Water handling, sanitation and defecation practices in rural southern India: a knowledge, attitudes and practices study

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Summary
Diarrhoea and water-borne diseases are leading causes of mortality in developing countries. To understand the socio-cultural factors impacting on water safety, we documented knowledge, attitudes and practices of water handling and usage, sanitation and defecation in rural Tamilnadu, India, using questionnaires and focus group discussions, in a village divided into an upper caste Main village and a lower caste Harijan colony. Our survey showed that all households stored drinking water in wide-mouthed containers. The quantity of water supplied was less in the Harijan colony, than in the Main village ($P<0.001$). Residents did not associate unsafe water with diarrhoea, attributing it to ‘heat’, spicy food, ingesting hair, mud or mosquitoes. Among 97 households interviewed, 30 (30.9%) had toilets but only 25 (83.3%) used them. Seventy-two (74.2%) of respondents defecated in fields, and there was no stigma associated with this traditional practice. Hand washing with soap after defecation and before meals was common only in children under 15 years (86.4%). After adjusting for other factors, perception of quantity of water received ($P<0.001$), stated causation of diarrhoea ($P=0.02$) and low socio-economic status ($P<0.001$) were significantly different between the Main village and the Harijan colony. Traditional practices may pose a significant challenge to programmes aimed at toilet usage and better sanitation.

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1. Introduction

Diarrhoea and water-borne diseases are leading causes of mortality and morbidity in developing countries (WHO/UNICEF, 2000). Target 10 of the UN Millennium Development Goals (MDG) is to reduce by half the proportion of people without sustainable access to safe drinking water by 2015. Approximately 88% of diarrhoeal diseases are attributed to unsafe water supply, and inadequate sanitation and hygiene (WHO, 2004). Recent studies estimate a possible 6–25% decrease in diarrhoea morbidity by improving water supply, 32% reduction by improving sanitation (Esrey et al., 1991), 47% reduction by hand washing with soap (Curtis and Cairncross, 2003; Luby et al., 2005) and 35% reduction with point-of-use microbial water treatment (Clasen et al., 2006a; Fewtrell et al., 2005). These estimates have provided fresh impetus to the implementation of simple interventions, such as chlorination and solar irradiation, designed to reduce the incidence of diarrhoea.

Water safety in a community depends on a range of factors, from the quality of source water to storage and handling in the domestic setting. While earlier studies from India have focused on water quality and usage (Brick et al., 2004; Clasen et al., 2006b), there are few reports on defecation practices and availability/usage of toilets, particularly from rural India. In order to understand the socio-cultural factors impacting on water usage and safety, we conducted a study to document knowledge, attitudes and practices (KAP) with regard to water handling, sanitation and defecation practices in rural Tamilnadu. This information was required for the design of locally relevant and culturally acceptable interventions to provide safe and acceptable drinking water to rural communities in India.

2. Materials and methods

2.1. Study area

This study was carried out in Nelvoy, a village in the Kaniyambadi block of Vellore district, in the state of Tamilnadu in southern India. This village is located to the east of a state highway from Vellore town to Arni town and is approximately 6 km from the Community Health and Development Hospital, a secondary care unit of the Christian Medical College, Vellore, India. The village is divided into two parts, the Main village, and an area demarcated for lower-caste people, called the Harijan colony.

2.2. Study population

The total population of the village was 1166 permanent residents with 562 males and 604 females (41% resident in the Main village and 59% in the Harijan colony). Men were predominantly farmers and women were mainly housewives. According to the Department of Community Health and Development (CHAD) census 2005 for Nelvoy and surrounding areas, the adult literacy rate was 83.7%, and 21.3% belonged to the low, 34.7% to the middle and 44% to the high socio-economic status (SES) category. The SES classification used by CHAD had been calculated using the Modified CHAD SES Scale that takes into account caste, type of house, land ownership, and education and occupation of the head of the household (Raghava, 2004).

