Original Article

Identifying water sources, quality of drinking water, implications and prevalence of Gastrointestinal problems and its associated risk factors in rural area of India: A Community Based Cross-Sectional and Observational Study

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Abstract

Background: Water is the most common and essential resources on earth and there are no creatures without it in globe. The quality of drinking water is finding out from its physical, chemical and biological characteristics. In this study, we have to identify water sources, quality of drinking water, its implications and the prevalence of selected water borne disease in the study rural area of South India.

Materials and Methods: A Community-Based Cross-Sectional and Observational Study of two villages namely Villipakkam and Puthirankottai was conducted with a sample of 1517 individuals were interviewed with a pre-tested pre-designed questionnaire.

Results: In our study, we surveyed two villages with a total of 1517 study participants, of which 797 (52.5%) were females. Overall, 58 (11.8%) of the households had gastrointestinal (GI) problems in the last 3 months. 64.4% were consuming non-chlorinated water and 53.3% of household members didn't consume boiled water. 68.7% didn't had toilet facility. Variables like educational status, occupational status, boiling of drinking water, washing hands before eating, using pipe water for drinking purpose showed statistically significant association with people those who were affected by GI problem with $p<0.05$. The mean pH level was found as 7.14 ± 0.43 (6.50 – 7.65).

Conclusion: From our study findings, we have concluded that half of the households were only used the pipe water for drinking purpose, weren't consumed chlorinated water, didn't drink hot water and didn't have latrine facilities and awareness is needed to the community.

Keywords: water quality, prevalence, rural population, water quality, water borne diseases, community-based study

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Introduction:

Water is the most prestigious and essential resource on the earth. No creatures on the earth without that. [1] Water quality based on physical, chemical and biological properties, which is an important factor of health. It is an essential for human life and other creatures. It can transmit many communicable diseases including some vector borne diseases in this world. The quality water prevents and reduces the mortality due to communicable diseases. [2] The most predominant water borne disease is diarrhea of which 88% is attributed to unsafe water supply, inadequate sanitation and hygiene. Diarrhea causes 11% of deaths in the world population. [3] Nearly 2.2 million deaths in children with aged <5 years in developing nations. [4] In developing countries, over 3.86 million deaths occur annually due to diarrheal disease and it happened very highly in India. [5] Nearly, one third of the communicable diseases in India are water as per World Bank. In 1999, an estimated 7 million of deaths due to diarrhea alone occurred in India with an average of 1,600 deaths/day. The highest mortality from diarrhea is in children under the age of five, highlighting an urgent need for focused interventions to prevent diarrhea disease in this age group. [6] Large scale droughts and floods contribute to water related disease which continues as a major health disease in worldwide. Especially in India, monsoon season results in stagnation of water which serves as breeding ground for vectors. Though water quality is not a major determinant of vector borne diseases, however, an intermediate link exists between household water storage and vector breeding. [7] Globally in recent times, the prevalence rate of Dengue fever has increased by 50 times especially in tropical and sub-tropical countries including urban and rural areas where Aedes mosquitoes breed easily in small pits of stagnated water collections. [8] In recent years, the

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has increased to endemic level in India [9]. In year 2012, about 9,249 cases and 60 deaths due to dengue were reported in Tamil Nadu thus contributing highest number of cases among all states in India. [10]

The viral infection due to Rotavirus is third leading cause for Diarrhea resulting in hospitalization worldwide. [16] In India, most of the source of water makes bacterial infections like Cholera and Typhoid. Sixty-eight outbreaks were occurred in eighteen states and union territories and the overall number of cases was over 2.22 million. As per World Health Organization (WHO) reported that 37,783 cases and 823 deaths and overall case fatality rate was 0.37% in between years 1997-2006. The states of Orissa, West Bengal, Andaman and Nicobar Islands, Assam and Chhattisgarh accounted for 91% of all outbreak related cases. [11] The incidence of typhoid cases common among age group 5-14 years. Totally, 151 cases were reported per 10,000 populations and 50 deaths were reported. More number of cases are reported in West Bengal India. [12]

In 1981 the 34th World Health Assembly in a resolution emphasized that safe drinking water is a basic element of "Primary health care" which is the key to the attainment of "Health for all" by the year 2000. [13] In 2001, safe drinking water is a basic need for human development health and drinking water accepted human right as WHO report. In the Millennium Development Goal [14], Goal 7; Target7 calls for don't have access to safe drinking water and basic sanitation by 2015. [15] Nearly, 1.2 million people not consuming safe drinking water in the world level. Nearly, more than 3/4th of population has using safe drinking water. [16] Most of the wastewater was used for crop irrigation. Wastewater resources are polluted with untreated/partially treated wastes from industry, domestic sewage and fertilizer/pesticide run off from agriculture fields. Deficit of sewage treatment facilities in most cities and not available in low-income countries. [17] Thus, the study was planned to assess the water quality and its implications in rural area in Tamil Nadu, to measure the prevalence of selected water borne diseases in the study area and to recommend the possible remedial measures based on the findings of the study to the community, panchayat leaders and to the policy makers.

