

## Original Research Article

DOI: <https://dx.doi.org/10.18203/2394-6040.ijcmph20212012>

# A cross sectional study on household dependence on well water, source of contamination and well protection measures adopted by an urban and rural population in Kollam, Kerala

Jeffy Binu\*, Halma Salam, Jibina K. A., Fathahiya Fazil, Hasnath K. T., Greeshma S.

Department of Community Medicine, Azeezia Institute of Medical Sciences and Research, Kollam, Kerala, India

Received: 15 April 2021

Revised: 11 May 2021

Accepted: 12 May 2021

**\*Correspondence:**

Jeffy Binu,

E-mail: jeffy.binu@gmail.com

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## ABSTRACT

**Background:** Wells are a common ground water source readily explored to meet community water requirement. Open wells of Kerala have the problem of bacterial contamination, which causes diarrhea diseases especially in children. Close proximity of well to septic tank, waste pit and cattle shed can be considered as a leading cause of contamination of water. The present study had gone into the details of dependence of dug well, possible source of contamination and protective measures taken for drinking water safely by various households in both urban and rural population.

**Methods:** Cross sectional study design applied in order to address the objectives of the study. Using systematic random sampling techniques 80 households were selected from urban and rural areas. Pretested interview schedule were used as the data collection tool.

**Results:** 100% of households are depending on dug well for all their use like drinking, cooking, cleaning etc. 95% households treat water and among them 93.4% boil water before drinking. 40% of houses followed well protection measures. Significant association was found between urban and rural set-up in the distance of well from septic tank (p value is  $0.004 < 0.01$ ). There is statistically significant association in frequency of chlorination in urban and rural population (p value is  $0.015 < 0.05$ ). Occurrence of diarrhea was found to be nil in past two weeks from the time of data collection among under-fives.

**Conclusions:** Disease like diarrhea can be prevented in under-fives by following well protection measures and boiling water before drinking in both urban and rural areas.

**Keywords:** Well water, Chlorination, Water treatment

## INTRODUCTION

Water in its diverse forms constitutes the major component in cellular to the inanimate global level. Around 3% of the total water available on earth is fresh water, of which 68% are groundwater and 30% surface water.<sup>1</sup> The ground water is estimated to provide about 80% of water for domestic use in rural areas and about 50% of water in urban and industrial areas. Open dug wells are important groundwater extraction structures and is the most common source of drinking water.<sup>2</sup>

Traditional homestead type of habitation in Kerala is generally characterized by a well in each compound to tap groundwater. Therefore, it is estimated that the state has around 65 to 70 lakhs wells.<sup>3</sup>

It is documented that more than 76% of the people in the state extract ground water for domestic use from the dug wells and dependence on wells is higher in rural areas of the state. Kerala has the highest well density in the country. The average is 140 open wells per km<sup>2</sup>, whereas in the coastal area it is 200 wells per km<sup>2</sup>.<sup>4</sup>

At present, 1.1 billion people are drinking water that is not safe, especially among the developing countries, contributing to millions of young deaths. An estimated 2.6 billion people lack adequate sanitation globally. Those most susceptible to water-borne illnesses are children, elderly, pregnant women, and immune compromised individuals. Water-borne illnesses are one of the five leading causes of death among children under the age of 5 years.<sup>1</sup>

Kerala is endemic for water-borne diseases like enteric fever and viral hepatitis apart from acute diarrheal diseases, all of them showing seasonal trends, with aggravation in summer. Cases of cholera have also been reported from within the state.<sup>1</sup> The cause of contamination is attributed to close proximity of latrines to wells, unhygienic usage of wells etc. Fecal coliform contamination was found to be highest in Thrissur and lowest in Pathanamthitta district. The health hazard due to coliform contamination could be minimized by maintaining better hygiene with good sanitation facilities and practices such as Chlorination, boiling and filtration of drinking water prior to use, constructing septic tank away from drinking water source and periodical checking of drinking water quality of wells.<sup>3</sup> Ground water is likely to get contaminated by various causes such as lack of sanitation, unsafe pit latrines, domestic waste dumps and proximity of wells to latrines, waste dumps and cattle sheds.<sup>4</sup>

