



## Behavioural Factor of Boiling Drinking Water in Rural India

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**Abstract** In India, 0.4 million children die from diarrhoea which is a particularly alarming figure. There are several kinds of water sources in rural India, but most of them are contaminated. Boiling is an effective way to purify water and improve its safety for drinking. The objective of this study was to reveal the behavioural factor of boiling. A village near Sompeta city in Andhra Pradesh, India was selected as a survey site of this study. On-site surveys were conducted from 14th to 29th April and from 23rd September to 5th October in 2012. The surveys consisted of a water quality test of boiling and interviews with all 53 households that had a child of 3 or 4 years old. The contents of water quality test were coliforms, iron and total hardness, and the interview questions were about habits and thoughts relating to boiling. The effect of boiling, the reduction of infection risks, could be observed by the test. However, the evaluation of the taste of boiled-water was worse than non-boiled-water, even though iron could be removed. Thirty-two per cent households always use boiled-water and 15% use it only in rainy season. The main reason for boiling was to prevent infections. They knew boiling is an effective way to reduce the risk of infection and thus use boiled-water daily. On the other hand, 42% households use boiled-water only when they get sick and 11% of households do not use it. The reason for not boiling was not the cost and trouble but a lack of awareness of the necessity for it. In this area, doctors had given advice to boil water for the sake of children's health. Some households followed the advice and used boiled-water; however, there were a number of households that did not follow the advice and still used water without boiling.

**Keywords** drinking water, boiling, diarrhoea, child health, India

## INTRODUCTION

About 1.5 million children aged five and below die from diarrhoea every year. This is the second cause of death in children (WHO, 2008). The most seriously affected country is India, in which about 0.39 million children die from diarrhoea (UNICEF and WHO, 2009). Pathogens which cause diarrhoea are spread from excreta to new patients through hands, animals, water, etc. (Carr et al., 2001). Building toilets, developing water sources, improving water quality, and improving hygiene habits can relatively reduce the risk of diarrhoea (Fewtrell et al., 2005). In order to prevent children's death from diarrhoea, the United Nations set a goal to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation" in Millennium Development Goals, and many kinds of activities were conducted all over the world.

Now 84% people have sustainable access to safe water in rural India (WHO and UNICEF, 2010) but it is not always safe and many people do not use it because of wrong recognition about the safety of the water source and bad taste (Sato and Yamaji, 2012). Furthermore, there is a high possibility that water is not safe at the point of use, even if the water source is safe (Wright et al., 2004). Household water treatment and safe storage (HWTS), including boiling, chlorinating, and

filtering water at home, can be effective to improve the quality of drinking water and prevent diarrhoea (Fewtrell et al., 2005). Boiling is the most common method of treating water at home and the effect is evident in India (Clasen et al., 2008), but a number of households do not boil water for drinking purposes. There are some studies concerning the promotion of boiling behaviour, for example, promotion through school (Freeman and Clasen, 2010) and women's self-help groups (Freeman et al., 2012), but the behavioural factor of boiling drinking water is not made explicit.

## OBJECTIVE

The objective of this study was to reveal the behavioural factor of boiling drinking water, that is, the reason why a number of people don't boil it, in rural India. In order to discuss the most feasible method there, the effect of boiling at the site was presented first. Subsequently, the behavioural factor was examined.

## METHODOLOGY

A village near Sompeta, in the city of Srikakulam district in Andhra Pradesh state, India was selected as the survey site of this study (Fig. 1). People in this village use three kinds of drinking water sources: (i) temple well that it is in the temple and has been used for a long time; (ii) bore well, of which there were 11 in this village and they were built by the state government about 10 years ago; and (iii) private well that was built in a house lot, of which the number are increasing. About 80% of households do not have a toilet thus surface water and ground water of unconfined aquifer are contaminated.