Materials and Methods:

We have done a community based cross-sectional study with ten villages of Chunambedu area of Kancheepuram district, Tamil Nadu, which comes under the area of Training Centre of Pondicherry Institute of Medical Sciences. The villages are Illedu, Villipakkam, Agaram, Kayanallur, Vannianallur, Manapakkam, Pudupattu, Chunampet, Puthirankottai and Kavanur are under the field practice areas of RHTC, PIMS. This study was done in between 6th January 2014 – 1st February 2014. From these villages, two villages namely Villipakkam in **Figure–2 (Map 1 and 2)** and Puthirankottai in **Figure–3 (Map 3 and 4)** under Cheyyur taluk were selected by randomly and conducted this study. The total population of Puthirankottai was 1893 as per 2011 census and 471 households. **Sample Size Calculation:** A study was done by Janani [18] related to the prevalence of gastrointestinal symptoms among the population in the North west of Chennai, South India was 8.05%, $Z_{1.96}$ at 5% alpha error (α) = 1.96, 95% statistical significance, 80% statistical power (β) and 20% allowable error (d) of prevalence (in percentage). Sample size was arrived by, $N = 4pq/d^2$. Based on the above formula the sample size was calculated as 1143. But we have included and conducted this study with 1517 individuals and were interviewed. **Sampling technique for the main survey:** The present Study was conducted in the rural areas of in and around areas of Chunambedu, Chithamur Block in Kancheepuram district, Tamilnadu which comes under the field practice area of PIMS RHTC, Chunambedu Village as shown in **Figure–1**. We had chosen villages like Villipakkam and Puthirankottai were recruited and included in the present study and samples were collected by simple random method. Water samples were collected from the common water sources of study areas and tested microbiologically. Data were collected from the permanent residents of both villages with an inclusion of all aged those who are residing in the two villages.

Method of data collection: Data collection was done as hous-to-house survey was conducted as 24 x 7 hours by under graduate medical (MBBS) students with the supervision of Community Medicine faculties by using the questionnaire, with additional guided by the interns, Post Graduates medical students, nurses and social workers of Rural Health and Training Centre of Chunampet, Tamilnadu. Pre-designed and pre-tested proforma was used to collect basic information, sources, details of drinking water, gastro intestinal symptoms from the households randomly. We introduced ourselves and very clearly explained the need and purpose of our study to the study participants. Obtained the written consent from the study participants and information was obtained from the participants and recorded in the proforma. The entered proformas were verified by CRRIs, medical graduates and community medicine teaching staffs on the same day itself and preserved in the PIMS training center, Chunampet, Tamil Nadu, India. A pre-designed and pre-tested questionnaire was used as a study tool containing details regarding demographic variables, sources, details of drinking water and family members with gastro intestinal symptoms. Sterile wide mouthed container for water sample collection for microbiological assessment. Study participants were residents of the villages Villipakkam and Puthirankottai with an inclusion criterion of all age groups and those are permanent residents of the villages by identified their respective ration cards and an exclusion criterion of those who were critically ill and those who weren't willing to participate in our present study.

Methodology of the collection of water samples and its progress: The water samples collected from Puthirankottai and Villipakkam villages were subjected to microbiological analysis.

Method of Water Samples Obtained: Water samples were obtained in heat sterilized glass bottles of 230 ml with ground glass stoppers protected by Kraft paper. (i). Sampling from a tap or pump outlet: The tap or pump outlet was cleaned from outside. The tap was turned at a maximum flow rate and the water was let to flow for 5 minutes. The stopper was opened, filled with water and the stopper was replaced. (ii). Sampling of water from a reservoir (streams, rivers, lakes and tanks): The stopper was removed and the bottle was submerged to a depth of about 20 cms with mouth facing upwards.

1. **Transport of water samples:** The water bottles were wrapped in a Kraft paper. The water samples were properly labelled with details of the source, time and date of collection and delivered to the microbiology laboratory within 4 hours. The water samples were processed on the same day.
2. **Methods of Analysis:** The test was employed normally for water bacteriology and follows: (i). Presumptive coliform count; (ii). Differential coliform count.

