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Drinking Water Practices, Quality and GIT Disturbances at Household Level in Rural Setting of Wardha District, Maharashtra, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Limited availability of safe drinking water and poor sanitation can lead to water borne diseases. In India, alone waterborne diseases are projected to have an economic burden of approximately USD 600 million a year. Rural population face water, sanitation, and hygiene-related health issues. In India, many programs are running since decades, but there is need to understand current scenario of drinking water practices in the community.
Objectives: To assess the drinking water practices, purification methods, drinking water quality at household level and Gastrointestinal GIT disturbances among the visited household.
Methods: This community based cross-sectional study was conducted during July-December 2019 in purposively selected three villages of field practice area JNMC, Wardha. Sample size is calculated to be 96 household and rounded up to 100 for each village (total 300 household). Households of Village A, B, and C are 392, 388 and 381 respectively. 100 household were selected by systematic random sampling method. Information was collected by interviewing adult at home

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after verbal consent by using Pre-structured, pre-tested questionnaire. Randomly ten water samples from each village tested for quality.

Results: Most of the household i.e. 80% have water source in their premises into dwelling (47%) or own yard (32%). Overall 61% of the household had adopted purification method. Village-wise distribution for adoption of purification methods, it is found significantly highest in village C and lowest in A (X^2 -8.54, p=0.013). On an average 25% of the household reported that family members were suffered from gastrointestinal disturbances. Village-wise distribution for GIT disturbances cases, it is found significantly highest in village A and lowest in C (X^2-19.25, p=0.0001). Most common purification method is filtration by using cloth or net by 41%. Total 76.67% water samples were contaminated.

Conclusion: Village which shows higher percentage of HH adopted purification method suffered less from GIT disturbances. Most of water samples were unsafe for drinking purpose. Hence community can be aware through an integrated approach such as Village, health sanitation and nutrition committee can be strengthened.

Keywords: Drinking water; practices; quality; rural settings; household level

1. INTRODUCTION

Universal availability of safe drinking water is a fundamental necessity and a human right. This was the basis for target 10, goal 7 of the Millennium Development Goal which aims to reduce number of people who does not have availability of clean water by half by 2015 [1]. Water is important not only in terms of quantity, but also in terms of quality. In order to achieve good personal and domestic hygiene practices, access of water in appropriate amounts is important, whereas good water quality has ensured that consumed water does not pose a health risk, even after a lifetime of use.

In India, alone waterborne diseases are projected to have an economic burden of approximately USD 600 million a year. This is particularly true for areas which are vulnerable to floods and droughts, which have affected a third of the nation in the last couple of years [2].

Rural population in developing countries like India face water, sanitation, and hygiene-related health issues.[3] Depleting ground water and deteriorating ground water quality are threatening the sustainability of both rural and urban parts of India. Drinking water has become a luxury, particularly in rural and semi-urban areas, because of the problem of not having availability of water or having availability of contaminated water [4]. Limited availability of safe drinking water and poor sanitation can cause water borne diseases, the heaviest burden being diarrheal diseases, soil transmitted diseases and skin infections and all these can lead to under nutrition and the vicious cycle goes on [5].

Many communicable diseases like cholera, typhoid can be managed effectively by improving the sanitation, hygiene, safe water storage and usage practices [6]. The safe water chain refers to all of the steps involved in ensuring that water does not become contaminated at any point along the way i.e. from collection point to storage of water to consumption of water. The main steps in the safe water chain are- source of water, collection, handling, transportation, storage and treatment of water, and consumption by human being. Most water supply systems which are used in India are still not regular with irregular pressure and unsatisfactory water quality [7]. Water in rural areas is not available throughout the day, and this irregularity in supply makes water storage at houses an absolute requirement. This storage of water is a challenge and also an opportunity at the same time. There is high chances of recontamination of drinking water between source and point-of-use [8-12] as it depends on the ability at household level to reduce bacterial contamination by treatment, such as use of bleaching powder and chlorine tablets [13,14,15].

