (Cairncross, 2003; Esrey, Potash, Roberts & Shiff, 1991; Gupta & Pal, 2008). A systematic review of the literature reveals that unsafe water and inadequate sanitation cause diarrhea, hookworm infection, and other diseases that threaten human life (Esrey et al., 1991). Many infectious diseases are associated with human excreta that is not isolated from the population as a whole and not kept out of water sources, and that therefore allows pathogens to flourish and spread disease (Bartram & Cairncross, 2010; Mishra & Goldar, 2008). Improved sanitation helps to prevent diseases such as intestinal worms, malaria, and trachoma (Cairncross, 2003; Chaplin, 1999; Gopal et al., 2009). Inadequate management of wastewater, untreated composite pits, sewerage, and poor solid waste management causes malaria (Inah, Uwadiegwu, Eko & Inah, 2017; Mauti, Mauti & Kowanga, 2015). People residing in slums are more prone to health risks, such as stomach problems, malaria, diarrhea, typhoid, jaundice, other fevers, and vector-related diseases, including dengue, and chikungunya (Kumar, Kar & Jain, 2011; Mara et al., 2010; Mishra & Goldar, 2008). Overcrowding, high population density, and environmental pollution in slums can lead to stomach infections that affect a large proportion of young children (Davis, White, Damodaron & Thorsten, 2008; Nath, 2003).

Growing numbers of cities (in India) are facing a severe crisis of demand for and supply of amenities like drinking water, adequate sanitation facilities, and necessary infrastructure (Kumar & Harada, 2002). Most cities and towns in India are characterized by overcrowding, congestion, inadequate water supply, and poor sanitation facilities regarding the disposal of human excreta, wastewater, and garbage disposal, which affect the health of the urban population (Chaplin, 2011; Joardar, 1998). A study suggests that India is on track to meet its target of improving access to safe drinking water, with a sharp reduction in urban-rural disparities. However, as far as sanitation facilities are concerned, the country lags far behind (Kumar & Das, 2014), with 60% of its population having to practice open defecation due to a lack of sanitation facilities (Coffey et al., 2014).

The literature suggests that WASH conditions are significantly associated with infectious diseases. A number of studies have explored sanitation conditions (Kumar, 2015; Dobe, Sur & Biswas, 2011; Gupta & Pal, 2008; Nath, 2003) and their association with health at micro and national levels (Reese et al., 2017; Baranwal, Baranwal, & Roy, 2014; Kumar & Das, 2014;

Kumar & Harada, 2002; Gupta & Pal, 2008; Puri, Kumar & Johal, 2008). However, there have been no studies focusing on WASH practices and their link with selected diseases in urban households in India. Previous studies have brought out significant disparities in WASH conditions in rural versus urban settings concerning access to sanitation facilities (Reese et al., 2017; Das & Das, 2015). The relationship between WASH and the prevalence of diseases in urban settings is still unexplored at the national level. Therefore, the present study seeks to examine the coverage and distribution of WASH conditions and their association with illnesses such as stomach problems, skin diseases, malaria, and fever from diseases other than malaria in urban areas of India. The results are expected to be useful for understanding the present water, sanitation, and hygiene conditions in urban India. The study utilizes survey data from the 69th round (2012) of the National Sample Survey (NSS), which is a nationally representative household survey with a stratified multi-stage sampling design that provides comprehensive results. This study on WASH conditions in urban households focused on essential aspects of living facilities along with the surrounding environment, both of which factors are closely related to health.

