International Journal of Scientific Reports
Chhabra S et al. Int J Sci Rep. 2023 Aug;9(8):251-258
http://www.sci-rep.com
pISSN 2454-2156 | eISSN 2454-2164
DOI: https://dx.doi.org/10.18203/issn.2454-2156.IntJSciRep20232188

Original Research Article

Safe drinking water in remote rural communities in present era

Shakuntala Chhabra[1]*, Nilesh Solanki[2], Vilayatkar[3]

[1]Department of Obstetrics and Gynaecology, MGIMS, Sevagram, Aakanksha Shushu Kalyan Kendra, Melghat Project, Amravati, Maharashtra, India
[2]Department of Obstetrics and Gynaecology, MGIMS, Sevagram, Wardha, Maharashtra, India
[3]Melghat Project, Amravati, Maharashtra, India

Received: 28 April 2023
Revised: 21 June 2023
Accepted: 23 June 2023

***Correspondence:**
Dr. Shakuntala Chhabra,
E-mail: chhabra_s@rediffmail.com

ABSTRACT

Background: Groundwater is important source of drinking water particularly in rural communities though river, dam water too is also used globally. Many sicknesses, deaths are due to water, major media for carrying causes of illnesses. Community based study was carried out to know about drinking water sources, action before consumption by rural communities.
Methods: Community based qualitative study using predesigned tool was carried out in tribal communities of 140 villages of forestry hilly region over one year with 25 women of 15 to 60 years randomly included from each village, total 4500.
Results: Reported sources of drinking water at home were public taps in 1671 (37.1%), public borewells 1195 (26.6%), wells in outskirts of villages 929 (20.6%), rivers 381 (8.5%), other sources 324 (7.2%) (harvested rainwater, dams). Of 4500 study subjects, total 1522 (33.8%) women reported no road for going to collect water. Only 1936 (43.0%) women had drinking water at work places, (310 (16.0%) borewell, 313 (16.2%) matka (mud pot), 999 (51.6%) well, 314 (16.2%) other sources. Those who did not have water at work places, 393 (15.3%) took water from home, 767 (29.9%) went to river. Before use at home, 3510 (78.0%) women did filtration, usually with cloth torn from old saree, 690 (15.3%) boiled, 300 (7.3%) used other methods (bleaching powder or alum).
Conclusions: In present era in well doing province untreated river water for drinking at home, work places are real dangerous practices, much more dangerous at work places as water is consumed directly from river without any action.

Keywords: Safe drinking water, Women, Rural remote communities

INTRODUCTION

Groundwater is widely acknowledged to be an important source of drinking water in low-income regions around the world. Also, there are many illnesses and deaths, especially in infants and children because of water consumed, a major media for carrying the causes of illnesses, particularly in rural communities around the world. Recent statistics reveal that only a small proportion, 18 per cent, of rural households get piped water supplied to their dwellings and more than half of all rural households still rely on public or common sources of water in India.[1] The comptroller and auditor general (CAG) in his performance audit report of the national rural drinking water programme in India 2018, reported that the "coverage of rural habitations increased by only 8 per cent at 40 litres per capita per day or water available per person (lpcd) and 5.5 per cent on the basis of 55 lpcd during 2012-2017 despite the expenditure of Rs 81,168 crores".[2] The majority (51 per cent) of rural households in India use a tube well, or hand pump or borewell for their water requirements (NFHS-4, 2015-2016).[2] These sources dry up and become defunct as the groundwater table goes down during the summer month. According to the United

Nations Resolution 64/292: "The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses".[3] Rogers et al have earlier opined that community water systems (CWS) were facing significant external forces for change due to decreasing water-resources, stricter water-quality regulations in some parts and no control in other parts of the globe.[4]

Objectives

Community based study was done to know about drinking water sources and action taken in rural communities.

METHODS

Information was collected by interviews of study subjects at the place in the village mutually convenient to research assistant and the woman after approval of ethics committee of base institution and recorded on the predesigned tool no one was given to fill the toot to fill.

Study setting

Study was carried out in tribal communities of 140 villages in forestry and hilly region near health facility.

Study design

It was a community based qualitative study using predesigned stool.