Household water chlorination is one of the recommended options to be practiced to prevent diarrhea disease, especially in household with under five.<sup>5</sup> Unsafe drinking water along with poor sanitation and hygiene is the main contributor to an estimated 4 billion cases of diarrhoea disease annually, causing 1.8 million deaths, mostly among children younger than 5 years of age. In India alone more than 4,50,000 deaths per year are attributable to diarrhea diseases, representing 9.1% of all deaths in children younger than 6 years of age. Evidence has shown that treating water at the household level is effective in improving the microbiological quality of drinking water and in preventing diarrheal diseases. Boiling is perhaps the older means of disinfecting water at the household level. It is the most widely used means of treating water in the house. If practiced correctly boiling is one of the most effective killing or deactivating all classes of waterborne pathogens. India is a country in which boiling is used to disinfect drinking water by 10.6% of Indian households.<sup>7</sup> In our field practice area, it has been seen that women usually complain about the occurrence of diarrhoea for their children. This makes us to think that contamination in drinking water can be a reason for it. Hence the rationale for the study.

The objective of the study was to find the dependence of the households on well water; to assess the well water protective measures adapted by them and the possible sources of contamination.

## METHODS

A community based cross sectional study was conducted in Chandanthoppu, Edanad and Meeyyanoor, which is field practice area of the department of community medicine of a tertiary care center in Kollam district. The duration of data collection was one month (April 2017). Our sampling unit was a single household. Three wards were assigned to the department in Edanad and from that by using simple random sampling technique (SRS-lottery method) one ward is selected. Nearly 125 houses were present in that selected ward.

The sample size obtained on calculation by applying 7% allowable error is 80 households. From Chandanthoppu and Meeyyanoor we selected a ward using SRS. 27 houses each were selected from Meeyyanoor and Edanad which are rural areas. 26 houses were selected from Chandanthoppu, which is an urban area. By applying systematic random sampling technique every 5<sup>th</sup> house was selected from Meeyyanoor and Edanad area and every fourth house was selected from Chandanthoppu area as there were only 100 houses in the selected ward.

A team of 4 members constitute the data collection group. Details were obtained from an adult member of the household present in the house during our visit. Informed verbal consent obtained from the respondent before data collection. If one house found to be locked, the next consecutive house was selected in to the study.

The study tool consisted of a structured interview schedule which had domain relating to the demographic profile of the household members, their dependence on well water, their water usage pattern, variables relating to type of water sources, household practices concerning well chlorination, well cleaning and boiling of water. Apart from the details pertaining to the well, its built up, drainage; floor lining, cover and mode of drawing water were also asked. The survey also took consideration the distance of well from the nearest septic tank, cattle shed and any other nearby contamination. Ethical clearance obtained from institutional ethical committee.

Categorical variables were expressed as proportions. Graphs and charts were used to explicit the categorical variable. In order to find the association between categorical variables, Chi square test has been applied. Data collected were tabulated, coded and entered in Microsoft excel and analysed using EZR software (version 1.54).

## RESULTS

The study included 80 houses, of which 66 (82.5%) were female responders and they are the ones looking after the day to day water use, drawing water from wells and those who take measures to ensure safe water at the source level and at the point of consumption. The entire 80 (100%) household were dependent on dug wells for almost all their

use like drinking, cooking, cleaning etc. There were 27 (33.8%) houses dependent on household tap as other source of water. 18 (22.5%) houses around Meeyyannor area were dependent on public taps also as another source of water. 59(73.8%) of the houses had a water tight lining, made of bricks or cement at least 6 m of 20 feet deep. 73 (91.3%) wells were covered by iron grills or net covering.

As we wanted to find out the potential sources of contamination, the distance of septic tanks from the wells were found. 18 out of 80 (23%) had well within 20 feet from septic tank; 25 (31%) had within 30 feet; 25 (31%) had within 40 feet and only 12 (15%) had well more than 50 feet from septic tank. Only 7 houses were having cattle shed. Among them 4 houses had their cattle shed within 20 feet distance, one house had within 30 feet distance, two houses had within 40 feet distance from the well.