Material and Methods

The current study used secondary data from the National Sample Survey's (NSS) 69th round data collected in 2012. The 69th round survey data gathered information on drinking water, sanitation, and hygiene in all states and union territories (Uts) of India. For sample collection purposes, a stratified multi-stage design was adopted for each state and UT and independently for the urban and rural areas within the states and UTs. For the urban areas, the latest updated list of the Urban Frame Survey (UFS) blocks was considered as the sampling frame. The objective of the NSS-69th round was to provide information on drinking water, sanitation, hygiene, and housing conditions through Schedule 1.2 covered mainly the following: a) drinking water and water for household activities, b) the micro-environment, and c) incidence of some specific types of illness (stomach problems, skin disease, malaria, and fever other than malaria during the last 30 days). The total surveyed sample of households was 94,548. Of this, 42,156 households were selected from the urban area and 53,393 households from the rural area. For the present analysis, the study used only the urban sample. The details of the study description, design, and materials are available from the following link: http://www.icssrdataservice.in/datarepository/index.php/catalog/95.

Description of variables

Four types of diseases were taken as the outcome variables: (i) stomach problems, (ii) malaria, (iii) skin disease, and (iv) fever due to diseases other than malaria. The illness was ascertained based on the following question asked of the household member(s): 'Has any of the household members suffered from an illness, such as stomach problems, malaria, skin disease, or fever due to diseases other than malaria during the last 30 days?' The responses were coded as '1' for having an illness and '0' for not having an illness.

The following predictor variables were included in the analysis

In order to draw the association between selected diseases and WASH, a set of WASH variables were used. First, sources of drinking water were divided into two categories, namely 'improved' sources and 'unimproved' sources. Improved sources of drinking water included piped water in the dwelling, piped water to a yard/plot, public taps/standpipes, tube wells/boreholes, bottled water, and protected wells and springs. Unimproved sources included unprotected wells and springs, rainwater collection, tanks/ponds, rivers/dams/streams/canals/lakes, tanker-trucks/carts with small tanks or drums, etc. Next, water sources for household activities were categorized as 'improved' or 'unimproved' along the lines of sources of drinking water. Finally, the distance to sources of drinking water from the household was categorized as 'within premises' and 'outside premises'.

The survey sought two kinds of information on latrine facilities. The first concerned access to latrines, with the answer options being: exclusive use by household, common use in the building, public/community latrine without payment, public/community latrine with payment, others, no latrine. The second concerned the type of latrine used, with the answer options being: flush/pour-flush to piped sewer system/septic tank/pit latrine/elsewhere (open drain, open pit, open field, etc.); ventilated improved pit latrine, pit latrine with slab, pit latrine without slab/open pit, composting toilet, others; and no latrine. For the purpose of analysis, using the above information, we categorized latrine facilities as 'improved' and 'unimproved'. Unimproved also included situations where no information on latrine use was given.

Type of drainage system was divided into three categories: improved (covered pucca and open pucca), unimproved (open katcha), and no drainage facility. Ventilation facilities in households were categorized as good, satisfactory, and bad. Garbage collection from households was categorized as follows: i) collection by government bodies (Panchayat/municipality/corporation), ii) arrangements made by residents (by a resident/group of residents/others), and iii) no arrangement. Information on flies and mosquitoes in households for 365 days preceding the survey was classified into three categories: severe, moderate, and no problem. The responses were categorized as yes (severe and moderate) and no.

The monthly per capita consumer expenditure (MPCE) was calculated based on the total household consumer expenditure for 30 days prior to the survey. To get the per capita expenditure, the total expenditure was divided by the total number of members in the household. Further, households were classified, using the quantile method, as poorest, middle, and richest. The states and union territories were divided into six geographical regions. The Northern Region included Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Chandigarh, Delhi, Rajasthan, and Uttarakhand. The Central Region comprised Uttar Pradesh, Madhya Pradesh, and Chhattisgarh. The Eastern Region included Bihar, Jharkhand, West Bengal, and Odisha. The North-Eastern Region comprised the states of Sikkim, Tripura, Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, and Mizoram. The Western Region included Maharashtra, Gujarat, Goa, Dadra & Nagar Haveli, and Daman & Diu. The Southern Region comprised Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Andaman & Nicobar, Puducherry, and Lakshadweep.