Presumptive coliform count: Multiple tube method was generally adopted for measuring of probable number of coliform bacilli in water.

double strength medium respectively. 10 ml of water each to 5 tubes of 10 ml double strength medium. In each to 5 tubes of 1 ml of water and of 5 ml single strength medium. The inoculated tubes / bottles were incubated at 37^0 for 48 hrs. An estimate of coliform count per 100 ml was made from the tubes / bottles showing acid and gas production using the probability table. The presumptive coliform count of 0 taken as excellent, 1-3 as satisfactory, 4-10 as suspicious and >10 unsatisfactory per 100 ml.

By this, the most probable number of coliform organisms were detected in hundred ml.

a). **Media:** Twice and single strength Mac Conkey broths in bottles or tubes containing Durham's tube for indication of gas production were used. These media contain bromocresol blue as indicator. b). Procedure: Measured amounts of water samples were added by sterile graduated pipettes as below: Each bottle of 50 ml in one and

Figure: 1 Distribution of districts among Tamilnadu State and Taluka map of Kancheepuram district and the map of Chunampet Village

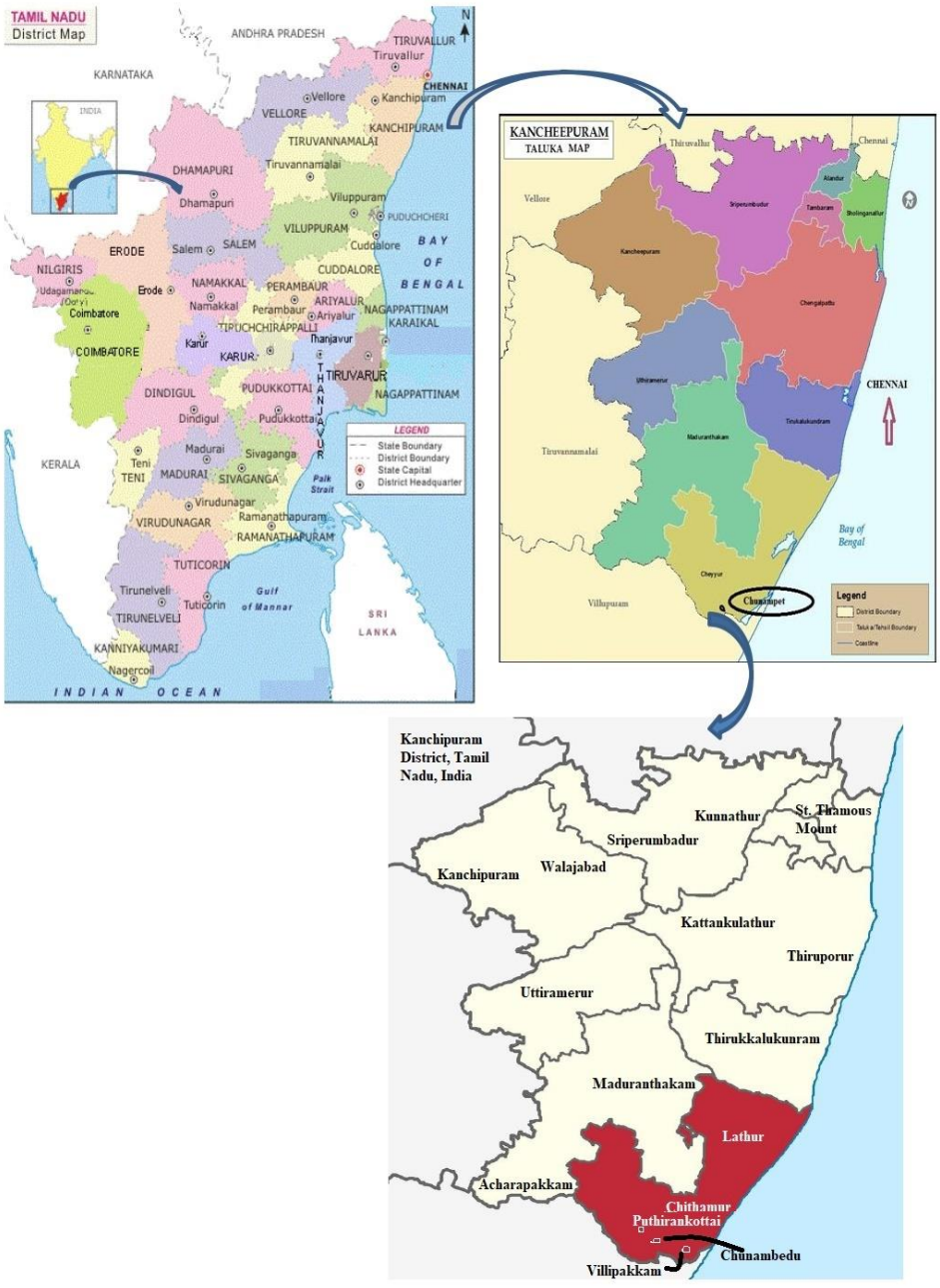
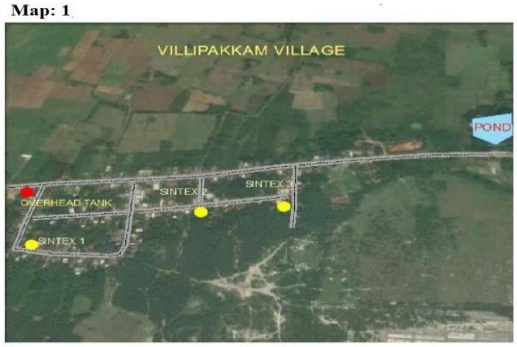