Nearly 58% (46 out of 80) of houses usually dumped domestic waste in open area and burned. 39% (31 out of 80) dump in a waste pit within the compound. Among those who were having waste pit, only 3.8% had waste pit within 20 feet distance, 11.3% had waste pit within 30 feet, 12.5% had within 40 feet distance and 10% had waste pit within 50 feet distance or more from well (Table 1).

**Table 1: Frequency of distance of septic tank, cattle shed and waste pit from well.**

Distance (feet)	Distance of septic tank from well	Distance of cattle shed from well	Distance of waste pit from well
<b>20</b>	18 (23)	4 (5)	4 (3.8)
<b>30</b>	25 (31)	1 (1.3)	9 (11.3)
<b>40</b>	25 (31)	2 (3)	10 (12.5)
<b>Greater than 50</b>	12 (15)	-	8 (10)
<b>Not applicable</b>	-	73	49

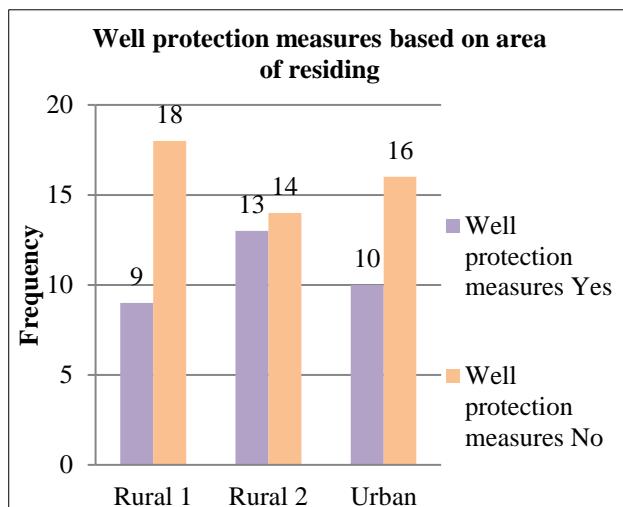
92.5% of houses add chlorine to their well. 24 (30%) add in every 3-6 months, 35 (43.8%) add chlorine in 6 months, 15 (18.8%) houses add in a time period of 6 to 11 months and 6 out of 80 (7.5%) households add chlorine to their well yearly. Nearly 72.5% (58 out of 80) houses clean their dug well yearly. Only one house cleans their household well in every 6 months. 25% clean their well in 2 to 5 years. 92.5% of houses think that their dug well water is safe to drink. 76 out of 80 houses (95%) treat the water in one form before drinking. Among these 76 houses, 71 (93.4%) boil the water before drinking and 5 (6.5%) houses uses water filter. 31 out of 80 houses keep drinking water in a container, all of them keep it in a closed container. In rural area 92.3% treat the water by boiling it and in urban area 82.14% boil water before drinking.

Three variables were considered to analyse the possible source of contamination of well water that is distance of

septic tank, cattle shed and domestic waste pit from the well. The distance from the well in each case less than 50 feet is considered as the possible source of contamination. 45 out of 80 houses (56.3%) had one source as possible source of contamination. 24 (30%) had two sources as possible source of contamination and only one house (1.3%) had all three sources as point of contamination to the well water.

We considered five variables to find out how diligently people followed the well protection measures; variables are Water tight lining, open or covered well, adding chlorine to well, frequency of chlorination (adding chlorine to well in every 3 month or every 3 to 6 months or yearly) and frequency of cleaning well (cleaning well in 6 months or yearly). If all these measures are followed by a particular house, then we will say that the house is following well protection measures. There are 32 out of 80 houses (40%) following well protection measures and 48 out of 80 (60%) houses not following all the well protection measures. We tried to find a relation between level of education completed by the female head of household and well protection measures adopted by the household, the Chi-square value obtained is 7.376 with 4 degrees of freedom with a p value of  $0.117 > 0.05$ , hence we couldn't establish the relationship. Surprisingly we have seen that among those who were having collegiate education only 16.6% is following well protection measures compared to those who were having secondary education in which 47.6% follows well protection measures.