Study period

The duration of the study was from December 2021 to December 2022.

Study sample

The sample size (n) was 4500 women calculated by the following formula.

$$\boldsymbol{n = [DEFF \times Np(1-p)]/[(d^2/Z^2{}_{1-\alpha/2} \times (N-1) + p \times (1-p)]}$$

Results from Open Epi, version 3, open source calculator—SS Propor.

Inclusion, exclusion criteria

Total 4500 women of 15 to 60 years willing to be part of study, in a condition to answer questions, randomly including 25 women from each village.

Data analysis

The information collected was entered in an offline form, and the results were inserted in to Microsoft excel and analyzed. Data was checked for consistency and completeness; data entry errors were spotted and corrected.

RESULTS

Of 4500 study subjects, sources of drinking water for use at home were public taps 1671 (37.1%), public borewells 1195 (26.6%), wells in the outskirts of village 929 (20.6%), river 381 (8.5%) and other sources 324 (7.2%) (harvested rainwater, dams). Total 1522 (33.8%) women did not have road for going to source of water. Details of relationship with source of water with variables like age, education, job and economic status are in Table 1. There was significant difference with education and drinking water source at home (p value <0.0001), also with profession (p value is <0.00015). Of 4500 study subjects, only 1936 (43.0%) had drinking water at work places, 310 (16.0%) borewell, 313 (16.2%) matka (mud pot), 999 (51.6%) well, and 314 (16.2%) used other sources (harvested rain water, dams). The details of relation of water at workplaces with age, education, job, economic status are in Table 2. Those who did not have water at work places, 393 (15.3%) took water from home, 767 (29.9%) went to river for drinking water. They used their own hands or empty lunch boxes for drinking water from river, 740 (29.0%) went to well at a distance, at the periphery of village, 399 (15.6%) nearby borewell, and 261 (10.2%) used other sources. There was significant difference with education with drinking water source at work places (p value is <0.00001) and also profession (p value is <0.00015). Of 4500 study subjects, 3510 (78.0%) reported filtration of water before use at home, usually with cloth torn from used old saree, 690 (15.3%) boiled water, 300 (7.3%) used other methods (like adding bleaching powder or alum to water). The details of relation of processing in relation to age, education, job, economic status are in Table 3.

DISCUSSION

Access to safe drinking water is essential for healthy life, one of the basic human rights but is not being taken care in many parts of the world. Marino et al reported that there have been major changes in the way villages in State of Alaska in USA, procured water for drinking and other uses.[5] Researchers of North Western Alaska did a study about using or not using centralized water systems by rural communities and concluded that local culturally specific ideas about health and acceptable drinking water quality must be taken into account for water schemes to be successful. In villages where study has been done did have some system, but not for every one and not all the time and all the seasons.

In addition, villagers have their own beliefs. Penn et al also opined that many researchers and professionals agreed that water insecurity was a problem in rural Alaska, although the scale and nature of the problem was contested.[6]

Table 1: Sources of drinking water at home.

Variables	Total	Source										Road for getting water	
		Public tap	%	Borewell	%	Well	%	River	%	Others	%	Yes	%
Education													
Illiterate	754	234	31.0	200	26.5	150	19.9	75	9.9	95	12.6	439	58.2
Primary	1450	520	35.9	400	27.6	275	19.0	150	10.3	105	7.2	905	62.4
Secondary/higher secondary	2191	877	40.0	570	26.0	485	22.1	144	6.6	115	5.2	1540	70.3
Graduate / post graduate	105	40	38.1	25	23.8	19	18.1	12	11.4	9	8.6	94	89.5
Total	4500	1671	37.1	1195	26.6	929	20.6	381	8.5	324	7.2	2978	66.2
Profession													
Home maker	320	120	37.5	110	34.4	45	14.1	25	7.8	20	6.3	225	70.3
Agriculture labourer	2072	747	36.1	525	25.3	439	21.2	186	9.0	175	8.4	1390	67.1
Casual labourer	1218	459	37.7	315	25.9	250	20.5	100	8.2	94	7.7	733	60.2
Shop keeper	890	345	38.8	245	27.5	195	21.9	70	7.9	35	3.9	630	70.8
Total	4500	1671	37.1	1195	26.6	929	20.6	381	8.5	324	7.2	2978	66.2
Economic status													
Upper class	150	87	58.0	40	26.7	20	13.3	2	1.3	1	0.7	140	93.3
Upper middle class	460	110	23.9	100	21.7	95	20.7	85	18.5	70	15.2	290	63.0
Middle class	835	276	33.1	200	24.0	160	19.2	105	12.6	94	11.3	465	55.7
Lower middle class	1255	537	42.8	355	28.3	225	17.9	78	6.2	60	4.8	833	66.4
Lower class	1800	661	36.7	500	27.8	429	23.8	111	6.2	99	5.5	1250	69.4
Total	4500	1671	37.1	1195	26.6	929	20.6	381	8.5	324	7.2	2978	66.2