Figure – 2 Distribution of water sources in Villipakkam Village

Map: 1



Map: 2

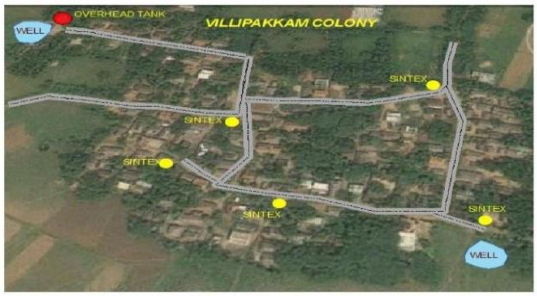
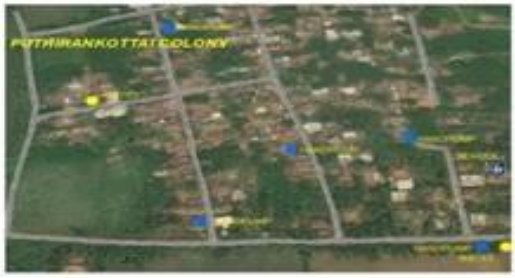


Figure – 3 Distribution of water sources in Puthirankottai Village

Map: 3

Map: 4



ii). Differential coliform count Eijkman test: Some spore-bearing organisms give false positive reactions in the presumptive coliform test. The test was done to confirm that the coliform bacilli detected in the presumptive test are *Escherichia coli*. After the usual presumptive test, subcultures were made from all +ve tubes / bottles to fresh tubes of single strength Mac Conkey broth with Durham's tube. These were incubated at 44^0 Celsius in water bath and examined after 24 hrs. Those tubes showed gas in Durham's tube contained *Escherichia coli*. Confirmation of *Escherichia coli* was made by plating on solid media and indole production.

The location of the water sources was plotted in the respective village maps. Geographic Information System was used to map the villages. The brief procedure was the base maps of Puthirankottai and Villipakkam villages were downloaded from Google Earth. The village maps were obtained from the concern Village Administrative Officer. The Latitude and Longitude of the common water sources in those villages were recorded with the help of a compass, at the time of collection of the water samples. The location of these common water sources was plotted on the respective base maps with the help of Arc GIS software [19], with the assistance of the Department of Earth Science, Pondicherry University. The infected common water sources, the households with Gastro Intestinal symptoms and demarcation of houses receiving water from a particular water source were plotted on the respective base maps in **Figure – 4 (Map 5 and 6).**

Data entry, management and compilation: Data were entered and complied by Microsoft excel 2010 [Microsoft Ltd., USA]. The entered excel sheets were verified and checked for the wrong entry, missing data by the under graduate and post graduate of medical students and faculties. Data was analyzed by SPSS 20.0 version [IBM Ltd., USA].

Statistical Analysis: Descriptive statistics like mean and standard deviation were used to express continues variables, frequency and proportions were expressed as qualitative variables. For association between the categorical variables was by Chi-Square test. The level of significant was taken as p-value<0.05. Data analysis was done by the students under the guidance of the Post Graduates Medical Students and faculties.