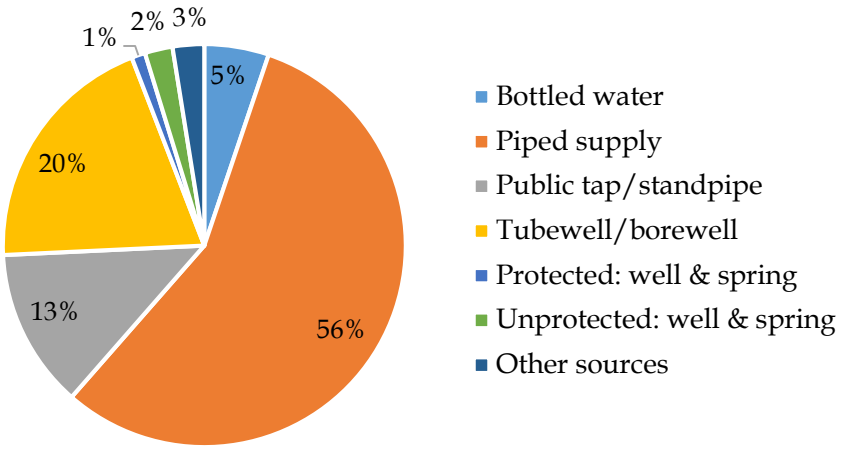
A logistic regression model was used to examine the adjusted statistical significance of the association of water, sanitation, and hygiene conditions with the diseases under study. The results are presented at the 95% confidence interval. All the analysis was performed using the Stata13 software package.

Results

WASH conditions

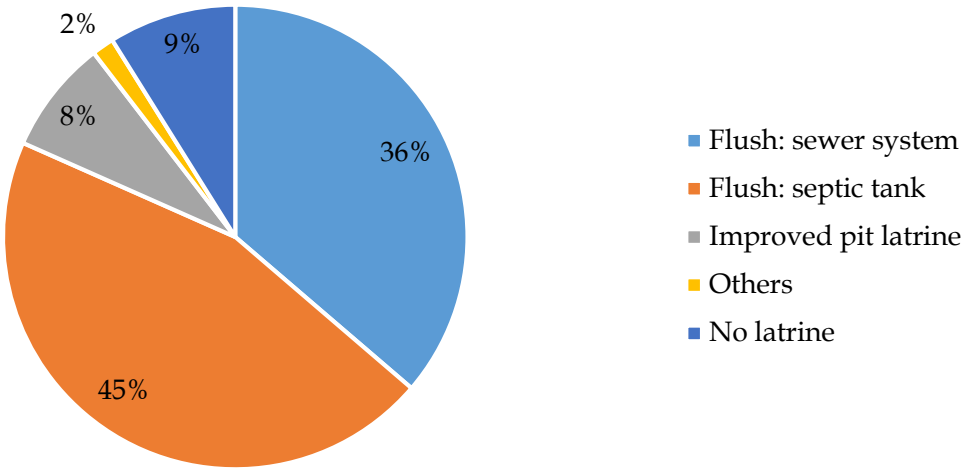
Figure 1 reveals that the primary source of drinking water in urban households was piped water (56%)), followed by tube-well/bore-well (20%), public tap/standpipe (13%), bottled water (5%), protected well and spring (3%), and unprotected well and spring (2%). Forty-five percent of households had a flush toilet that was connected to the septic tank, and 36% had their flush toilet connected to the sewerage system. Only 8% of households had the improved type of pit latrine, whereas 9% had no latrine and practiced open defecation (Figure 2). Most of the households (95%) got their drinking water from improved sources, and only 5% still used unimproved water sources (Figure 3). For household activities, 89% of the urban households got water from improved sources while the rest got it from unimproved sources. About three-fourths (77%) of the urban households had their water sources within the premises, and 12% of households reported that there had been problems with the quality of drinking water. More than three-fourths of the households had a bathing facility within the house. Wastewater and solid waste disposal systems were also given importance in the study on sanitation within and outside the households. About one-fifth (19%) of the households had no drainage facility or connectivity with their households and wastewater disposal, and more than one-third (35%) of the households had no proper arrangements for garbage collection. Almost all the households (96%) faced the problem of flies and mosquitoes either severely or moderately.