*Small scale, (food, shoes making, bamboo itoms) industry, welding workshop, brick furnace

Table 2: Drinking water at work places.

Variables	Total	Water Available												Alternative source									
		Yes	%	Source								No	%										
				Bore	%	Mat-ka	%	Well	%	Others	%			From home	%	River	%	For off well	%	For off bore-well	%	Others	%
Education																							
Illiterate	754	297	39.4	71	23.9	37	12.5	142	47.8	47	15.8	457	60.6	117	25.6	122	26.7	97	21.2	62	13.6	59	12.9
Primary	1450	618	42.6	92	14.9	112	18.1	297	48.1	117	18.9	832	57.4	122	14.7	237	28.5	242	29.1	132	15.9	99	11.9
Secondary/higher	2191	964	44.0	139	14.4	155	16.1	525	54.5	145	15.0	1227	56.0	137	11.2	400	32.6	395	32.2	195	15.9	100	8.1

Continued.

Variables	Total	Water Available																					
		Yes	%	Source								No	%	Alternative source									
				Bore	%	Mat-ka	%	Well	%	Others	%			From home	%	River	%	For off well	%	For off bore-well	%	Others	%
secondary																							
Graduate /post graduate	105	57	54.3	8	14.0	9	15.8	35	61.4	5	8.8	48	45.7	17	35.4	8	16.7	10	20.8	10	20.8	3	6.3
Total	4500	1936	43.0	310	16.0	313	16.2	999	51.6	314	16.2	2564	57.0	393	15.3	767	29.9	744	29.0	399	15.6	261	10.2
Profession																							
Home maker	NA																						
Agriculture labourer	2392	1006	42.1	141	14.0	152	15.1	554	55.1	159	15.8	1386	57.9	223	16.1	409	29.5	397	28.6	214	15.4	143	10.3
Casual labourer	1218	552	45.3	117	21.2	101	18.3	237	42.9	97	17.6	666	54.7	97	14.6	198	29.7	192	28.8	105	15.8	74	11.1
Shop keeper	890	378	42.5	52	13.8	60	15.9	208	55.0	58	15.3	512	57.5	73	14.3	160	31.3	155	30.3	80	15.6	44	8.6
Total	4500	1936	43.0	310	16.0	313	16.2	999	51.6	314	16.2	2564	57.0	393	15.3	767	29.9	744	29.0	399	15.6	261	10.2
Economic status																							
Upper class	150	64	42.7	24	37.5	10	15.6	20	31.3	10	15.6	86	57.3	69	80.2	6	7.0	5	5.8	4	4.7	2	2.3
Upper middle class	460	218	47.4	57	26.1	52	23.9	72	33.0	37	17.0	242	52.6	77	31.8	47	19.4	42	17.4	37	15.3	39	16.1
Middle class	835	363	43.5	82	22.6	72	19.8	147	40.5	62	17.1	472	56.5	127	26.9	122	25.8	92	19.5	67	14.2	64	13.6
Lower middle class	1255	499	39.8	54	10.8	85	17.0	270	54.1	90	18.0	756	60.2	70	9.3	230	30.4	265	35.1	126	16.7	65	8.6
Lower class	1800	792	44.0	93	11.7	94	11.9	490	61.9	115	14.5	1008	56.0	50	5.0	362	35.9	340	33.7	165	16.4	91	9.0
Total	4500	1936	43.0	310	16.0	313	16.2	999	51.6	314	16.2	2564	57.0	393	15.3	767	29.9	744	29.0	399	15.6	261	10.2

*Small scale, (food, shoes making, bamboo itoms) industry, welding workshop, brick furnace; others –harvested rain water, dams

Table 3: Water processing at home.