Ethical Approval and Clearance: The study was done with prior permission was obtained from the Director-Principal and the Head of the Department of Community Medicine of PIMS, Kalapet, Pondicherry, South India. The ethical approval was obtained properly from the Institutional Research and Ethical Committee of PIMS, **IEC No:** RC/12/112, dated on 24/12/2013 before conducting this study with patients' consent. The patients' data were confidential and preserved in the RHTC, Chunampet, Chyyar Taluk, Kanchipuram District, Tamilnadu, South India. We didn't get any type of financial support from PIMS and other financial institutions/organizations. We didn't give any incentives to the study participants.

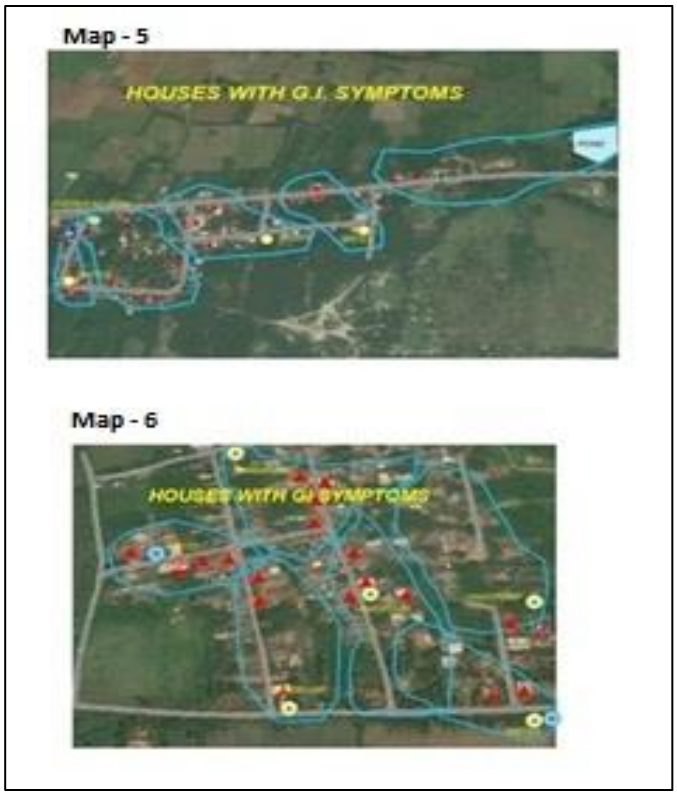
Results:

A total of 492 households were surveyed of which 224 (45.5%) were from Villipakkam and 268 (54.5%) were from Puthirankottai villages. Form these household, 1517 individuals were interviewed

by face-to-face. Among 1517 individuals, 797 (52.5%) were females and 720 (47.5%) were males. 348 (22.9%) were illiterate, 135 (8.9%) had higher secondary education, 32 (2.1%) were professionals, 109 (7.2%) were graduates, 8 (0.5%) were postgraduates and 55 (3.6%) were children with below 3 years. 384 (25.3%) were clerical, shop owners and farmers, 154 (10.2%) were skilled workers, and 495 (32.6%) were unemployed. In the surveyed 492 households, 156 (31.7%) heads of the households were illiterate, 239 (48.6%) heads of the households were clerical/shop owners/farmers. 421 (85.6%) households belong to nuclear family. Out of 492 households, 230 (46.7%) were overcrowded, 244 (49.6%) belong to Class-II Socio-economic status. 241 (49%) were kutcha house, 338 (68.7%) threw the dry waste in open, 338 (68.7%) didn't had toilet facility, 252 (51.2%) used wood for cooking and 292 (59.3%) households used piped water for drinking purposes.

Majority 457 (92.9%) did not have any complaints of any odor in their drinking water. Majority 465 (94.5%) did not complain of any taste/unpleasant taste in their drinking water. Among 492, majority 424 (86.2%) of households were reported that the drinking water looked clear, while 230 (46.7%) consumed boiled water. 37 (18.5%) households found precipitates on boiling the drinking water and 18 (9%) had foam when using water with soap. 447 (90.9%) washed the vessels before collecting water, 337 (68.5%) households were using closed vessels while storing the drinking water. More than half of the households 284 (57.7%) used plastic pots/containers for storing water.