Availability of safe drinking water, proper sanitation services and good hygiene practices can help in preventing a significant amount of diseases in general population. It is estimated that 3.6 % of the total DALY global burden of disease is alone from the diarrhoeal diseases and is responsible for the deaths of 1.5 million people/ year (WHO 2012) [16]. Around 8,42,000 deaths/ year that is 58% of that burden is from unsafe water supply, sanitation and hygiene and includes 3,61,000 deaths of children under age five, mostly in developing countries (WHO 2014) [17]. Due to lack of safe water and unhygienic

environment every minute a newborn die from infection (WHO 2015). In rural areas of India 89.3%, while in Maharashtra State, 85.6% of household has improved_drinking water source (NFHS-4) [18].

Safe drinking water availability at doorstep is the first step in this process. Many programs are running in India for provision of wholesome drinking water emphasizing in rural settings such as Rajiv Gandhi National Drinking Water Mission (1991) [19], National Water Policy (1987, 2002,2012),[20] National Rural Drinking Water Program-(Jalmani) under Ministry of Drinking Water and Sanitation [21,22].

These programs are running since decades, but there is need to understand the current scenario in the community regarding their practices for drinking water collection, storage, purification methods. Water testing for quality standards will be helpful to assess the safety level. Hence we planned this survey in the rural community.

1.1 Objectives

1. To assess the drinking water practices and purification methods at household level in selected villages of field practice area.
2. To know the prevalence of water borne diseases among the visited household.
3. To study the drinking water quality at household level by laboratory methods in the selected villages.

2. METHODOLOGY

2.1 Study Design and Settings

This community based cross sectional study was conducted in purposively selected three out of six villages of field practice area (*Sukhlibai as village-A*, *Wadgaon Kala as village-B*, *and Surgaon as village-C*), of Department of Community Medicine, J. N. Medical College, in Wardha district. The study was conducted during the period of July 2019 to December 2019 (six months).

2.2 Sample Size and Sampling Technique

Three villages having near about matching population are purposively selected. Population of villages A, B, and C are approximately 2010, 1983 and 1996 respectively. Proportion of improved source of domestic water is 90% according to the NFHS-4 data [18]. In the present study, by considering 5% the level of significance and error of margin 0.06%, the sample size is calculated to be 96 household and rounded up to 100 for each village (total required sample size is 300 household). Households of Village A, B, and C are 392, 388 and 381 respectively. 100 household were chosen by systematic random sampling method.

2.3 Data Collection Tools and Technique

Questionnaire was prepared for assessing the drinking water practices at household level, (11 questions) by using NFHS-4 (2015-16) Performa, and some extra questions were added to fulfil the study objectives. This tool contained questions regarding source, storage, purification, withdrawal of drinking water from storage container and symptoms like Gastro-intestinal disturbance (vomiting and diarrhoea). Drinking water samples in autoclaved bottles were taken from randomly selected ten houses of each three villages (total 30 -water samples) for testing the drinking water quality as per WHO standards. Compiled data is presented in frequencies, percentage and mean of each variable is calculated.

3. RESULTS

The classification of household based on socio demographic details was done, percentage distribution is given in Table 1. It is observed that Village C has highest percentage of nuclear family (59%), mostly pukka houses and more families with monthly income of > Rs.10,000 as compared to other two villages. Socioeconomic status of village C is observed to better than village B. Monthly income in village A is observed to be less than B and C. Similar difference in proportion was observed for type of house quality.

Table 2 reflect the percentage distribution of household based on source of water supply in household, location of water source, time taken to bring water from the source and category of person fetching the water from the source.

Highest mean percentage i.e. 47% is for source of water being piped water into dwelling followed by piped water into own yard/plot i.e. 32% and rarely the use of tubewell/borewell i.e. 2%. Village C (57%) followed by village B (56%)

counted highest contribution in above average of piped water into dwelling as a source. Out of three, village C reported most number of households i.e. 22% were using public tap/ Hand pump than other two villages.

Most of the household have water source in their premises. So for most household (mean-62%) it takes hardly 5 minutes to fetch water from the source followed by 5-10 min in 29% household. It is an adult female who fetched water most of the time amounting to 95%. Female and male child (<15 years) also help in collecting the water from the source; 2% and 3% respectively.

Enquiry was made if the household treats the drinking water before consumption and those who said 'YES' to the above asked question, they were further enquired about the method of purification of drinking water. Table-3 shows the percentage distribution of household by adoption of any purification method and gastrointestinal disturbances such as nausea, vomiting and diarrhoea among family members in the last 30 days of the visit.