Variables	Total	Modality					
		Cloth filtration	%	Boiled	%	Other	%
Education							
Illiterate	754	490	65.0	200	26.5	64	8.5
Primary	1450	1118	77.1	240	16.6	92	6.3
Secondary/higher secondary	2191	1832	83.6	220	10.0	139	6.3
Graduate/post graduate	105	70	66.7	30	28.6	5	4.8
Total	4500	3510	78.0	690	15.3	300	6.7
Profession							
Home maker	320	220	68.8	80	25.0	20	6.3
Agriculture labourer	2072	1625	78.4	315	15.2	132	6.4
Casual labourer	1218	927	76.1	195	16.0	96	7.9
Shop keeper	890	738	82.9	100	11.2	52	5.8
Total	4500	3510	78.0	690	15.3	300	6.7
Economic status							
Upper class	150	98	65.3	30	20.0	22	14.7
Upper middle class	460	143	31.1	260	56.5	57	12.4
Middle class	835	483	57.8	270	32.3	82	9.8
Lower middle class	1255	1121	89.3	80	6.4	54	4.3
Lower class	1800	1665	92.5	50	2.8	85	4.7
Total	4500	3510	78.0	690	15.3	300	6.7

*Small scale, (food, shoes making, bamboo itoms) industry, welding workshop, brick furnace; others- bleaching powder or alum

Lucas et al did a study in communities paying for an in-home non-potable water reuse system in rural Alaska and reported that several rural communities lacked piped water and sewer services, leading to residents self-hauling drinking water and manually disposing of waste.[7]

The results also suggested myriad of local factors that impacted acceptance, desire and willingness to pay for in-home water reuse. Something like rural Alaska was happening in study villages of the present study, where of the 4500 interviewed study subjects, women of 15 to 60 years who were responsible for arranging water for the family, 1671 (37.1%) reported use of public tap, 1195 (26.6%) public borewell, and 929 (20.6%) well in the outskirts of their villages, but overall 381 (8.5%) women collected water from river, and 324 (7.2%) used other sources like harvested rainwater or from dam. In some villages there was system of disinfection with bleaching powder in wells and main water tanks which were connected to public taps with pipes but regularity of bleaching as well as surity of water in taps was notthere. Underground water collected from Borewell had no system of purification except whatever women did at home. Rowles et al [8] initiated a study for assessment of water quality, including microbial ecology, off the grid Alaskan water supply (i.e., primarily groundwater wells) and results revealed location-specific elevated Arsenic concentrations. Reddy et al did a study in Andhra Pradesh of India and reported that 69% rural households reported doing nothing at home to make the tap water safe for drinking, 90% reported storing water in utensils covered with lids and retrieving water by dipping glass kept around.[9] The same was happening at the work places in the villages where study was done. Some women went to nearby river to drink water with their hands. The river banks were used for defection, washing clothes and animals were washed in the rivers with challenges of processing of water before use and changing such systems. Of 4500 study subjects, 3510 (78.0%) reported filtration of water with cloth torn from old saree, 690 (15.3%) boiled water, 300 (7.3%) used other methods (bleaching powder or alum at home). In the region where study was done, quite a few women used ground water without any processing. Lapworth et al reported that groundwater provided a vital source of drinking water for rural communities in many parts of Africa, particularly in dry seasons when there were few safe alternative sources.[10] Bariki et al also did a study in the same state and reported that around 60% of the households got water from unprotected wells, surface water and unprotected springs.[11] For purification most communities did boiling (64%), some did chlorination (4%), cloth filtration (14%) and ceramic filtration (2%), but 16% did not do anything. Of the 100 households, 20% households reported that at least one household had suffered from water-borne diseases in the past year. Many households could access water sources, but access to safe drinking water was a major challenge. There was inconsistent and inadequate utilization of water purification techniques leading to consumption of contaminated water. Reddy et al also did a study in Andhra Pradesh, India and reported that 90% of spring water used for drinking, samples did not meet Bureau of Indian Standards (BIS) and World Health Organization (WHO) standards and were highly contaminated.[12] The interrelated effects have definite impact on developmental efforts and ill effects on health