2.3. Knowledge, attitudes and practices

The study was conducted through interviews at three levels. The village was divided into five geographical zones that corresponded to the streets and roughly to the number of houses and two investigators in each zone administered a semi-structured questionnaire (‘general questionnaire’) to one individual in each household to elicit basic demographic details, sources of water, availability of toilets and their usage, and sites/locations where people defecated.

Four focus groups were conducted in order to determine where people obtained water and how it was handled, toilet usage, animal waste disposal and defecation practices, and prevalent beliefs regarding causes of diarrhoea. Focus groups were conducted separately for men and women both in the Main village and in the Harijan colony because of social sensitivities. During administration of the general questionnaire, about 10 individuals who appeared to be opinion leaders in the community were chosen and invited to participate in each focus group (Dawson et al., 1993). Each discussion was led by a Tamil-speaking investigator, under supervision from an experienced health educator from CHAD. An assistant recorded notes on the discussion and group interactions (Jones et al., 2005). The information obtained was used to design a more detailed ‘individual questionnaire’ aimed at obtaining information regarding water safety, sanitation and defecation practices.

This individual questionnaire was administered to 10% of the population selected randomly after age/sex stratification of the village population. Information was obtained on water collection, storage practices, disposal, quantification of need, ‘cleaning’ (microbial water treatment) practices and concepts of ‘clean’ water. Questions were asked about defecation practices, including presence of a toilet at home, usage, reasons for non-usage, use of alternate defecation sites and hand washing after defecation. Additional questions addressed the use and disposal of animal waste, as well as beliefs about causes of diarrhoea. Interviewers were trained in communication and interview techniques through role plays. Verbal consent was obtained from all participants. No repeated attempts were made to interview inhabitants of houses that were locked. No incentives were offered for participation in the study.

2.4. Statistical analysis

Data were entered and analyzed using SPSS for Windows version 11.0.1 (SPSS Inc., Chicago, IL, USA) and CLINSTAT (Bland, 1996). To test the difference between the different sub-groups, $\chi^2$ tests and two-tailed Fisher’s exact test were used for categorical variables, and Student’s t-test was used for continuous variables. Multiple logistic regression was performed to assess the difference between the Main village and Harijan colony with respect to certain important explanatory variables. Strata with too few numbers in each cell were merged, where possible. To adjust for the effect of multiple tests in the ‘individual questionnaire’, the Bon-
Table 1  Storage, concepts and practice regarding water safety and diarrhoeal disease from the quantitative individual questionnaire administered in Nelvoy

<table>
<thead>
<tr>
<th>Water safety and diarrhoea</th>
<th>Main village ( (n = 41) ) ( n (%) )</th>
<th>Harijan colony ( (n = 56) ) ( n (%) )</th>
<th>Total ( (n = 97) ) ( n (%) )</th>
<th>( P )-valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate storage of drinking water</td>
<td>41 (100)</td>
<td>43 (76.8)</td>
<td>84 (86.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Microbial treatment of drinking water</td>
<td>12 (29.3)</td>
<td>29 (51.8)</td>
<td>41 (42.3)</td>
<td>0.04</td>
</tr>
<tr>
<td>Concept of safe water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear appearance</td>
<td>13 (31.7)</td>
<td>8 (14.3)</td>
<td>21 (21.6)</td>
<td>0.07</td>
</tr>
<tr>
<td>Water from bore well</td>
<td>20 (48.8)</td>
<td>15 (26.8)</td>
<td>35 (36.1)</td>
<td>0.04</td>
</tr>
<tr>
<td>No salty taste</td>
<td>3 (7.3)</td>
<td>1 (1.8)</td>
<td>4 (4.1)</td>
<td>0.4</td>
</tr>
<tr>
<td>Odourless</td>
<td>2 (4.9)</td>
<td>20 (35.7)</td>
<td>22 (22.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>From clean tank</td>
<td>3 (7.3)</td>
<td>12 (21.4)</td>
<td>15 (15.5)</td>
<td>0.10</td>
</tr>
</tbody>
</table>

a Following Bonferroni adjustment, \( P \)-value of <0.002 was considered statistically significant.

ferroni method (Blund and Altman, 1995) was used. After adjustment, for inferences in this study, a \( P \)-value <0.002 was considered to be statistically significant.