Overall 61% of the household had adopted purification method in drinking water while 39% household directly consume the water from the source for drinking. When data is analysed to assess the village-wise distribution for adoption of purification methods, it is found significantly highest in village C and lowest in village A (X^2 -8.54, p=0.013).

Table 1. Socio demographic information of study participants from three villages

Socio demographic information		Village A	Village B	Village C	Mean %
1. Type of family	Nuclear	55%	57%	59%	57%
	Joint/ Extended	45%	43%	41%	43%
2. Type of house	Pukka	55%	76%	77%	69%
	Semi pukka/kutcha	45%	24%	23%	31%
3. Monthly Income	Rs. <2,500	19%	4%	3%	9%
	Rs. 2,500-5,000	33%	27%	18%	26%
	Rs. 5,000-7,500	21%	17%	27%	22%
	Rs. 7,500-10,000	13%	35%	18%	22%
	Rs. >10,000	14%	17%	34%	22%

Table 2. Drinking water -main source, location, time taking and person for fetching the water

Source	Village 1	Village 2	Village 3	Mean (%)
Piped water into dwelling	27%	56%	57%	47%
Piped water into own yard/plot	41%	24%	30%	32%
Public tap/ Hand pump	22%	13%	3%	13%
Surface water	3%	0%	6%	3%
Protected/unprotected dug well	4%	5%	3%	4%
Tubewell/Borewell	3%	2%	1%	2%
Location				
In own dwelling	26%	49%	47%	41%
In own yard	50%	33%	36%	40%
Elsewhere	24%	18%	17%	20%
Time in minutes				
<5 min	48.5%	68%	69%	62%
5-10 min	34.5%	23%	28%	29%
10-15 min	13.4%	8%	2%	8%
>15 min	3.8%	1%	1%	2%
Who generally fetches water from the source				
Adult woman	94%	96%	95%	95%
Adult man	10%	8%	7%	8%
Female child(<15 years)	3%	1%	3%	2%
Male child(<15 years)	5%	2%	1%	3%

Table 3. Water purification adopted and Family member suffered from symptoms of GIT disturbances, vomiting and diarrhoea in last 30 days of survey

Status	Village A (n=100)	Village B (n=100)	Village C (n=100)	Mean	X^2, (p value)
Any type of purification adopted for drinking water					
YES	52%	60%	72%	61%	8.54
NO	48%	40%	28%	39%	(p=0.013)
GIT disturbances					
YES	39%	24%	12%	25%	19.25,
NO	61%	76%	88%	75%	(p=0.0001)

Table 4. Drinking water purification methods, storage practices, withdrawal from the stored container

Type of Purification Method (52%)					NA
	Out of 52 (%)	**Out of 60 (%)**	**Out of 72 (%)**	**Out of 61 (%)**	
Cloth	21 (40.38%)	32 (53.33%)	39 (54.16%)	31 (50.81%)	
Net Filter	15 (28.84%)	5 (8.33%)	9 (12.5%)	10 (16.39%)	
Sedimentation	1 (1.92%)	1 (1.66%)	1 (1.38%)	1 (1.63%)	
Bleaching Powder	5 (9.61%)	11 (18.33%)	12 (16.66%)	9 (14.75%)	
R.O.	2 (3.84%)	3 (5%)	7(9.72%)	4 (6.55%)	
Boiling	8 (15.38%)	8 (13.33%)	3 (4.16%)	6 (9.83%)	
Drinking water storage practices					
Steel container*	75%	59%	58%	64%	
Earthen Pots*	22%	52%	46%	40%	
Plastic container*	3%	3%	3%	3%	
Withdrawal of drinking water from the stored container					
Use of utensils like glass, jug etc by hand	74%	85%	14%	58%	
Tap of storage pot	15%	6%	19%	13%	
Tumbler	11%	9%	67%	29%	

**covered container*

On an average 25% of the household reported that family members were suffered from gastrointestinal disorders while 75% didn't show any symptoms. When data is analysed to assess the village-wise distribution for GIT disturbances cases, it is found significantly highest in village A and lowest in village C (X^2-19.25, p=0.0001).