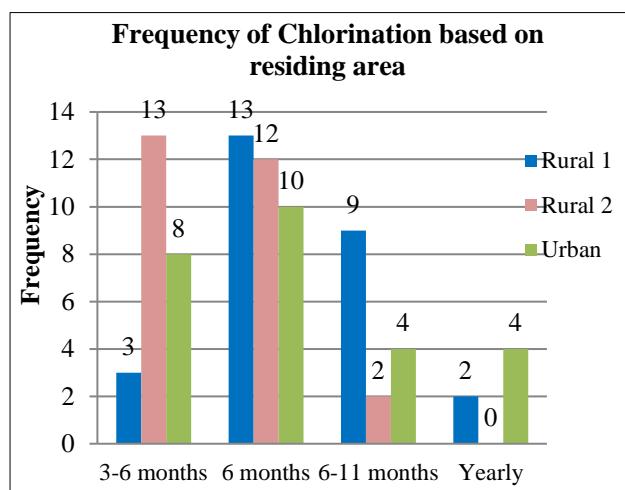
There is no significant association between area of residing and well protection measures adopted, Chi square value is 1.273 with 2 degrees of freedom with a P value  $0.529 > 0.05$ . In Meeyyannor (rural 1) area the well protection measures adopted is low which is 33% compared to other two areas that is Edanad (rural 2) which is 48% and Chandanthoppu (urban) which is 38% (Figure 1).



**Figure 1: Well protection measures adopted.**

Chi-square test was done to find out the association between household's residing area and distance of septic tank from Well. Significant difference was found between urban and rural set up in the distance of well from septic tank, Chi-square value is 18.948 with 6 degrees of freedom with p value as  $0.004 < 0.01$ . More households in urban area are having distance of septic tank from well less than 30 feet than the ones in rural area.

Frequency of chlorination was found to statistically significant in urban and rural population, where the Chi-square value is 15.722 with 6 degrees of freedom with p value as  $0.015 < 0.05$ . It has been seen that among those who chlorinate in 3-6 months one of the rural area outrages urban area, where in the rural area it is 54% and in urban area it is 33%. 75.9% of household in rural areas and 69.2% of household in urban area chlorinate their well once in three-six month or once in 6 month (Figure 2).



**Figure 2: Frequency of chlorination.**

20% of the respondents wash their hand with soap always and 76% wash their hand with soap sometimes.

We selected the occurrence of diarrhea in past two week's period from the time of data collection as a cause of contamination of drinking water among under-fives. 20 out of 80 houses had under-fives and the occurrence of diarrhea was nil among under-fives.

The findings of the study shows that the drinking water is safe to drink in our study areas and almost all households surveyed, recorded that they consider their well water to be a safe source devoid of any unsightly color or appearance.

## DISCUSSION

In our study 100% of households were dependent on dug wells. In a study done in Trivandrum it has been seen that 73% of households used dug wells as the prime source of drinking water.<sup>1</sup> In another study done in Mayyanad and Edamulakkal panchayats 91% and 95% of households were depending on dug well water.<sup>4</sup>

73.8% of the houses had water tight lining in our study, while in a study it was found that 85% houses did not have water tight lining or casing and were open type.<sup>4</sup>

As we wanted to find out the potential sources of contamination, the distance of septic tanks from the wells were found and 53.8% houses had their septic tanks at a distance of <30 feet, which was in contrary to a study wherein 80-90% of households had their latrines at distance of <30 feet from the well.<sup>4</sup> In our study 71.4% households had distance of cattle shed less than 30 feet from the well. In a study it was found that 75% to 87% of households had the distance of cattle shed less than 30 feet from dug well.<sup>4</sup> In our study 41.9% households had distance of waste pit <30 feet from the well. In a study done in Trivandrum it has been seen that 39% of wells had intermediate risk for contamination followed by 31% of high risk of contamination.<sup>1</sup>

In a study done in Mayyanad and Edamulakkal, the percentage of households disposing domestic waste in their backyard without treatment ranged from 45 to 51%.<sup>4</sup> In our study 57.5% dumped domestic waste in the open area or burnt them. Percentages of households with distance of septic tank less than 30 feet from well was found to be less in our study compared to referred studies but the distance of cattle shed less than 30 feet and percentages of houses dumping waste in open area seems to be somewhat similar with referred studies. Distance of septic tank from well was less than 30 feet for more households in urban area than in rural area, which was found to statistically significant also. This may be because of less land in urban set up.

