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Availability, Practices and Microbiological quality of drinking water among rural households of Belagavi, North Karnataka

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Abstract: *Introduction:* World Health Organisation (WHO) Global Report 2022 on Water, Sanitation & Hygiene (WASH) reported that 6 billion people had access to safely managed and improved drinking water source and 1.7 billion people had an access to contaminated drinking water source. Rural areas are vulnerable, because they lack access to improved water sources. *Materials & Methods:* A community based cross–sectional study was conducted among 415 rural households and fourty water samples were collected. Twenty main water sources as well as twenty from household water samples were tested for the presence of coliform counts using the most probable number method. The study was conducted from 1st January 2021 to 31st December 2021. *Results:* 86.0% were having continuous availability of water from their source every day. 70.8% were using piped water as a primary source of drinking water. Among 40 water samples tested 4 (10%) were found fit for human consumption. Enteric bacteria isolated were Klebsiella (86%). *Conclusions:* Seven out of ten households were using piped water for drinking water. Majority of the samples from households drinking water were found to be unfit for drinking purpose and showed various micro-organisms.

Keywords: Drinking Water, Sanitation, Household Water Treatment, Rural Household, Waterborne Disease.

Introduction

Access to clean water, basic sanitation and proper hygiene facilities are essential basic needs for human survival and wellbeing. Lack of these result in deterioration of health conditions of millions of people, especially rural population are at higher risk [1]. 'Safely managed drinking water' is defined as 'drinking water from improved water resource, which is located near premises accessible when needed and free from faecal, chemical and pathological matter" [2].

World Health Organisation (WHO) Global Report 2022 on Water, Sanitation & Hygiene (WASH) reported that 6 billion people had access to safely managed and improved drinking water source and 1.7 billion people had an access to contaminated drinking water source [3]. According to National Family Health Survey - 5 in India report 2019 - 2021, 99% of urban households and 95% of rural households had safe access to improved sources of drinking water [4]. NFHS - 5 Survey in Karnataka 2019 - 2021 reported 95.5% of the households had access to safe improved drinking water sources [5]. NFHS - 5 Survey in Belagavi district 2019- 2021 reported that 94.4% of the population had improved accessibility to safe drinking water [6]. In 2015, United Nations set the 'Sustainable Development Goal 6' to ensure availability and sustainable management of 'water and sanitation for all'. SDG 6.1 aimed to achieve universal and equitable access to safe and affordable drinking water for all by 2030' and SDG6.2 aimed at achieving access to adequate and equitable sanitation and hygiene for all and end open sanitation practices by 2030 [7].

'Globally access to safe water source has increased from 91% in 2015 to 94% in 2020 [8]. According to the Central Pollution Control Board (CPCB) in India, New Delhi 2022, the release of untreated sewage from industrial effluents, and organic runoff from agricultural areas are the main causes of water pollution in India [9]. Rural areas are vulnerable because they lack access to improved water sources and they live in unhygienic environments [10]. Previous studies were done on the microbiological quality of water among the public main water source supply for drinking purpose, only few studies have been done to assess both main water supply and the household water supply, hence this study was done to assess the microbiological quality of water among main water source and household water sources.

Material and Methods

A community based cross – sectional study was conducted from 1st January 2021 to 31stDecember 2021 in the rural field practice area of PHC Vantamuri, under the administrative control of J.N. Medical College, KAHER in Belagavi district, Karnataka state, India. Sample size calculation was done by using the formula $n = 4pq/d^2$, taking the prevalence (p) as the prevalence of water practices, as 50% and allowable error as 5%. (Based on various studies done in India, reference range of 49.5% - 50.5%). Estimated sample size was 400. A population proportionate sampling method was used to choose a representative sample of households from each village from the five subcentres.

Ethical clearance was obtained from the Institutional Ethics Committee for Human Subjects' Research of the Medical College dated 25/01/2021 vide under letter MDC/DOME/78. The investigator interviewed study participants using pre - validated and pre - tested questionnaire regarding practices about drinking water among rural households using modified WHO/UNICEF 2018 questionnaire [11].