Figure 1: Principal source of drinking water in urban areas of India



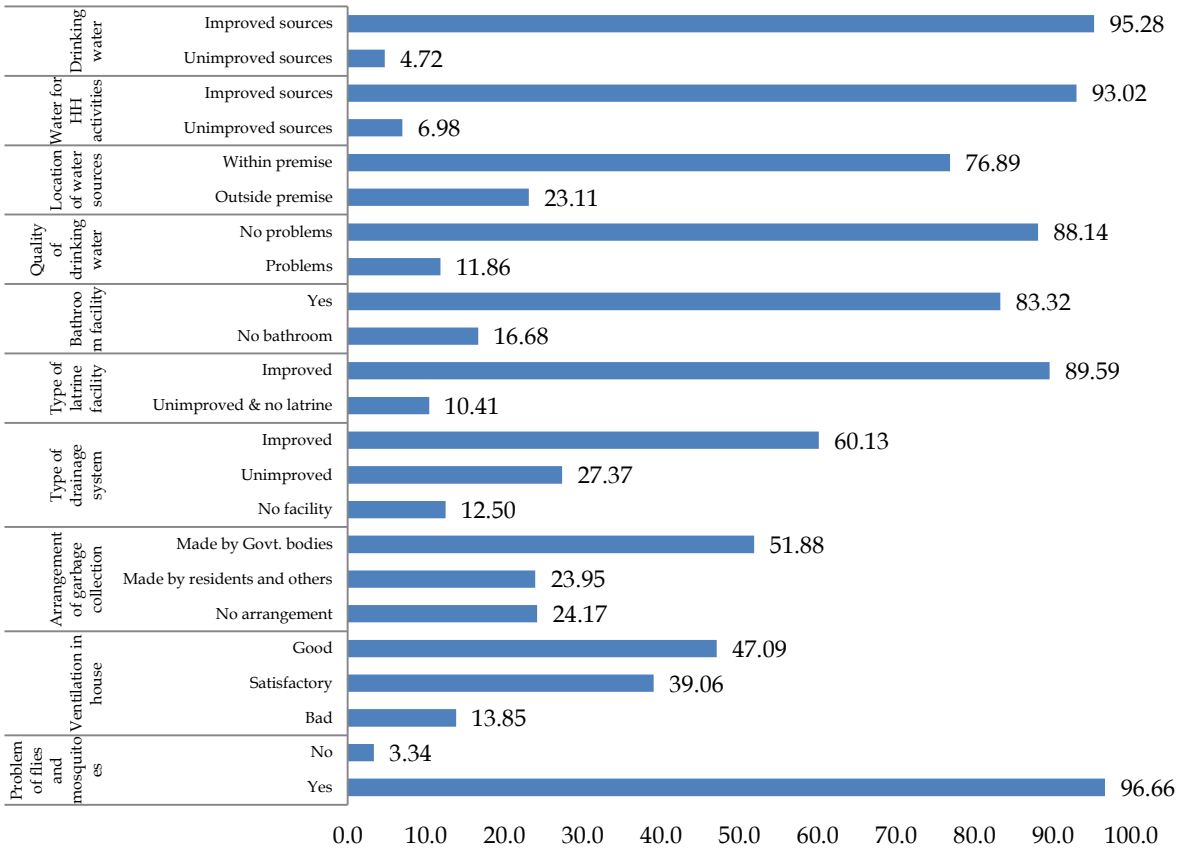
Data source: NSSO 69th round survey, 2012, Surveyed sample 42,156

Figure 2: Distribution of latrine facilities by type in urban areas of India



Data source: NSSO 69th round survey, 2012, Surveyed sample 42,156

Figure 3: Distribution of water, sanitation, and hygiene practices (WASH) in urban areas of India



Data source: NSSO 69th round survey, 2012, Surveyed sample 42,156

Prevalence of selected diseases by region in urban India

Table 1 presents the prevalence rate of the studied diseases by water sanitation and hygiene practices in urban households. Twenty-seven percent of household members suffered from fever other than malaria, 14% had stomach problems, 5% had skin diseases, and another 3% had Malaria. The Central Region reported more stomach problems (27%), skin diseases (8%), malaria (8%), and fever other than malaria (41%). Fewer stomach problems (5%), malaria (1%), and fever other than malaria (23%) were reported in the Southern Region than other regions of India (Table 1).