On-site surveys were conducted from 14<sup>th</sup> to 29<sup>th</sup> April 2012 and from 23<sup>rd</sup> September to 5<sup>th</sup> October in 2012. The survey consisted of a water quality test of boiling and an interview survey in households. All 53 households in this village that had a child of 3 or 4 years old were interviewed about their way of thinking regarding boiling. The boiling test was conducted on the temple well, a bore well in an elementary school, and a private well, by using a pot and gas stove in a household's kitchen. One litre of water was put into the pot and heated on the gas stove. Water was taken to measure water quality four times: before heating; 0 minutes after start of boiling; 5 minutes after start of boiling; and 10 minutes after start of boiling. The contents of the measurement were coliforms, Fe (iron) and TH (total hardness). The Sun Chemical Co. Ltd. detection paper was used for coliforms, and the Kyoritsu Chemical-Check Lab. Corp. test kit was used for Fe and TH.

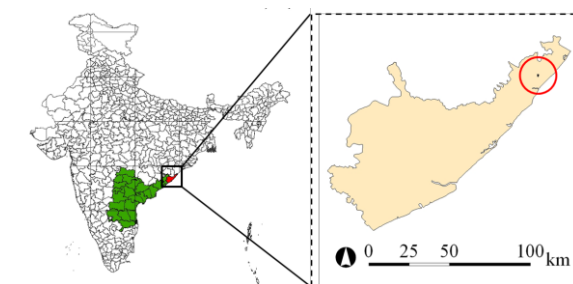


Fig. 1 Survey site

## RESULTS AND DISCUSSION

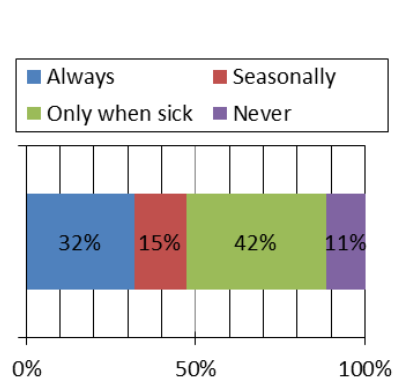
Boiling habit for child is showed in Fig. 2. Thirty-two per cent of households always used boiled water for their child and 15% of households only used boiled water in rainy season. They use boiled water before the child becomes sick to prevent disease. On the other hand, 42% households used boiled water to relieve disease only when the child becomes sick. Furthermore, 11% of households never boiled water for their child.

The results of the boiling test for density of coliforms are shown in Fig. 3. According to the WHO's guidelines for drinking water quality, coliforms should not be detected in 1mL of sampled

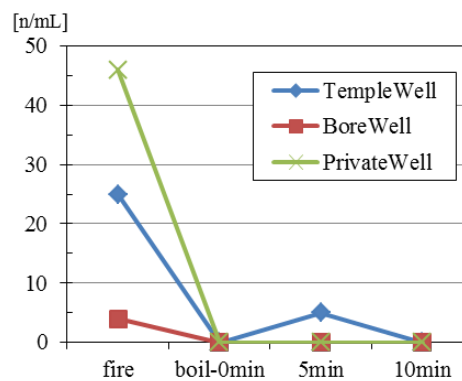
water. Water from all sources had coliforms before boiling and this means all sources contained risks of diarrhoea. In particular, the temple well and private well had more coliforms as their depth is shallower than the bore well. However, water from all sources contained no coliforms after 10 minutes of boiling. Coliforms were killed by boiling therefore it can reduce risk of diarrhoea.

Table 1 shows the numbers and ratios for the frequencies of infection with cholera and typhoid that were added up by households' boiling habit. The households that did not have a habit of boiling water for their child before becoming sick tended to be infected with cholera and typhoid more often than the households that regularly boiled water. These results also suggest that boiling can reduce the risk of diarrhoea.