of the tribal communities because of water borne diseases. Wilson et al have reported that the material dimensions of water security alone were in adequate even in Yukon Canada.[13] Researchers concluded that more holistic approaches were needed to explain relationships of health of indigenous people to water, including the use of traditional water sources such as mountain creeks and springs. Indigenous water relations invited a shift towards a holistic understanding of water security. Singh et al did a study in Maharashtra, India and reported that there were high levels of spatial heterogeneity in water services within, as well as between, blocks and there were broad patterns of priorities for planning and also policy purposes.[14] Marwaha et al did a study for identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities of America.[15] Targeted managed aquifer recharge on agricultural land near rural communities was one such strategy that could potentially stabilize groundwater tables and maintain or improve groundwater quality in domestic supply wells. The research revealed new understanding of the factors contributing to community vulnerability and resilience to changes in drinking water supply. Satyam also did a study in India and reported that the existing situation of drinking water supply under national rural drinking water programme (NRDWP) had clusters and habitations who were not able to access water from the common water supply schemes located in rural and tribal areas.[16] Segev et al reported isolated incidences of lead and geologically-attributable arsenic exceeding environmental protection agency standard in rural Maine of USA.[17] So there are various issues in water for human consumption around the world, though the problems are much more in developing countries, especially in rural remote regions and more in forestry regions as was found in the present study. Of the 4500 study subjects, 1522 (33.8%) did not even have road for going to water source. Water was almost always collected by women. It is so dangerous for young girls, elderly and pregnant women with water pots on head, or shoulder walking on broken stony narrow pathways and river water for drinking without processing, very dangerous practice. Maramraj et al did a study in India and reported 709 acute diarrheal disease (ADD) outbreaks.[18] Researchers investigated to describe the epidemiology, identify risk factors, and provide evidence-based recommendations and reported that an ADD outbreak with high attack rate in a remote tribal village was associated with drinking water from shallow downhill bore-wells, likely contaminated via runoff from open defecation areas after heavy rains. Researchers reported 27% not having accessibility to safe drinking water and 75% households not having toilets. Collins et al reported that government initiatives to address the chronic problem of 'boil water advisories' within indigenous communities, did not recognize, source water protection (SWP) planning as a cost effective tool for improving drinking water quality.[19] McLeod et al did a study with quantitative analysis of drinking water advisories among rural communities in Canada and reported the disparities associated with indigenous and non-indigenous small drinking water systems.[20] Carrard et al from Australia reported that their review findings supported the case for governments and development agencies to strengthen engagement with groundwater resource management as foundation for achieving sustainable water services for everyone.[21] Alam et al reported that assessment of water samples from various methods indicated that majority of the ground water in the study area was chemically suitable for drinking and agricultural use in Delhi India.[22] However microbial study was not done. Lapworth et al from Africa reported that while the overall level of microbiological contamination from hand pump equipped boreholes was low, results from their study strongly suggested that at a national and regional level, microbiological contamination rather than chemical contamination provided a greater barrier to achieving targets set for improved drinking water quality.[23] Efforts should be made to ensure that boreholes are properly sited and constructed effectively to reduce contamination. A study in Pakistan by Khan et al revealed that the order for the overall safety level for water quality in their study area was tube wells, followed by open wells, hand pumps and springs, both geogenic and anthropogenic activities with the sources of drinking water contaminated.[24] Waterborne diseases were highest in respondents who took their drinking water from springs, whereas reports of diseases were moderate in respondents taking water from open wells and hand pumps and lowest in respondents taking water from tube wells. In the present study of 4500 study subjects, 1671 (37.1%) used public tap connected, with main tanks which had erratic chlorination. Wells in out skirts also had erratic system of chlorination. Wells were not covered with any things. Water levels of wells became so high in rains that animals could drink water directly from well, 1195 (26.6%) public borewell, 929 (20.6%)wells at outskirts, but 381 (8.5%) collected water from river, and 324 (7.2%) used other sources for drinking water at home. In the present day drinking untreated river water where animals are cleaned and cloths washed is dangerous. It must be changed. Actually river banks are used for defection also. Over all of 4500 study subjects, only 43% had drinking water at work places, (6.9% borewell, 7% matka, 22.2% well, and 7% other sources). Of 56.9% who did not have drinking water at work places, only 8.7% women took water from home, 17% went to river, 16.5% wells, 8.9% to borewell, and 5.8% to other sources including harvested rain water. Universal access to safe water and sanitation remain unrealised due to both historical disparities and current challenges in high income communities. These challenges have been mostly invisible in the global water, sanitation, and hygiene (WASH) discourse, which focuses primarily on low income and middle-income countries.[25] Masten et al reported that the highly visible cases like the lead crisis in Flint, Michigan, United State of America in which more than 100000 people were exposed to elevated lead levels in drinking water.[26]