Figure–4 Distribution of households who had attended function/festival/fair and had GI problems in the last 3 months



175 (35.6%) households consumed chlorinated water. 47 (39.2%) of the study population clean their household water tank. 44 (36.7%) of households use water tanks with lid. Majority 457 (92.9%) of the households wash their hands before eating, most of the households 145 (29.5%) used soap for washing their hands. Overall, 58 (11.8%) of the households had gastrointestinal (GI) problems in the last 3 months. 8 (13.7%) of the households who had attended function/festival/fair and had GI problems in the last 3 months as shown in **Figure – 4 (Map – 5 and Map – 6).**

Out of 492 households, 58 (11.8%) households had GI problems in the last 3 months. The association between gender, using soap while hand washing, washing the vessel before collecting, consumption of chlorinated water didn't show any statistical significance with people those who were affected by gastrointestinal disease ($p>0.05$). But, the variables like educational status, occupational status, boiling of drinking water, washing hands before eating, using pipe water for drinking purpose showed a significant association with people those who were affected by GI ($p<0.05$). Gender, using soap while hand washing, washing the vessel before collecting water, consumption of chlorinated water didn't show any significant association, with p-value of > 0.05 as shown in **Table – 1**.

Microbiological Analysis of water:

For microbiological analysis of water, four samples from Villipakkam and six samples from Puthirankottai were collected. The water samples collected from Villipakkam showed heavy growth of *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and Enterobacter. The water samples collected from Puthirankottai showed heavy growth of *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Escherichia coli*. But this is unlikely to cause any GI illness in our study population as shown in **Table – 2.**

The mean pH level was found as 7.14 ± 0.43 (6.50 – 7.65). The overall report of the results of physical analysis of the water samples was satisfactory as shown in **Table – 3**.

Discussion:

Among the study population, half of the study population belonged to Class – II Socioeconomic status based on Modified BG Prasad classification 2013. One fourth of the study population were clerical/shop owners/farmers and were illiterate. In these villages, more than half of the study population were using piped water for drinking purposes. Among 492 households, 230 (46.7%) were consuming non-chlorinated water and 262 (53.3%) of household members didn't consume boiled water. Three fourth of the households didn't have proper latrine facilities. Very less no. of household members had gastrointestinal problems in the past 3 months. In our study, nearly more than half of the household members didn't consume chlorinated water, and it was associated with gastrointestinal problems/episodes.

A study done by Sathe et al [21] showed 6.67% persons had GI problems due to drink non-chlorinated water. Firth et al [22] conducted a study in India on point of use intervention to decrease water contamination and importance of chlorination of water in a rural area. In our present study, half of the household members didn't wash their

Table – 1 Distribution and association between socio economic, other variables and people affected by Typhoid in the past three months (N = 1517)

Basic Characteristics and Other Variables	People affected by Typhoid in the past three months		Total N (%)	Chi-Square test value & p-value
	Yes 45 (2.97%)	No 1472 (97.03%)		
Gender (N=1517)				
Male	26 (57.8)	694 (47.1)	720 (47.5)	1.979 0.159
Female	19 (42.2)	778 (52.9)	797 (52.5)	
Educational Status (N=1517)				
Illiterate	4 (8.9)	344 (23.4)	348 (22.9)	12.953 0.00032**
Primary	6 (13.3)	187 (12.7)	193 (12.7)	
Middle	12 (26.7)	313 (21.3)	325 (21.4)	
High School	17 (37.8)	295 (20.1)	311 (20.6)	
Higher secondary	3 (6.7)	132 (9.0)	135 (8.9)	
Profession	0 (0.0)	32 (2.2)	32 (2.1)	
Graduate	2 (4.4)	107 (7.3)	109 (7.2)	
Post graduate	1 (2.2)	7 (0.5)	8 (0.5)	
Other (Children below 3 years)*	0 (0)	55 (3.7)	55 (3.6)	
Occupational Status (N=1517)				
Profession	0 (0)	56 (3.8)	56 (3.7)	7.535 0.006**
Semi-profession	0 (0)	30 (2.0)	30 (2.0)	
Clerical, shop owners, farmers	6 (13.3)	378 (25.7)	384 (25.3)	
Skilled worker	14 (31.1)	140 (9.5)	154 (10.2)	
Semi-skilled worker	2 (4.4)	54 (3.7)	56 (3.7)	
Unskilled worker	0 (0.0)	28 (1.9)	28 (1.8)	
Unemployed	14 (31.1)	481 (32.7)	495 (32.6)	
Students	9 (20.0)	250 (17.0)	259 (17.1)	
Children below 3 years*	0 (0.0)	55 (3.7)	55 (3.6)	
Boiling of drinking water (N=492)				
Yes	8 (28.6)	222 (47.8)	230 (46.8)	3.940 0.047*
No	20 (71.4)	242 (52.2)	262 (53.3)	
Washing Hands Before eating (N=492)				
Yes	11 (39.3)	446 (96.1)	457 (92.9)	129.080 0.0001**
No	17 (60.7)	18 (3.9)	35 (7.1)	
Using soap while hand washing (N=492)				
Yes	4 (36.4)	141 (29.3)	145 (31.7)	0.111 0.739^
No	7 (63.6)	340 (70.7)	347 (70.5)	
Washing the vessel before collecting water (N=492)				
Yes	26 (92.9)	421 (90.7)	447 (90.9)	0.143 1.000^
No	2 (7.1)	43 (9.3)	45 (9.2)	
Consumption of Chlorinated Water (N=492)				
Yes	7 (25.0)	168 (36.2)	175 (35.6)	1.447 0.229
No	21 (75.0)	296 (63.8)	317 (64.4)	
Using pipe water for drinking purpose (N=492)				
Yes	22 (78.6)	255 (55.0)	277 (56.3)	5.985 0.014*
No	6 (21.4)	209 (45.0)	215 (43.7)	