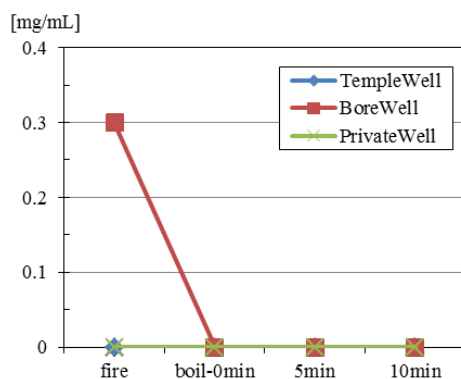
Figure 4 shows the results of the boiling test for the density of Fe, and Fig. 5 shows the same results for TH. A bore well with an iron pipe often makes the Fe density of its water high and makes its taste worse. According to the WHO's guidelines on drinking water quality, there is a reference value about Fe from a viewpoint of taste and colouring, though not from a viewpoint of safety. It specifies that the density of Fe should be under 0.3 mg/L. After boiling, Fe cannot be detected: the density was 0mg/mL. At that time, there was some white powder at the bottom of the pot which may have contained Fe. Boiling makes it possible to remove Fe from water. TH was often used as an indicator to check the taste of water, but it is not specified in the WHO's guidelines because the preference toward it depends on the person and region. TH tended to decrease by boiling, as Fig. 5 indicates.



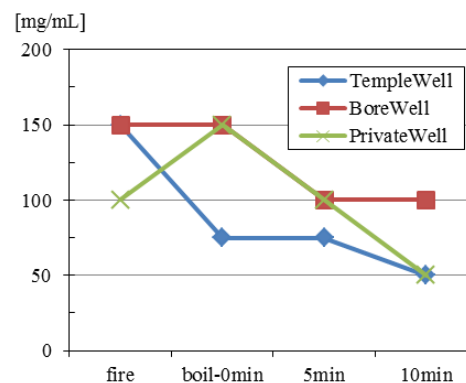
**Fig. 2 Boiling habit for child**



**Fig. 3 Results of boiling test for coliforms**



**Fig. 4 Results of boiling test for Fe**



**Fig. 5 Results of boiling test for TH**

**Table 1 Frequency of infection with Cholera and Typhoid by households' boiling habits**

	Always / Seasonally				Only when sick / Never				Total			
	Cholera		Typhoid		Cholera		Typhoid		Cholera		Typhoid	
Occasionally	1	4%	1	4%	3	13%	2	8%	4	9%	3	6%
Once	0	0%	4	16%	1	4%	8	33%	1	2%	12	24%
Never	23	96%	20	80%	19	83%	14	58%	42	89%	34	69%
I don't know	1	-	0	-	5	-	4	-	6	-	4	-
Total	25		25		28		28		53		53	100%

Each household evaluated which water was tastier: before boiling or after boiling. Table 2 presents the results that were added by households' boiling habits. Most of the households evaluated that water that was not boiled did not taste better than boiled water, regardless of the habit of boiling. Table 3 shows the results of the evaluation of the taste of boiled water. Households with a daily boiling habit tended to set a high value on the taste of boiled water compared to those without this habit. The taste of water may improve after boiling because Fe can be removed by boiling, but people's evaluations did not correspond with this. During the survey, some households said that boiled water was not tasty because it is warm. This suggested the possibility that boiling makes water taste worse by raising the water temperature. Indeed, most of households in this area do not have a refrigerator thus it is difficult for them to have cold water at home.

Table 4 shows the numbers and ratios of the reasons for not boiling that were added by households' boiling habits. Some households without a boiling habit answered "Bad Taste" as the reason. But according to this information alone, it is not clear why the mothers were not willing to give boiled water to their child, despite the fact that boiling water is safer. Two households answered "Cost" as the reason for not boiling. During the survey, they said that they want to boil but they do not have enough money for it. Figure 6 is a boxplot about household income that was added by boiling habits. The exchange rate was Rs 1 equals about USD 0.02 on 14th Dec 2012. The average income of all households was Rs 23,000. The households with high income tended to have a habit of boiling. However, the number of households with boiling habits that have a smaller income than the median income of households without boiling habits was not a few. It is possible for households with a small income to boil water daily. Boiling habit may also depend on whether they have a gas stove or not because it is related to income, costs, and labour. In this village, 62% of households had a gas stove for cooking and 38% did not have a gas stove. Figure 7 illustrates a comparison of boiling habits between households with gas stove and those without. There were small differences between them therefore the ownership of a gas stove does not have a significant effect. According to Table 4, all households that boil water in rainy season alone think boiling is not needed except in this season, and most of households that boil water only when their child is sick think that it is unnecessary to boil water before sickness occurs. The main cause of not boiling water for their child is a lack of awareness of its importance and necessity.