Hermans et al reported that the inadequate water and sanitation in refugee camps in Greece showed gaps in services deeply affected the health and quality of life of

marginalised populations, even in countries with ample resources to address such problems.[27]

Wolf et al by using database estimate that 1·4 (95% CI 1·3–1·5) million deaths and 74 (68–80) million disability-adjusted life-years (DALYs) could have been prevented by safe water, sanitation and hygiene (WASH) in 2019 across the four designated outcomes, representing 2·5% of global deaths and 2·9% of global disability-adjusted life-years (DALYs) from all causes.[28]

Limitations

Limitations of the study were the amount, frequency of bleaching powder or alum used to clean water, chlorination of wells, water tanks cleaning was not known.

CONCLUSION

In a reasonably well doing province of India using unsafe water for drinking, a dangerous practices need to be changed. It is much more dangerous at work places as river water is used with not any action. Also, women walk long distances with no roads to get water to drink.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. National Family Health Survey, India. NFHS-4 fact sheets for key indicators based on final data. Available at: http://rchiips.org/nfhs/factsheet_nfhs-4.shtml. Accessed on 17 February 2023.
2. Comptroller and Auditor General of India. Available at: https://cag.gov.in/sites/default/files/audit_report_files/Report_No_15_of_2018_Performance_Audit_on_National_Rural_Drinking_Water_Programme_in_Ministry_of_Drinking_Water_and_Sanitation.pdf. Accessed on 17 February 2023.
3. United Nations (UN). Resolution Adopted by the General Assembly on 28 July 2010. Available at: http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/64/292. Accessed on 17 February 2023.
4. Rogers JW, Louis GE. Method for comparative performance assessment and evaluation of consolidating community water systems as a regional water system. J Infrastructure Systems. 2007;13(4):280-6.
5. Marino E, White D, Schweitzer P, Chambers M, Wisniewski J. Drinking water in Northwestern Alaska: using or not using centralized water systems in two rural communities. Arctic. 2009;75-82.
6. Penn HJ, Loring PA, Schnabel WE. Diagnosing water security in the rural North with an environmental security framework. J Env Management. 2017;199:91-8.
7. Lucas C, Johnson B, Hodges Snyder E, Aggarwal S, Dotson A. A Tale of Two Communities: Adopting and Paying for an In-Home Non-Potable Water Reuse System in Rural Alaska. ACS ES&T Water. 2021;1(8):1807-15.
8. Rowles III LS, Hossain AI, Aggarwal S, Kirisits MJ, Saleh NB. Water quality and associated microbial ecology in selected Alaska Native communities: Challenges in off-the-grid water supplies. Science of The Total Environment. 2020;711:134450.
9. Reddy BV, Kusuma YS, Pandav CS, Goswami AK, Krishnan A. Water and sanitation hygiene practices for under-five children among households of Sugali tribe of Chittoor District, Andhra Pradesh, India. J Env Public Health. 2017;31.
10. Lapworth DJ, MacDonald AM, Kebede S, Owor M, Chavula G, Fallas H, et al. Drinking water quality from rural handpump-boreholes in Africa. Env Res Letters. 2020;15(6):064020.
11. Bariki SK, Reddy B. Access To Drinking Water Sources, Water-Born Disease Prevalence And Water Purification Methods Adopted By Tribes Of Visakhapatnam District, Andhra Pradesh, India. International J Eng Sci Res Technol. 2017;6(5):509-16.
12. Reddy BT, Lakshmi KV, Geetha S, Ramana CV, Syam Kumar B. Microbiological Quality Of Some Spring Drinking Water Samples In Tribal Areas Of Chintapalli Mandal, Visakhapatnam District, Andhra Pradesh, India. Int J Adv Biol Res. 2014;4(1):27-30.
13. Wilson NJ, Harris LM, Joseph-Rear A, Beaumont J, Satterfield T. Water is medicine: Reimagining water security through Tr'ondëk Hwëch'in relationships to treated and traditional water sources in Yukon, Canada. Water. 2019;11(3):624.
14. Singh R, Brahmankar R, Murty JV, Verma P, Wescoat JL. Analyzing rural drinking water services for district planning in Maharashtra, India. Water Policy. 2020;22(1):37-51.
15. Marwaha N, Kourakos G, Levintal E, Dahlke HE. Identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities. Water Resources Res. 2021;57(3):e2020WR028811.
16. Satyam S. Drinking water in tribal areas: A policy analysis. J Rural Industrial Dev. 2017;5(2):71.
17. Segev T, Harvey AP, Ajmani A, Johnson C, Longfellow W, Vandiver KM, et al. A case study in participatory science with mutual capacity building between university and tribal researchers to investigate drinking water quality in rural Maine. Env Res. 2021;192:110460.
18. Maramraj KK, Subbalakshmi G, Ali MS, Dikid T, Yadav R, Sodha SV, et al. A community-wide acute diarrheal disease outbreak associated with drinking contaminated water from shallow bore-wells in a tribal village, India, 2017. BMC Public Health. 2020;20(1):1-8.
19. Collins L, McGregor D, Allen S, Murray C, Metcalfe C. Source water protection planning for Ontario First