Table 1: Regional differences in prevalence rates of selected diseases (WASH) in urban India, 2012

Background Characteristics	Stomach Problems	Skin Disease	Malaria	Fever other than Malaria	Total Sample (in numbers)
Total	**13.5**	**4.9**	**2.8**	**26.9**	
Region (all states and union territories)					
North	17.9	7.5	3.0	31.7	7,088
Central	26.6	8.2	8.4	41.4	7,384
East	21.4	8.0	2.8	33.3	6,712
Northeast	19.0	6.3	2.7	27.6	4,579
West	10.1	3.2	3.8	24.8	6,244
South	5.2	3.6	0.9	23.1	10,149
Surveyed sample#	**5,670**	**2,049**	**1,184**	**11,346**	**42,156**

 # Sample size presented based on weighted analysis

Association of WASH practices with selected diseases in urban households in India

The odds ratios resulting from the binary logistic regression analysis of selected diseases and their association with water, sanitation, and hygiene practices was presented in table 2. Unimproved sources of drinking water were significantly associated with stomach problems, skin diseases, and malaria. Where drinking water was perceived as being problematic (with problems including smell, taste, etc.) stomach problems, skin diseases, malaria, and fever other than malaria were significantly more common than where drinking water was not perceived as problematic. Households without latrine facilities reported more stomach problems, skin diseases, malaria, and fever other than malaria compared with those which had latrine facilities. The absence of a garbage collection facility was significantly associated with higher levels of stomach problems, malaria, and fever other than malaria. Households with bad and satisfactory ventilation were a significant predictor of stomach problems, skin diseases, malaria, and fever other than malaria as compared to good ventilation facility. Households with problems of flies and mosquitos reported significantly higher odds for stomach problems, skin disease, malaria, and fever other than malaria. The richest households were less likely to be associated with the problem of selected diseases than the poorest households. In the context of a regional analysis, households in the Eastern, Western, Northern, Southern, and North-Eastern regions were significantly less likely to be associated with all selected diseases than those in the Central region.

Table 2: Odds ratio from multivariate logistic regression of selected diseases on water, sanitation, and hygiene practices (WASH), and control variables among urban India, 2012

Background Characteristics	Stomach Problems	Skin Disease	Malaria	Fever other than Malaria
	Odds ratio (95% CIs)	Odds ratio (95% CIs)	Odds ratio (95% CIs)	Odds ratio (95% CIs)
Principal sources of drinking water facility				
Improved@				
Unimproved	1.19**(1.04, 1.37)	1.37***(1.13, 1.65)	1.31**(1.04, 1.63)	1.07(0.98, 1.17)
Source of water for household activities				
Improved@				
Unimproved	0.84***(0.75, 0.93)	0.92 (0.78, 1.07)		
Availability of water sources				
Within premise@				
Outside premise	1.00(0.93,1.06)	1.08(0.98,1.19)		
Quality of drinking water				
No problem@				
Any problems	1.73***(1.61,1.87)	1.73***(1.55,1.92)	1.28***(1.11,1.49)	1.25***(1.17,1.33)
Bathroom facility				
Yes@				
No	0.98(0.90,1.06)	0.89*(0.79,1.01)		
Latrine facility				
Improved@				
No facility	1.22***(1.12,1.33)	1.19***(1.05,1.35)	1.38***(1.19,1.59)	1.10***(1.03,1.17)
Types of the drainage system				
Improved@				
Unimproved	0.93(0.84,1.03)	1.06(0.92,1.22)	0.89(0.74,1.08)	0.91**(0.84,0.99)
No facility	0.84***(0.77,0.91)	0.84***(0.74,0.95)	0.92(0.78,1.07)	0.95(0.89,1.01)
Arrangement of garbage collection				
Yes@				
No	1.08**(1.02,1.15)	1.01(0.92,1.11)	1.12*(1.00,1.26)	1.13***(1.08,1.19)
Ventilation facility in house				
Good@				
Satisfactory	1.20***(1.12,1.28)	1.08(0.97,1.19)	1.22***(1.07,1.39)	1.22***(1.16,1.28)
Bad	1.43***(1.31,1.56)	1.15**(1.01,1.31)	1.30***(1.1,1.53)	1.28***(1.19,1.37)