**Table 2 Preference taste of water between before boiling and after boiling**

	Always		Seasonally		Only when sick		Never		Total	
Before	14	82%	8	100%	19	90%	4	100%	45	90%
After	3	18%	0	0%	2	10%	0	0%	5	10%
No answer	0	-	0	-	1	-	2	-	3	-
Total	17		8		22		6		53	100%

**Table 3 Evaluation about the taste of boiled water**

	Always		Seasonally		Only when sick		Never		Total	
Very Good	0	0%	0	0%	2	9%	0	0%	2	4%
Good	8	47%	3	38%	4	18%	0	0%	15	29%
Not Bad	5	29%	1	13%	6	27%	1	20%	13	25%
Bad	4	24%	4	50%	10	45%	4	80%	22	42%
No answer	0	-	0	-	0	-	1	-	1	-
Total	17		8		22		6		53	100%

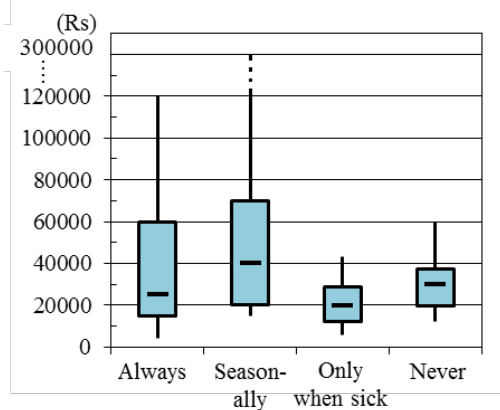
**Table 4 Reason for not boiling water**

	Seasonally		Only when sick		Never		Total	
Bad taste	0	0%	0	0%	3	75%	3	14%
Cost money	0	0%	2	13%	0	0%	2	9%
No need	8	100%	14	88%	1	25%	17	77%
No answer	0	-	6	-	2	-	14	-
Total	8	100%	22	100%	6	100%	36	100%

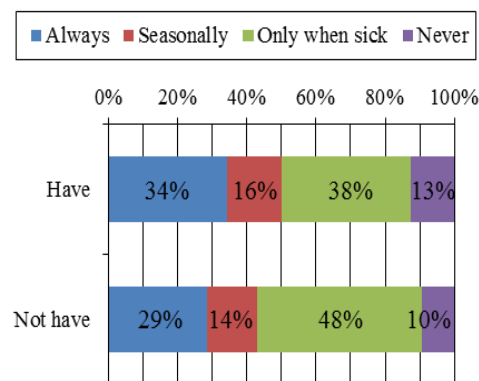
Table 5 shows the numbers and ratios of the reason for boiling that were added by households' boiling habits. Most of the households with a habit to boil water always or seasonally answered "Prevention from disease" as the reason. On the other hand, half of the households that boil water only when their child is sick answered "Relieve disease," while the remaining half answered "Doctor's advice" as the reason. They boil water only for the treatment of disease, not for the prevention.

Each household evaluated which water is safer, before boiling or after boiling. Table 6 shows the results that were added by households' boiling habits. The option of "No answer" was not shown as all households answered this question. All of the households with a boiling habit who stated that they boil water for the prevention from disease evaluated that boiled water is safer than non-boiled water. On the other hand, some of the households without daily boiling habits evaluated that non-boiled water is safer than boiled water. Furthermore, 23% of households that boil water only when the child is sick follow the doctor's advice and boil water for the treatment of disease in spite of the fact that they think non-boiled water is safer than boiled water.

Numbers and ratios of households that have been advised by a doctor to boil water were added by households' boiling habits, as shown in Table 7. Almost all households have been advised by a doctor; however there were still households without a boiling habit, regardless of the fact that they were advised by a doctor to do it. Doctors can influence people to enhance their awareness of child health, but not all people.