3. Results

A total of 179 'general questionnaires' were administered to one individual from each household in the village and 84.8% of the households were thus covered. The Harijan colony had a larger population than the upper caste Main village, with more households (119 vs. 60) and with a larger mean family size (4.78 ± 2.12 vs. 4.07 ± 1.99, \( P = 0.03 \)).

Of a total of 110 individuals selected for the individual questionnaire, 97 (88.2%) completed the questionnaire; 41 (42.3%) respondents were from the Main village and 56 (57.7%) from the Harijan colony. The difference in the distribution of the respondent households between the Main village and the Harijan colony was not statistically significant (\( P = 0.15 \)). Data from the individual questionnaire are presented in Tables 1—3. From the individual questionnaire, SES was obtained for 95 (97.9%) individuals. Differences between the SES in the sample and the entire village were not significantly different (\( P = 0.46 \)). However, there were significant differences in the SES of the Main village (\( P = 0.02 \)) and the SES of the Harijan colony (\( P = 0.003 \)) when compared separately with that of the entire village. Results from both questionnaires and focus group discussions are presented below.

Table 3  Post-defecation hand-washing with soap by age-group in Nelvoy

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Use soap after defecation ( (n = 66)^a ) ( n (%) )</th>
<th>Soap not used after defecation ( (n = 29)^a ) ( n (%) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15b</td>
<td>19 (86.4)</td>
<td>3 (13.6)</td>
</tr>
<tr>
<td>15—40</td>
<td>24 (68.6)</td>
<td>11 (31.4)</td>
</tr>
<tr>
<td>41—60</td>
<td>20 (66.7)</td>
<td>10 (33.3)</td>
</tr>
<tr>
<td>&gt;60b</td>
<td>3 (37.5)</td>
<td>5 (62.5)</td>
</tr>
</tbody>
</table>

a Data unavailable for one individual in each group.
b Between <15 and >60 years, Fisher's exact test \( P = 0.03 \) (following Bonferroni adjustment, \( P \)-value of <0.002 was considered statistically significant).

3.1. Water supply and storage

Ninety-five (97.9%) of the 97 individuals interviewed (and their households) obtained their water supply from the government piped supply, derived from two bore wells. Only two households (in the Harijan colony) had private bore wells. All open wells and hand pumps, previously important sources of drinking water of the village, had been dry for almost 5 years. Eighty-four (86.6%) individuals interviewed kept drinking water separate from water used for other purposes such as washing vessels and clothes, and for toilet purposes. Water was stored in steel vessels in 74 (76.3%) households,
with the remaining using plastic (5; 5.1%), brass (12; 12.4%) and earthenware (6; 6.2%). Eighty (82.2%) respondents did not have any specific reason for choosing a particular container. Reasons for choosing a specific type of container included taste (13; 13.4%) and temperature (2; 2.1%) of water as well as affordability (2; 2.1%). All water storage vessels were kept covered, and 100% of households used drinking water by dipping into the wide-mouthed container with a cup held in the hand.

3.2. Perception of water availability

A significantly greater proportion of individuals from the Main village (38; 92.7%) than from the Harijan colony (17; 30.4%) felt they received an adequate supply of water (P < 0.001). Water received was measured in ‘kudams’ (wide-mouthed containers measuring approximately 12 l). On average, an individual in the Main village received a significantly larger volume of water per day (mean 45.32 ± 18.87 l), than in the Harijan colony (mean 26.74 ± 12.99 l, P < 0.001). Throughout the entire village, any excess water remaining after the day’s use was poured away the next day before fresh water was collected.