Table – 2 List of source of water and results of microbiological analysis of the water samples

Sample no.	Village	Sources	Inference	Report
1	Villipakkam	Pond water	*Klebsiellapneumoniae*	Unsatisfactory
2		Overhead water tank	Pseudomonas aeruginosa	Unsatisfactory
3		Water tank	*Klebsiellapneumoniae*, Enterobacter	Unsatisfactory
4		Water tank	*Klebsiellapneumoniae*, Enterobacter	Unsatisfactory
5	Puthirankottai	Water tank	*Klebsiellapneumoniae*, *Pseudomonas aeruginosa*	Unsatisfactory
6		Hand pump	*Pseudomonas aeruginosa*	Unsatisfactory
7		Hand pump	*Klebsiellapneumoniae*, *Pseudomonas aeruginosa*	Unsatisfactory
8		Water tank	*Klebsiellapneumoniae*, *Pseudomonas aeruginosa*	Unsatisfactory
9		Water tank	*Klebsiellapneumoniae*	Unsatisfactory
10		Water tank	*Klebsiellapneumoniae, E.coli*	Unsatisfactory

Table: 3 Distribution of results of physical analysis of the water samples

S_No	pH (6.5 - 8.5)	TDS (500 – 2000 mg/L)	EC (< 2000 us/cm)	Report
1	7.32	1638.848	1048.863	Satisfactory
2	7.45	1132.305	724.6752	Satisfactory
3	7.42	1837.716	1176.138	Satisfactory
4	7.5	1250.871	800.5574	Satisfactory
5	7.17	1277.538	817.6243	Satisfactory
6	7.65	2923.789	1871.225	Satisfactory
7	6.79	973.946	623.3254	Satisfactory
8	6.99	1694.681	1084.596	Satisfactory
9	7.55	1004.771	643.0534	Satisfactory
10	7.58	968.561	619.879	Satisfactory
11	6.69	1314.61	841.3504	Satisfactory
12	7.55	738.59	472.6976	Satisfactory
13	7.58	1464.987	937.5917	Satisfactory
14	6.69	1434.849	918.3034	Satisfactory
15	6.52	1221.775	781.936	Satisfactory
16	6.54	1057.84	677.0176	Satisfactory
17	6.51	1625.625	1040.400	Satisfactory
18	6.5	1979.762	1267.048	Satisfactory
19	7.34	1638.681	1048.756	Satisfactory
20	7.42	1527.241	1536.028	Satisfactory

hand before eating which was a risk factor for GI illness. Lee et al [23] revealed that using alcohol-based hand sanitizer would increase the GI problem in 3/4th of persons in house because not wash their hands properly before eating. In our study more than half of household members didn't consume boiled water which probably caused GI problems.

Sophie et al showed that the process of heating of drinking water could kill almost all the microorganism, viruses and by this helped to decontaminate the water. [24]. In our study, we have found that GI illness was associated with factors like consuming non-chlorinated water, without heating, not washing hands before eating, poor latrine facility and disposing waste in open space. Similar type of results and relationships were found in a study by Greenwell et al [25] wherein it was seen that typhoid was preventable by use of safe water, adequate sanitation and, simple hygienic behavior like hand washing by using soap. In our study, more than half of the households used pipe water for drinking purposes.

Similar results were seen in a study conducted by Gasem et al. [26] In our study, 11 (39.3%) of the individuals were affected with GI problems and they weren't washing their hand before eating and the association was highly significant with p-value = 0.0001 (<0.001). Similar results were found in a study by Vollaard et al. [27] In this study, very few (8.9%) of the subjects were illiterate and showed statistically significant with p-value = 0.044 (<0.05) and 64% of household members were consuming non-chlorinated water but didn't show statistical significance with p-value = 0.229 (>0.05).