Total of 415 study participants took part in the study. Water samples were collected after taking informed consent from households and concerned gram panchayats. Drinking Water samples were collected based on 10% of total no of households selected for study (n=415). Water samples were collected from each subcentre, chosen by 10% of the selected households, total 40 samples were collected from all five subcentres of PHC Vantamuri, which includes twenty main water source and twenty households water samples. The water samples that were tested unfit were further processed for identification of bacteria contaminating the sample by phenotypic methods testing for fit/unfit was done at the microbiological lab of JNMC, KAHER, Belagavi.

The data collected was coded and entered in MS Excel sheet and analysed the data IBM SPSS 20.0 version was used. Frequency and percentages were calculated. Chi-square test was used to find the association between the predictor variables and the outcome variables. A probability value (p value) of less than 0.05 was considered as statistically significant.

Procedure for water collecting and testing (at department of microbiology) [12]: Sterile covered water bottle containers were taken from the microbiology lab and the water bottles were transported to study area in aseptic condition. For taking main water source, opened the source of water and allowed to flow for 30 seconds to one minute, then collected 20 ml of drinking water in a container. Collected drinking water bottle container were taken to microbiology lab. Each water sample was tested for presence of coliform by inoculating 5ml of sample in single strength and double strength MacConkey broth. The inoculated broth that showed turbidity and colour change after 24 hours incubation, was further processed for identification of coliform

Interpretation: MacConkey agar plate incubated at 37degree C for 18-24 hours. After 24 hrs – organisms were identified & reports were generated as fit/unfit for human consumption. Unfit samples were identified and bacteria was reported to the PHC medical officer for further necessary action.

Results

A total of 415 participants were interviewed and analysed for the study. Out of which 138 were males and 277 were females. 254 (61.2%) of the participants were home makers, and 266 (64.1%) belonged to socio

economic status class IV, 100 (24.1%) of them were aged between 31 to 40 years and the age between 21 to 30 years of age were 84 (20.2%) [Table 1].

Table-1: Distribution of the study participants according to their socio demographic variables (n = 415)

Socio Demographic Variables		Frequency	Percentage
Age in years	18-20	64	15.4
	21-30	84	20.2
	31-40	100	24.1
	41-50	41	9.9
	51-60	56	13.5
	>60	70	16.9
Gender	Male	138	33.3
	Female	277	66.7
Educational qualification	Illiterate	24	5.8
	Primary/Secondary School (Completed 7th Std)	192	46.3
	High School (Completed Up To 10th Std)	106	25.5
	PUC/Diploma/ITI	79	19.0
	Graduate/PG	14	3.4
Occupation	Home maker	254	61.2
	Govt Employee	9	2.2
	Private Employee	39	9.4
	Agriculture	6	1.4
	Labourer	55	13.3
	Self-Employed	5	1.2
	Unemployed	47	11.3
SES (as per modified B G Prasad's classification)	Class-II	15	3.6
	Class-III	61	14.7
	Class-IV	266	64.1
	Class-V	73	17.6

Out of 415 study participants, [Graph 1] 294 (70.8%) were using piped water as a primary source of drinking water, 283 (68.2%) were using piped water as a secondary source of drinking water for their households. Out of 294 households with piped water supply, 221 (75.2%) were using public tap or stand pipe for purpose of drinking water, 34 (11.6%) were getting piped water connection into compound, 21 (7.1%) were having piped water connection into yard or plot/ dwelling and only 18 (6.1%) were collecting piped water from neighborhood. Out of 49 households using dug well as source of drinking water supply, 23 (47%) were using protected dug well water source for drinking water and 26 (53%) were using unprotected dug well water.

Out of 26 households using delivered water, 22 (84.6%) were using water tanker – trucker for the purpose of drinking water and only 4 (15.4%) were using cart with small tank or water storage drum as a source of delivered drinking water. Out of 44 households using tube well/bore well as source of drinking water supply, 32 (72.7%) were using bore well/tube well which were present outside their compound and 12 (27.3%) were using tube well/bore well, which were present inside their compound.