3.3. Microbial water treatment practices and beliefs about water

Thirty-five (36.1%) individuals regarded bore well water as ‘clean’ whereas 21 (21.6%) regarded water that was clear in appearance as ‘clean’ water. Data on microbial water treatment practices and beliefs about water are given in Table 1. Treated drinking water was usually reserved for babies. The techniques used to treat drinking water were filtering with a cloth or sieve (16; 40%), boiling (14; 35%), both filtering and boiling (6; 15%), and heating (4; 10%). During the focus group discussion respondents stated that they treated water only during bouts of illnesses and that they believed that there was no need to purify water at other times.

3.4. Beliefs about diarrhoea

Beliefs about diarrhoea varied widely with 42 (43.3%) individuals believing that food was the cause of diarrhoea. A significant number — 28 (28.9%) — considered other factors such as ‘heat’, ingesting hair or mud, and mosquito bites as causes of diarrhoea, whereas 15 (15.5%) said that they did not know the exact cause. Only 12 (12.4%) considered water as a source of diarrhoea. A common practice during an episode of diarrhoea was to self-medicate with a ‘yellow tablet’ (a combination of tinidazole and ofloxacin) which was freely available at the local provision store.

3.5. Toilet usage, beliefs and practices

Fifty-seven (31.8%) households interviewed in the general questionnaire had functional toilets, all built by the owners themselves. However, only 38 (67.9%) of those households with toilets actually used them. In the focus groups, the reasons given for not using toilets that were already built were that it was contrary to their custom especially among the elders of the village; there was also concern about the smell and possible water stagnation during the rainy season. The ownership and usage of toilets among those interviewed in the individual questionnaire is presented in Table 2. Eighteen (60%) owning toilets belonged to the high SES category, and 12 (40%) belonged to the middle and low SES categories. Of the individuals using toilets, 17 (68%) belonged to the high SES category and 8 (32%) to the middle and low SES categories. There was no significant difference in ownership or usage of toilets between the Main village and the Harijan colony (Table 2).

The government had attempted to construct toilets for every household; however, none had covered pits or were connected to septic tanks and hence they were non-functional. One set of public latrines for women had been built by the government but was seldom used because a monthly fee had to be paid for its use and because it sometimes lacked water. Even when used, it was for the purpose of bathing and washing clothes, rarely for defecation.

3.6. Defecation, beliefs and practices

Seventy-two (74.2%) respondents to the individual questionnaire defecated in open areas (Table 2). Predominantly barren land and fields outside the village were used for this purpose. Water from irrigation pumps was used for cleaning after defecation. A significantly greater number of individuals (P < 0.001) in the Main village preferred going alone for defecation (Table 2). Children accompanied women on early morning trips to the fields for defecation or defecated in a public place in the village and the area was later cleaned by their mothers.

In the focus groups, among the reasons stated for defecating in open areas were that it was an age-old custom and tradition, did not carry any stigma, and it was unacceptable to accumulate human faecal matter close to their dwelling, with respondents stating ‘why dirty the house, when the weather outside is so fine?’, while some regarded it as a social outing. Respondents also stated that they did not possess the required financial resources to build toilets and open field defecation eliminated the need to maintain toilets. Some individuals believed that toilet construction was very expensive. Participants from the Harijan colony also mentioned the scarcity of water as a reason for not constructing or using toilets. Most did not believe that there was any association between open-air defecation and diarrhoeal diseases. Some even felt it was a hygienic practice because ‘the sun burns up faeces’. Others felt there might be an association with disease, but felt their practices were not harmful as they defecated far from residential areas.

Hand washing with soap after defecation varied widely with age. When compared with people above the age of 60 years, a greater number of children (37.5% vs. 86.4%, P = 0.03) washed hands with soap after defecation and before meals (Table 3).

Microbial water treatment, SES, stated causation of diarrhoea, concept of safe water, and perception of adequate water supply were included in a multiple logistic regression model. After adjusting for these factors, only perception of quantity of water received (P < 0.001), stated causation of diarrhoea (P = 0.02) and low SES (P < 0.001) remained signif-
contaminated hands (Wright et al., 2004). Therefore, safer contamination of drinking water by contact with potentially mouthed stored drinking water pot with a cup held in the upper and lower caste people and inequalities that have remained uncorrected. Reflection of the continuation of historical segregation of communication). The difference in supply is likely to be a different, but also the distribution networks had no interconnections in other villages in this region, not only the sources of drinking water. With the recession of the water table, the only reliable source of water has become the deep bore wells installed by the government.