A study conducted by Tran et al [28] on-risk factors associated with typhoid fever, showed that illiteracy was significant associated, with p-value = 0.03 (<0.05) and consumption of untreated water was independently associated with typhoid fever with p<0.001. In our study, 13.3% of the individuals were unemployed and showed significant with GI problems with p<0.001. A review article by Duncan said that no water borne disease was ever associated with Klebisella in drinking water, but it caused only hospital acquired (nosocomial) infection. [29] The WHO article on "Heterophilic Plate count Measurement in Drinking Water Safety Management" concludes that there is no evidence for association of *Pseudomonas aeruginosa*, *Acinetobacter* spp., *Aeromonas* spp. *Klebsiella pneumonia*, Enterobacter with GI infection through the water-borne route among the population. [30]

Reza et al [31] conducted a study on ground water quality index in Orissa. Water quality index (WQI) rating was carried out to quantify overall ground water quality status of the area. The values of WQI have been affected mainly by the concentration of dissolved ions (F, NO, Ca and Mg) in ground water. Kumar et al [32] conducted a study on Ground water quality assessment using WQI in Vedaranayam, Tamil Nadu, India. They had collected 44 groundwater samples from bore and tube well. Nearly above half (66%) of ground water samples in post-monsoon season and one third of the samples in summer season which were found as non-consumable status. Fe and F values were found more in the 36 samples. NO_3 was found more value in 27 samples. This increment of poor category in post-monsoon when compared to summer season indicates the ground water quality in the study area was slowly getting degraded. Higher values of calcium and magnesium were found.

Revelle [33] has recommended the Cl-/(CO32- + HCO3-) be introduced to evaluate the salt water intrusion. The second parameter suggested for identification of saltwater contamination is total alkalinity/total hardness ratio (TA/TH). Priya et al [34] conducted a study on assessment of water quality Indices for Ground water in Singanallur Basin, Coimbatore. The study concludes that groundwater quality of city needs greater attention because it is the alternative source of water for domestic and agricultural purposes. The technology adopted combines field investigations and GIS (Geographic Information System) in Coimbatore aera. The WQI has been calculated for the Singanallur sub-basin and the entire sub-basin was zoned to study the suitability of water for drinking purposes using ArcGIS software and the results concluded that the ground water quality was unfit for drinking in some of the areas scoring a WQI>100. Although there were variations in the physical and chemical parameters of water from the normal levels, it is more unlikely to cause any gastrointestinal manifestations in our study population.

Conclusion:

Our study revealed that the population used water from various sources like tap water, pump water, and other sources like streams, rivers, lakes and tanks in both villages. Water samples were taken from all these sources for physical and microbiological analysis. Half of the households were using piped water for drinking purposes. Most of the participants weren't consuming chlorinated water. More than half of the study participants weren't consuming boiled/safe water and didn't have proper latrine facilities. The variables like educational status, occupational status, boiling of drinking water, washing hands before eating, using pipe water for drinking purpose showed statistically significant association with people those who were affected by GI problems. The results of microbiological analysis of the water samples collected showed the water quality to be unsatisfactory, but they were unlikely to cause any GI illness in the present study. The overall report of the results of physical analysis of the water samples was satisfactory. In our present study, 11.8% of the households had prevalence of GI problems. This was probably due to consumption of unsafe water, not washing their hands before eating and not consuming boiled drinking water which were the prominent risk factors for acquiring GI problems. Health education program and IEC activities were undertaken in the study areas through Government organizations, our institution and other non-Governmental organizations (NGOs) to create health awareness regarding safe drinking water and impact of water borne diseases on health.

Recommendation of possible remedial measures based on the findings of the study to the community, panchayat leaders and to the policy makers:

To the study Community People: To clean of all overhead and water tanks once in a month, to avoid pond water for drinking purpose, to avoid stagnation of drainage near drinking water sources, to clean the containers properly before storage, water containers and water pots is in the covered position, to consume boiled water and to wash hands properly with soap before eating as per WHO report.

Recommendations to the panchayat leaders: To ensure that all

overhead tanks and water tanks are thoroughly cleaned and chlorinated once in every month, to provide bleaching powder regularly for disinfection of the water tanks, to provide proper toilet facilities for their respective village, to provide pipe water facility at doorstep.

Recommendations to the policy makers: To locate the households affected with GI problems and to identify the water source used by them, with the help of GIS and to take necessary corrective measures and to conduct Behavior Change Communication (BCC) programs in the locality.

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Here, SV – Senthilvel Vasudevan, and PR – Priyanka Raj C K

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