238 (57.3%) were using plastic containers for storing drinking water, 146 (35.2%) were using steel containers, 28 (6.7%) were using

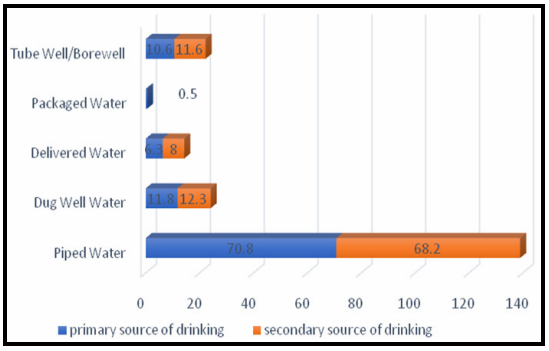
clay containers and only three (0.7%) were using copper containers for storing drinking water in their households.

Out of 415 households, 384 (92.5%) were washing their vessels used for drinking water storage daily, 22 (5.3%) were washing their stored containers weekly once and only 9 (2.2%) were washing on alternative days.

246 (64.6%) adult women > 18 years went to fetch water for their household and 109 (28.6%) adult man >18 years of age went to fetch water for their household and only 26 (6.8%) both adult woman and men went to fetch water for their household.

308 (74.2%) did not use any method for making the water safe for drinking purpose and 107 (25.8%) used some method to make water safer for drinking purpose at the household level. 59 participants (14.2%) used straining with cloth to make water safer for consumption, 55 (13.3%) used boiling method, 44 (10.6%) used tap filter, 32 (7.7%) used Reverse Osmosis purifier or Aqua guard filter and only three (0.7%) were keeping water under sunlight to make safer for drinking purpose.

Graph-1: Distribution of the study participants according to their primary source of drinking water (n=415)



9 (100%) participants who worked in government sector had continuous availability of water from their source every day, which was statistically significant with p = 0.002 (χ^{2-} 19.652) using Fisher's exact test and occupation had significant association with water availability. 78 (92.86%) of the study participants belonged to the age group of 21-30 yrs had continuous availability of water with p = 0.026 (χ^{2-} 12.464) using Fisher's exact test. Chi – square association with other socio demographic variables were not statistically significant [Table 2].

Table-2: Association between socio demographic variables of study participants with availability of water (n=415)

Socio – demographic variables of study participants		Availability of water		Chi-square	Fisher's exact P- value
		Yes	No		
Age in years	18-20	58 (90.63%)	6 (9.38%)	12.464	0.026
	21-30	78 (92.86%)	6 (7.14%)		
	31-40	88 (88%)	12 (12%)		
	41 – 50	32 (78.05%)	9 (21.95%)		
	51 – 60	48 (85.71%)	8 (14.29%)		
	>60	53 (75.71%)	17 (24.29%)		
Occupation	Home maker	215 (84.65%)	39 (15.35%)	19.652	0.002
	Government employee	9 (100%)	0		
	Private employee	34 (87.18%)	5 (12.82%)		
	Agriculture	5 (83.33%)	1 (16.67%)		
	Labourer	45 (81.82%)	10 (18.18%)		
	Self employed	2 (40%)	3 (60%)		
	Un employed	47 (100%)	0		
SES (as per modified B G Prasad's classification)	II	13 (86.67%)	2 (13.33%)	2.442	0.492
	III	49 (80.33%)	12 (19.67%)		
	IV	233 (87.59%)	33 (12.49%)		
	V	62 (84.93%)	11 (15.07%)		

Total 40 drinking water samples were collected for microbiological analysis. 20 (50%) water samples from the main source and 20 (50%) from the household water samples, among them four samples (10%) were found fit for human consumption, remaining 36 samples (90%) were found unfit for human consumption and showed Klebsiella, Pseudomonas and E. coli as isolated organisms. Total fourty drinking water samples were collected for microbiological analysis in the present study, 20(50%) water samples from the main source and 20 (50%) from the household, among them four samples (10%-one from household and three from primary source) were fit for human consumption and remaining 36 samples (90%) were unfit for human consumption.