A surprising finding was that there was a difference in the volume of water available in the Main village compared to the Harijan colony, which was both perceived by the residents of the village and measured by individual water usage. The reasons for the shortage were not apparent, but socio-cultural factors are likely to have a strong role. Traditionally, Harijan colonies and the non-Harijan areas in India have had separate water sources. In this study and in observations in other villages in this region, not only the sources of water to the two sections of the village were found to be different, but also the distribution networks had no interconnections (Prof. Muliyil, CHAD, Vellore, India, personal communication). The difference in supply is likely to be a reflection of the continuation of historical segregation of upper and lower caste people and inequalities that have remained uncorrected.

All the respondents interviewed dipped into the wide-mouthed stored drinking water pot with a cup held in the hand. This practice increases the risk of microbiological contamination of drinking water by contact with potentially contaminated hands (Wright et al., 2004). Therefore, safer practices such as using cups with long handles for drinking water must be encouraged. The most popular method of microbiological water treatment in Nelvoy village was filtering with a cloth or sieve, which is less effective than most other methods in preventing microbial contamination. Boiling, the next most popular method is more expensive and time consuming (Tumwine, 2005), and is prone to recontamination if water is not stored properly (Luby et al., 2000). In such situations, other techniques such as solar water disinfection (Rose et al., 2006) or point-of-use chlorination (Arnold and Colford, 2007) and the use of narrow-mouthed vessels for water storage (Mintz et al., 1995; Quick et al., 1996) need to be explored.

Beliefs about diarrhoea were diverse, with a significant proportion (44.3%) believing in a range of reasons from ingesting mud or hair to ‘heat’ to be its cause. For any point-of-use microbial water treatment intervention to succeed, the first step would be to ensure greater awareness, particularly regarding disease causation, transmission and effects. Educational and motivational interventions targeted towards changing microbial water treatment practices are critical.

Hand washing with soap after defecation was practiced more commonly by the under-15 age group due to education at local schools on good hygienic practices. With strong evidence on the efficacy of hand washing (Curtis and Cairncross, 2003), a greater emphasis on this practice including repeated messages in primary schools could be a part of an intervention package for long term behavioural change (Zwane and Kremer, 2007) and prevention of diarrhoea.

Ownership of toilets among households in Nelvoy village (31.8%) was higher than the national average of 18.9% (International Institute for Population Sciences and ORC Macro, 2000). However, many toilets hastily constructed by the government were non-functional and hence unusable. Studies have shown that the lack of sanitation in poor urban communities results from having to choose between badly constructed, poorly maintained government toilets and well-maintained, but expensive pay-for-use toilets (Burra et al., 2003).

Improved sanitation awareness, appropriate assistance and easy availability of building materials and construction skills have been known to increase the demand for household latrines (Water and Sanitation Program, 2002). However

<table>
<thead>
<tr>
<th>Variable</th>
<th>Main village n (%)</th>
<th>Harijan colony n (%)</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial water treatment</td>
<td>12 (29.3)</td>
<td>29 (51.8)</td>
<td>0.83</td>
<td>0.21–3.17</td>
<td>0.79</td>
</tr>
<tr>
<td>High SESa</td>
<td>27 (65.9)</td>
<td>8 (14.8)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Middle SES</td>
<td>11 (26.8)</td>
<td>27 (50)</td>
<td>2.53</td>
<td>0.59–10.77</td>
<td>0.21</td>
</tr>
<tr>
<td>Low SES</td>
<td>3 (7.3)</td>
<td>19 (35.2)</td>
<td>28.08</td>
<td>4.43–177.88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stated causation of diarrhoea</td>
<td>18 (43.9)</td>
<td>36 (64.3)</td>
<td>0.19</td>
<td>0.05–0.79</td>
<td>0.02</td>
</tr>
<tr>
<td>Concept of safe waterc</td>
<td>20 (48.8)</td>
<td>35 (5)</td>
<td>0(62.29</td>
<td>0.08–1.12</td>
<td>0.07</td>
</tr>
<tr>
<td>Perception of adequate water supply</td>
<td>38 (92.7)</td>
<td>17 (30.4)</td>
<td>27.86</td>
<td>5.80–133.72</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