Nations communities: Case studies identifying challenges and outcomes. Water. 2017;9(7):550.
20. McLeod L, Bharadwaj LA, Daigle J, Waldner C, Bradford LE. A quantitative analysis of drinking water advisories in Saskatchewan Indigenous and rural communities 2012–2016. Canadian Water Resources J. 2020;45(4):345-57.
21. Carrard N, Foster T, Willetts J. Groundwater as a source of drinking water in southeast Asia and the Pacific: A multi-country review of current reliance and resource concerns. Water. 2019;11(8):1605.
22. Alam M, Rais S, Aslam M. Hydrochemical investigation and quality assessment of ground water in rural areas of Delhi, India. Env Earth Sci. 2012;66(1):97-110.
23. Lapworth DJ, MacDonald AM, Kebede S, Owor M, Chavula G, Fallas H, et al. Drinking water quality from rural handpump-boreholes in Africa. Env Res Letters. 2020;15(6):064020.
24. Khan MH, Nafees M, Muhammad N, Ullah U, Hussain R, Bilal M. Assessment of drinking water sources for water quality, human health risks, and pollution sources: a case study of the District Bajaur, Pakistan. Arch Env Contaminat Toxicol. 2021;80(1):41-54.
25. The World Bank. World Bank country and lending groups. 2022. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519 - world-bank-country-and-lending-groups. Accessed on 14 December 2022.
26. Masten SJ, Davies SH, Mcelmurry SP. Flint water crisis: what happened and why? J Am Water Works Assoc. 2016;108(12):22-34.
27. Hermans MP, Kooistra J, Cannegieter SC, Rosendaal FR, Mook-Kanamori DO, Nemeth B. Healthcare and disease burden among refugees in long-stay refugee camps at Lesbos, Greece. Eur J Epidemiol. 2017;32:851-4.
28. Wolf J, Johnston RB, Ambelu A, Arnold BF, Bain R, Brauer M, et al. Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. Lancet. 2023;S0140-67.

Cite this article as: Chhabra S, Solanki N, Vilayatkar. Safe drinking water in remote rural communities in present era. Int J Sci Rep 2023;9(8):251-8.