**Fig. 6 Household income by boiling habit**



**Fig. 7 Comparison of boiling habit between households with gas stove and without it**

**Table 5 Reason for boiling water**

	Always		Seasonally		Only when sick		Total	
Prevention from disease	15	100%	6	86%	0	0%	21	55%
Relieve disease	0	0%	0	0%	8	50%	8	21%
Doctor's advise	0	0%	0	0%	8	50%	8	21%
Warm body	0	0%	1	14%	0	0%	1	3%
No answer	2	-	1	-	6	-	9	-
Total	17	100%	8	100%	22	100%	47	100%

**Table 6 Comparative evaluation of the water safety between before boiling and after boiling**

	Always		Seasonally		Only when sick		Never		Total	
Before	0	0%	0	0%	5	23%	2	33%	7	13%
After	17	100%	8	100%	17	77%	4	67%	46	87%

**Table 7 Numbers and ratios of households that have been advised by a doctor to boil water**

	Always		Seasonally		Only when sick		Never		Total	
Yes	17	100%	8	100%	21	95%	6	100%	52	98%
No	0	0%	0	0%	1	5%	0	0%	1	2%

## CONCLUSION

The effect of boiling water was observed and people's behavioural factor of boiling was examined in rural India. The risk of diarrhoea could be reduced by boiling. Water from a bore well with an iron pipe has a high level of iron which worsened its taste; however boiling could remove it. Nevertheless, evaluation of its taste was not good because the water temperature may increase after boiling. The main reason for boiling was the prevention of infection. Households with boiling habits knew that boiling was an effective way to reduce the risk of infection and consequently boiled water for their child daily. On the other hand, the reason for not boiling was not the cost and trouble, but a lack of awareness of necessity for it. This lack of awareness made difference in people's boiling behaviour.

In this survey site, doctors had advised mothers not to use water without boiling. Some households followed it and started boiling water, but a number of households ignored it. Doctors have contacts with almost all households and thus have the opportunity to enlighten them about the correct knowledge and habit of children's health, but some households doesn't follow doctors' advice. The type of households that tend to follow doctors' advice and the ways in which doctors can enlighten all households on the necessity of boiling water should be examined after this study. Furthermore, there are other ways besides the doctor to enlighten households on the benefits of boiling water for children's health and these methods also require further investigation.

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## REFERENCES

- Carr, R. and Strauss, M. 2001. Water quality: guidelines, standards and health. Assessment of risk and risk management for water-related infectious disease. International Water Association on behalf of WHO, 89-113.
- Clasen, T., McLaughlin, C., Nayaar, N., Boisson, S., Gupta, R., Desai, D., and Shah, N. 2008. Microbiological effectiveness and cost of disinfecting water by boiling in semi-urban India. *Am J Trop Med Hyg*, 79, 407-413.
- Fewtrell, L., Kaufman, R.B., Kay, D., Enanoria, W., Haller, L., and Colford, J.M.Jr. 2005. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *The Lancet Infectious Disease*, 5, 42-52.
- Freeman, M. and Clasen, T. 2010. A cluster-randomized trial to assess the impact of a school-based safe water intervention on household adoption of point-of-use water treatment practices in Southern India. *Am J Trop Med Hyg*, 84, 370-378.
- Freeman, M., Trinies, V., Boisson, S., Gregory, M., and Clasen, T. 2012. Promoting household water treatment through women's self help groups in rural India: assessing impact on drinking water quality and equity. *PLoS ONE*, 7, e44068.
- Sato, M. and Yamaji, E. 2012. Safety of drinking water source and people's choice behavior in rural India. *International Journal of Environmental and Rural development*, 3, 43-48.
- UNICEF and WHO. 2009. Diarrhoea: Why children are still dying and what can be done.
- WHO. 2008. The Global Burden of Disease: 2004 update.
- WHO and UNICEF. 2010. Progress on sanitation and drinking-water: 2010 update. Joint Monitoring Programme for Water Supply and Sanitation.
- Wright, J., Gundry, S., and Conroy, R., 2004. Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use. *Trop Med Int Health*, 9, 106-117.