SES: Socioeconomic status.

a Reference category.
b Food and water stated as causes of diarrhea were considered protective vs. all other causes.
c Water from clean tank and from borewell were considered protective vs. all other causes.

4. Discussion

To our knowledge this is the first KAP study to assess water usage, sanitation and defecation practices in a southern Indian rural community. The findings are important in that there is no stigma associated with open air defecation and a perceived lack of association between safe water and diarrhoeal disease.

The success of the government water supply scheme in rural Tamilnadu (International Institute for Population Sciences and ORC Macro, 2001) is reflected in our findings that the people of Nelvoy village predominantly derived their drinking water from the government supply. As recently as 5 years ago, water sources such as shallow bore wells, operated by hand pumps and open wells were used as sources of drinking water. With the recession of the water table, the only reliable source of water has become the deep bore wells installed by the government.

The reasons for the shortage were not apparent, but socio-cultural factors are likely to have a strong role. Traditionally, Harijan colonies and the non-Harijan areas in India have had separate water sources. In this study and in observations in other villages in this region, not only the sources of water to the two sections of the village were found to be different, but also the distribution networks had no interconnections (Prof. Muliyil, CHAD, Vellore, India, personal communication). The difference in supply is likely to be a reflection of the continuation of historical segregation of upper and lower caste people and inequalities that have remained uncorrected.

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Improved sanitation awareness, appropriate assistance and easy availability of building materials and construction skills have been known to increase the demand for household latrines (Water and Sanitation Program, 2002). However
in addition, the desire to be considered modern, ‘save face’ with guests and earn respect from neighbours also influences the demand for sanitation (Jenkins and Curtis, 2005). In a setting such as in Nelvoy village where open air defecation is rooted in traditional beliefs and is not associated with any stigma, educational interventions must focus on not only hazards of open air defecation, but project toilet usage as a modern, desirable practice. Sanitation must be ‘marketed’ in this and other villages to overcome local prejudices and barriers, and should use locally appropriate facilities promoted through the local government (Water and Sanitation Program, 2004). This may be more easily achievable in some sections of the community since people in higher SES category tend to use toilets more often (Table 4).

The relative lack of water in the Harijan colony may play a role in lower levels of sanitation and impede hygienic practices (Gilman et al., 1993). Dry sanitation, with its advantages of vastly reduced water use, recycling of bio waste and segregation of animal and human faeces to prevent groundwater contamination (Peasey, 2000; Scott, 2002), could provide a solution to the sanitation problems of Nelvoy village.

The survey was carried over 1 week and if individuals in the sample were not available for interviews, the study team did not have any opportunity to revisit houses. Since those not interviewed were only 10% of the total sample size, extreme opinions from this group are unlikely to change the findings of this survey.

The lack of hygiene, sanitation and microbial water treatment practices in this village create a situation ideal for the spread of diarrhoeal and water-borne diseases. If national and worldwide goals for provision of safe water to all communities are to be achieved, steps to promote water safety and sanitation must be undertaken, to protect those most vulnerable to the short and long term consequences of diarrhoeal diseases.

Authors’ contributions: All authors were involved in designing the study protocol and analysing and interpreting the data; KB, SG, JG, BBH, MBJ, PM, MES, TS, CRS, and VAT collected the data; RK conducted the focus groups; KB, SG, JG, BBH, MBJ, PM, MES, TS, CRS, and VB wrote the manuscript. All authors read and approved the final manuscript. KB, RS and VB are guarantors of the paper.

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