Out of three villages, maximum households reported GIT disturbances symptoms from village B i.e. 39%, followed by village A (24%) and least from Village C (12%). Purification methods adopted by 52% household in Village A, 60% in village B and 72% in village C.

Table 4 show the type of purification method adopted, type of container used for the storage of drinking water at household level and method of taking out the stored drinking water from the main container.

Most common purification method adopted by villagers is filtration by using cloth or net by 31% and 10% respectively. This is followed by use of bleaching powder by 9% families, and boiling of water by 6%, while only 4% household has R.O filters.

During survey it was observed that, 64% household stored water in covered steel containers followed by earthen pots in 40% household, whereas the use of plastic container was observed only in 3% families only. Few families responded using of more than one type of container. Most households i.e. 58% prefer to use utensils like glass, jug etc. for withdrawal of drinking water from the stored container followed by use of tumbler (29%) and rarely use of tap of storage pot (13%).

Ten drinking water samples from random houses from each village were collected for evaluating drinking water quality according to WHO standards. The water samples were collected; stored and properly handled following all the guidelines to prevent contamination. Autoclaved water bottles were used for the collection and storage of drinking water samples. Results are presented in Table 5.

Collected samples were also tested for bacteriological contamination in the Microbiology laboratory of our institution and it was found that all the samples were unsatisfactory with Maximum Permissible Number (MPN) per 100ml being more than or equal to 180. On culture media, micro-organisms like E-coli, Klebsiella, M. Pneumoniae, Citrobacter etc were also found in 9, 8 and 6 water samples out of 10 samples from each village A, B and C villages respectively , so total 76.67% i.e. 23 out of 30 samples were not safe for drinking.

4. DISCUSSION

In India, about 45,053 villages have availability of piped water supply and hand pumps, but 18,917 villages still have no access.[4] In the rural areas ,the main source of drinking water at household was hand pump and for the urban areas it is piped water into dwelling. While in Maharashtra state about 48.6% rural and 57.5% of urban household had piped water as major source of drinking water [23].

Table 5. Laboratory results of drinking water samples collected from ten households of each village

Sample No	TDS	Turbidity	O.T Test	Nitrate	Fluoride
Village-A					
1	511	0.6	0.1	30	1
2	285	0.6	0.1	15	0.5
3	312	0.9	0.1	45	0.5
4	445	0.5	0.1	30	0.5
5	513	0.7	0.1	30	1
6	615	0.7	0.1	30	0.5
7	639	0.5	0.1	30	0.5
8	421	0.4	0.1	30	0.5
9	615	0.1	0.1	15	0.5
10	406	0.4	0.1	30	0.5
Village B					
1	447	0.4	0.1	25	0.3
2	487	0.5	0.1	10	0.8
3	498	0.6	0.1	12	1
4	449	0.3	0.1	8	0.3
5	575	0.7	0.1	30	1
6	461	0.5	0.1	10	0.4
7	441	0.6	0.1	24	0.4
8	440	0.3	0.1	22	1.5
9	320	0.3	0.1	45	>1.5
10	612	0.9	0.1	50	1
Village C					
1	437	0.5	0.1	30	1
2	385	0.6	0.1	15	0.8
3	512	0.4	0.1	45	0.5
4	545	0.5	0.1	50	0.4
5	413	0.3	0.1	20	1
6	516	0.7	0.1	30	0.5
7	493	0.5	0.1	20	0.3
8	415	0.4	0.1	30	0.3
9	623	0.6	0.1	15	1
10	302	0.3	0.1	10	1.5

Water supply is available and accessible in studied villages. Piped water supply was widely distributed in all 3 villages (Mean% 47) and it was the most preferred source for drinking water and the preferred water source by the villagers. According to National Sample Survey (NSS) 76th round data (Maharashtra) pipe water into dwelling is 28% and pipe water into yard is 28.9% and tube well 8.6% [23].

Other water sources like surface water, tube wells were not preferred by the villagers but had to use them because of absence of piped water in some houses and also because the piped water supply was not available for 24 hours of the day rather only available for a limited period of time each day. The survey in Maharashtra observed that about 87.6% of households in rural areas and about 90.9% households in urban areas had sufficient drinking water available from the principal source all around the year [23].