Water samples in the surveyed areas were found to be grossly contaminated with coliform bacteria. The contamination was found in both underground sample and water vendor sample. Sample from one household that used RO filter was found to be fit, showing that filtration is the effective measure of obtaining safe drinking water. Main water source and piped water (main source) from two different areas were found to be fit, indicating that gram panchayat water was fit for human consumption. The eventual finding of the same water being unfit at households indicates that contamination could have occurred either during the supply chain of water or unhygienic practices at households. Klebsiella, Pseudomonas, E. coli were the organisms isolated from these unfit water samples.

The unfit water samples were documented and reported to the PHC medical officer by the investigator and Male Health worker. The household members from respective villages and gram village Panchayats were advised about alternative source of drinking water until the next sample was found fit. The medical officer of PHC submitted the report to the concerned gram panchayat and appropriate measures were taken like chlorination of water and giving health education to the respected community about the drinking safe water, sanitation, and hygienic practices.

Discussion

In the present study, among 415 samples collected 70.8% households were using piped water as a primary source of drinking water, 11.8% were using dug well water, 10.6% were using tube well/bore well. A cross-sectional study was conducted in 2016 among 796 households in West Bengal, 71.1% households used piped water as a source of drinking water, which was higher when compared to the present study. 8.4% used tube well as a primary source of drinking water. 2.8% used protected dug well as a primary source of drinking water, which was lower than the present study [10].

In the present study, 78.8% households used to cover the drinking water stored for drinking purpose. A cross-sectional study was conducted in 2014 among 152 households in urban and rural part of Delhi, 57% stored drinking water in closed containers, which was lesser when compared to present study [13]. In the present study, 57.3% were using plastic containers for storing drinking water. A study was conducted in 2014 among 300 households in Chandigarh; 58% stored drinking water in plastic bottle containers or buckets, which was similar to the results of the present study [14].

In the present study, 14.2% used straining with cloth to make water safer for consumption and 13.3% used boiling method to make safer for drinking. A cross-sectional study was conducted in 2016 among 796 households in West Bengal, 35.9% used boiling method, which was higher compared to the present study; 19.3% used straining with cloth to make safer for consumption, which was higher compared to the present study[10]. Total fourty drinking water samples were collected for microbiological analysis in the present study, 20 (50%) water samples from the main source and 20 (50%) from the household, among them four samples (10%-one from household and three from primary source) were fit for human consumption and remaining 36 samples (90%) were unfit for human consumption.

Klebsiella was found to be circulating in water samples collected. The probable reasons could be because of resistance to routinely used disinfecting agents (chlorine) and modern preparations. Alternative methods such as

filtration can be used [15]. Pseudomonas was found in 10% of water samples as it is found commonly in food and water. RO purification is recommended to remove the microorganisms [16].

Pseudomonas is a known contaminate of water source indicating contamination from dump area. In the present study, 90% drinking water samples tested were unfit for human consumption, A cross - sectional study was conducted in rural areas of coastal Karnataka in 2009 among 40 households. 70% water samples were found unfit for drinking purpose [17].

Conclusion

Two - thirds of the study participants were females, home makers and belonged to socio economic status IV. Seven out of ten households were using piped water as a primary source of drinking water. Two third of the participants were using improved source of drinking water. More than two - thirds of the participants covered drinking water containers. More than half of the participants did not use any purification method for the drinking water. One third of the main water sources from various panchayat under the study area were fit and two -third of the samples were unfit. Majority of the households drinking water were unfit for drinking purpose and shows various micro-organisms such as Klebsiella, E-coli.

Recommendations: Education and counselling should be given to the rural households about the hygienic practices to be followed while storing and using drinking water. Create awareness among public on safe drinking water practices like household purification, boiling, etc. concerned gram panchayat should take necessary action against opening of dug wells, and the dug well should be closed always and should be converted into sanitary well.

Household Level: Rural people should be educated to use piped water supply only, wherever available. Household members should close the water storage containers with the lid. Drinking water should always be treated by any one of the household purification methods before consumption.

Panchayat Level: Should provide periodic disinfection of all sources of drinking water in coordination with health workers.

PHC Level: Male health worker should regularly monitor the quality of drinking water at all sources and report to concerned gram panchayat for further action if required. He /She should keep a close watch for water related diseases in the community.

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