Background Characteristics	Stomach Problems	Skin Disease	Malaria	Fever other than Malaria
	Odds ratio (95% CIs)	Odds ratio (95% CIs)	Odds ratio (95% CIs)	Odds ratio (95% CIs)
Problem of flies and mosquitoes				
Yes[@]				
No	1.94***(1.58,2.39)	2.69***(1.83,3.95)	3.40***(1.87,6.19)	2.04***(1.75,2.39)
Monthly per capita consumer expenditure (MPCE)				
Poorest[@]				
Middle	0.87***(0.81,0.93)	0.77***(0.69,0.85)	0.76***(0.66,0.86)	0.78***(0.74,0.83)
Richest	0.60***(0.55,0.65)	0.54***(0.48,0.61)	0.58***(0.49,0.68)	0.49***(0.46,0.52)
Region (all states and union territories)				
Central [@]				
North	0.66***(0.61,0.72)	1.01(0.89,1.15)	0.40***(0.34,0.47)	0.78***(0.72,0.83)
East	0.80***(0.74,0.87)	1.05(0.93,1.20)	0.32***(0.27,0.38)	0.73***(0.68,0.79)
Northeast	0.78***(0.71,0.86)	0.88(0.75,1.03)	0.37***(0.30,0.46)	0.63***(0.58,0.68)
West	0.35***(0.32,0.39)	0.44***(0.37,0.52)	0.53***(0.45,0.62)	0.56***(0.52,0.61)
South	0.17***(0.16,0.19)	0.48***(0.42,0.55)	0.11***(0.09,0.14)	0.51***(0.47,0.54)

Source: NSSO 69th round survey data, 2012. Surveyed sample 42,156

® Reference category

**significant at p<0.1, **significant at p<0.05, ***significant at p<0.01*

Water for household activity, availability of water sources, quality of water sources, and bathroom and latrine facility were not adjusted in the model with malaria and fever other than malaria.

Discussion and Conclusion

India is the second-most populous country in the world, with 32% of its population residing in urban areas. This urban population is continuously increasing in size and is faced with challenges such as inadequate water, sanitation, and waste management facilities, and improper infrastructure in urban households.