Also, in the Maharashtra state Bottled water, piped water- in dwelling, yard/plot and from neighbour, public tap/standpipe, tube well, hand pump, protected well, public tanker truck, private tanker truck, and rain water collection were used by 94.5 percent of rural households and 97.4 percent of urban households, respectively [23].

Rainwater collection and harvesting is still a rare occurrence in India. India receives 1170mm of annual rainfall, but due to weak infrastructure, it can only store 6% of it, compared to 250 percent in developed countries [4]. Around 51.4 percent of rural households and 72.0 percent of urban households used an improved source of drinking water that was adequately accessible during the year and was located within household premises [23].

Around 79% of the household in the studied villages have water source located into their own dwelling/yard/plot this is mostly the piped water supply. This is better as compared to the data collected in 2018 from the state, it was estimated that only about 58.2% of the rural household and about 80.7% in the urban household had drinking water facilities within the household premises [23].

According to NSS 76th round Maharashtra, 66.5% household used purification methods while 33.5% didn't use any purification method [23]. Less number of families i.e. 61% households were following the purification methods in studied villages than state average. According to 76th round of NSS for the state, filtration by cloth 38.5% most used followed by bleach/chlorine tablets 13.3%, boiling 3.3% while only 4.1% has electric purifier [23]. The present study observations were matching with state average for two purification methods adopted by villagers i.e. 40% families were filtering the water by using cloth or net and 4% household were having electric purifier; and storing the drinking water in steel container among 64% household. Study findings were matching with state average for using earthen pot 24.1% and plastic container 9.4% [23]. One good observation was that every household use covered containers for the storage of water. 40-50% of the villagers in every studied villages use water direct from the supply without any purification at household level. Before drinking, these villagers generally check the water in container by naked eye only, whether the water is clear or not for drinking purpose. If the water looks clean, then the villagers assume that the water is safe for drinking. Although, water looks clean by eye examination might not always be safe for drinking. Studies on effects of unsafe drinking water on various groups were reported [24-28].

In this survey, water withdrawal from stored container was unhygienic, even after satisfactory purification of drinking water, hygienic withdrawal is also important as sometimes chance of contamination during withdrawal of water may occur. The villagers were not instructed about how often to chlorinate and contact time to be allowed. Almost all of the residents took less than 15 minutes to draw water from the source, which is consistent with the WHO guideline of taking no more than 15 minutes to and from the drinking water source to ensure sufficient water supply to meet drinking water and sanitation needs. The water samples were taken from different sources of drinking water that were commonly used by the villagers. After laboratory testing, it was found that the 76.67% water samples are not as per WHO standards and bacteriological contamination was present and unsafe for drinking.

5. CONCLUSION

Most of the household having sufficiency of piped water either in own yard or dwelling. Villagers didn't find it necessary to treat water and thought good for drinking and other household chores. Purification method was quite unsatisfactory which was limited up to draining of drinking water by using cloth or net. There is need of awareness

program regarding importance and methods of water purification, like use of chlorine drops or addition of bleaching powder and safe water withdrawal at household level.

Hence, only provision of water that is safe for drinking purpose is not enough to improve health status in the community, but household purification and utilization (withdrawal) practices needs to improve in the rural area.

Villagers can be suggested to use the container with tap for drinking water storage purpose. There is still lack of information about water storage, use, and purification practices. Hence, appropriate efforts to impart health education must be designed to increase community awareness. An integrated approach in the form Village Health sanitation and Nutrition Committee (VHSNC) is already working for achieving good health and hygiene associated with safe drinking water. But this committee needs to be strengthened.

6. RECOMMENDATIONS

Health awareness programs in these villages need to be planned under the VHSNC. Such activities can be conducted on village health, sanitation and nutrition day in every month through discussion, demonstration, debate, quiz or role play. So that villagers will be oriented about simple water purification methods such as boiling, chlorination, and adding alum. These activities will also help to guide them regarding importance of safe and wholesome drinking water and the diseases associated with unsafe water.

CONSENT

With the sampling interval three, every third household was visited and information was collected by interviewing the adult person at home after explaining the survey purpose and taking verbal consent.

ETHICAL APPROVAL

It's not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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