In present study 95% of households treat water in one form or other before drinking. 93.4% of households boil water before drinking. In the study done in Trivandrum it has been seen that majority of them that is 91.8% boiled water before consumption.<sup>1</sup> In a study done in Zambia it has been seen that in urban area 11.3% and in rural area 4% households boil water before drinking.<sup>6</sup> In our study we have seen that in rural area 92.3% and in urban area 82.14% households boil water before drinking. When compared with the referred study the prevalence in both rural and urban areas are high in our study. In our study the practice of boiling water is more in rural area than in urban area. In another study done in India it was found that boiling was associated with a 99% reduction in geometric mean fecal coliform and despite high levels of fecal contamination in source water, 59.6% of stored drinking water samples met the World Health Organization (WHO) standard for safe drinking water.<sup>7</sup> In one study in Cambodia it was mentioned that boiling resulted in significant reduction of *E. coli* in household stored water, they calculated a mean reduction of *E. coli* of 98.5% in stored boiling water. 90% of randomly selected households boil water daily as a means of household water treatment, the result of our study matches with the findings of this study.<sup>8</sup> According to DHS survey 65.1% of rural and 75% of urban reported boiling as a means of household treatment and is the most prevalent method for water treatment before consumption.<sup>9</sup>

We further analysed to find out if any under-fives had an episode of diarrhea in the past two weeks. Out of the 80 houses surveyed, only 20 houses reported under-fives and surprisingly there was not even one case of diarrhea reported. Even though there was possible source of contamination, the absence of diarrhea could be due to drinking boiled water by majority of the people and practice of chlorination by majority of households and it has been to be more common in one rural area than in urban area, which was found to be statistically significant also. In the study done in Trivandrum it was seen that 73.7% of their drinking water wells have fecal contamination since they had done water quality testing and confirmed the poor quality of water.<sup>1</sup> Boiling, disinfecting and filtering water within the home, can improve the microbiological quality of drinking water, but the impact of these interventions on diarrhea is unclear.<sup>10</sup>

Frequency of chlorination during 6 month is more in rural area that is 75.9% than in urban area which is 69.2% in the present study. In one study done in Zambia it has been seen that the use of chlorine or bleach was the most prevalent method of house water treatment, in urban area it is 76.9% and in rural area it is found to be 27.9%. In another study done in Ethiopia it is seen that in rural areas, 4.6% of caregivers were reportedly chlorinating water at point-of-use and in urban areas, 17.1% of caregivers were reportedly chlorinating water.<sup>5</sup> In our study, households in rural area does frequent chlorination than the one in urban area, may be because of the visit of ASHA worker in houses in rural area for distributing and putting chlorine in well by themselves. In urban area even though ASHA worker is distributing chlorine, she is not ensuring whether it has been used for chlorination of well.

We have seen that nearly 40% of households have practices like well chlorination, well cleaning and boiling and filtering of well water, but the risk of contamination exists viewing the distance of well from septic tank, cattle shed and waste pit and any other nearby contamination. It is true that we didn't get a case of diarrhea occurred within two weeks in under-fives, may be the practice of frequent chlorination and drinking boiled water by households both in urban and rural areas would have saved from any such occurrence. We cannot rule out the chance of contamination of drinking water as we have not done any microbiological investigations of water, which itself is the limitation of our study.

## CONCLUSION

Dependence of well water among households in our study is 100%. Following well protection measures like adding chlorine to well frequently preferably in 3-6 months, cleaning the well once in 6 months or yearly will improve the quality of drinking water. Practice of boiling water before drinking will enable to prevent disease like diarrhea in under-fives. Irrespective of whether the woman in the family is educated or not, health education needs to be given to households on using safe drinking water and well

protection measures. Permissible distance of well from septic tank needs to be complied during the construction of it especially in urban area.

**Funding:** No funding sources

**Conflict of interest:** None declared

**Ethical approval:** The study was approved by the Institutional Ethics Committee

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**Cite this article as:** Binu J, Salam H, Jibina KA, Fazil F, Hasnath KT, Greeshma S. A cross sectional study on household dependence on well water, source of contamination and well protection measures adopted by an urban and rural population in Kollam, Kerala. *Int J Community Med Public Health* 2021;8:3042-7.