The findings of this study reveal that WASH practices are significantly associated with stomach problems, skin disease, malaria, and fever other than malaria, and that this is due in large part to access to unimproved sources of water, as well as drinking water perceived to be of poor quality. A similar result was found by a previous study, i.e. that poor water supply was found to negatively influence health due to the presence of chemicals like arsenic and fluoride; poor personal hygiene was also found to affect health (Hunter, Zmirou-Navier & Hartemann, 2009). Water supplied through poorly maintained pipes may contain chlorine residues, rendering disinfection useless, and causing diseases (Macy & Quick, 2009). Our study findings show that stomach problems, skin disease, malaria, and fever from diseases other than malaria are more prevalent in the poorest population. From this, we can infer that the poorer sections of society are more vulnerable to water and sanitation-related problems. This finding is consistent with the findings of another study that suggested that improving water and sanitation in low- and middle-income settings would help prevent communicable diseases (Prüss Ustün et al., 2014). The present study found that the absence of latrine facilities is also significantly associated with stomach problems, skin disease, malaria, and fever other than malarial diseases. Previous studies support this finding and depicted that better sanitation facilities, such as access to toilets and proper disposal of wastewater, reduced the incidence of stomach problems and skin diseases (Das & Das, 2015; Garn et al., 2017). The Census of India estimated that around 10% of households in urban areas practiced open defecation (Census of India, 2011). Open defecation releases germs into the environment, which harm wealthy and poor alike, including those who use latrines (Coffey et al., 2014; Dobe et al., 2011). This fact is supported by the results of this study, which show unimproved sanitation to be associated with stomach and skin diseases and no latrine (open defecations) to be associated with malaria and fever other than malaria. Therefore, our study suggests that there is a need to treat wastewater using mechanical and biological processes and, where feasible, to remove/inactivate pathogens before the water is released into the environment for use. This study also found improper arrangements of garbage collection facilities to be one of the predictive factors for an increase in stomach problems, malaria, and fever other than malaria. This is because flies and mosquitoes thrive when garbage is dumped in an inappropriate manner and place. An earlier study also found malaria, dengue, Kala Azar, fever, and loose motion to be associated with the malpractices of solid waste management (Puri et al., 2008). This suggests the need for effective waste management and proper education, awareness, and knowledge to encourage the government, private investors, and the local population to keep the surroundings clean.

Unimproved sources of water and problems in the quality of drinking water are significant causes of stomach problems, skin disease, malaria, and fever from diseases other than malaria. The absence of a latrine facility and garbage collection are also predictive factors for these diseases, irrespective of whether or not households face the problem of flies and mosquitoes. Therefore, the study recommends that improved WASH conditions are key to achieving better health and development in the country. Proper awareness should be raised and knowledge disseminated regarding WASH practices and their impact on health at the individual, community, and societal levels in order to achieve long-term health benefits.

The results of the study may be useful for future health policies and programs and may be used as a benchmark for existing programs targeting WASH conditions associated with health, especially in urban India. The Government of India has initiated several programs related to WASH in urban areas, such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM; launched in 2005), the North Eastern Region Urban Development Programme (NERUDP; launched in 2009), the Swachh Bharat Mission-Urban (SBM-U; launched in 2014), and the Smart Cities Mission (launched in 2015). These programs are specifically focused on providing basic facilities and services like water supply, adequate sanitation, solid waste management, integrated housing, and other basic amenities to the urban population (MoHUA, 2019). Therefore, a considerable improvement in sanitation conditions (up from 54% in 2000 to 59% 2010), latrine facilities (up from 88.7% in 2000 to 91.2% in 2012), septic tank/flush (from 70.2% in 2000 to 81.6% in 2012), and availability of safe drinking water (from 90.0% in 2000 to 91.4% in 2011) has been observed in urban households (MoHUA, 2019). The recent National Family Health Survey 2015-16 shows that 71% (54.5% in 2005-06) of households use improved non-shared toilet facilities and 91.5% of households use an improved water source (IIPS & ICF, 2017). However, a severe problem of contamination in the process of supplying drinking water was still found, especially in the monsoon season (WHO & UNICEF, 2015).

These findings are based on a nationally representative household survey with a robust sampling design and are of use for efforts to improve the health situation in urban India. However, the study is based on self-reported diseases, and so there is a possibility of recall bias. Moreover, the association between the studied diseases and the WASH conditions used in this analysis lack temporal association due to the cross-sectional nature of the survey. Furthermore, the survey data collection period was July to December 2012, which may have influenced the prevalence of the studied diseases found.

Ethical Statement

This study used secondary household survey data from NSSO's 69th round on 'Drinking water, Sanitation, Hygiene and Housing conditions in India'; this data was considered to be reliable for research purposes. Ethical approval for the survey was provided by the National Sample Survey Organization (NSSO), and a standard ethical consent form was read out to each respondent at the time of the survey. No personal identifiers have been revealed in the dataset, ensuring respondents' privacy. The NSS 69th round data is also available in the public domain and can be downloaded from the following link:
http://www.icssrdataservice.in/datarepository/index.php/catalog/95.

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