Knowledge, attitudes, practices and implications of safe water management and good hygiene in rural Bangladesh: assessing the impact and scope of the BRAC WASH programme

Stephanie Fisher, Babar Kabir, Edward Lahiff and Malcolm MacLachlan

ABSTRACT

A substantial component of BRAC's WASH programme involves educating rural Bangladeshis about safe water management, good hygiene and the causes of diarrhoea. By conducting questionnaires and focus group discussions in two BRAC WASH villages and one control village, this investigation sought to assess the impact of BRAC's programme on knowledge, practices and diarrhoeal burden, to explore the extent to which knowledge determines practices, and to evaluate which factors were most predictive of diarrhoeal incidence. It was found that the programme had a beneficial effect on the subjects' knowledge and practices, and on the diarrhoeal incidence among their children. Furthermore, except for where personal financial expenditure was required, practices tended to follow on from knowledge. However, BRAC's intervention affected neither the frequency of soap use in handwashing by the mother, nor the child's consumption of unclean water outside of the home. These factors, along with the child's consumption of unclean water inside the home, were shown to be those most predictive of diarrhoeal incidence among the under-fives. It is recommended that BRAC continues to emphasize the importance of these points, while also potentially promoting the use of less costly alternatives to soap and cheaper point-of-use treatment materials, to induce positive behaviour change.

Key words | attitudes, diarrhoea, hygiene, knowledge, practice

Stephanie Fisher (corresponding author)
Edward Lahiff
Malcolm MacLachlan
Centre for Global Health,
3–4 Foster Place,
Trinity College,
Dublin 2,
Ireland
E-mail: *sfisher@tcd.ie*

Babar Kabir
BRAC Centre (8th floor),
75 Mahakhali,
Dhaka 1212,
Bangladesh

INTRODUCTION

Diarrhoeal disease resulting from unsafe water, sanitation and hygiene still represents a major barrier to global health, particularly for children under five years of age, whose immune systems have not yet fully developed (Trevett *et al.* 2005*b*). In 2002, such diarrhoeal disease was responsible for 3.2% of all deaths worldwide, and 4.1% of deaths in South-East Asia (WHO 2004), approximately 90% of which occurred among the under-fives.

Evidence of post-source contamination of drinking water, whether through collection, transportation, storage, or removal for consumption, is abundant within the scientific literature (Gasana *et al.* 2002; Trevett *et al.* 2004, 2005*a*; Wright *et al.* 2004; Taulo *et al.* 2008), although there is ongoing debate about the precise risk that such contamination poses for diarrhoeal disease (VanDerslice & Briscoe 1993; Trevett *et al.* 2005*b*). Nonetheless, many studies have demonstrated that use of a lid or a safe storage vessel, not introducing a utensil for water collection but pouring, and treating the drinking water at the point of use, can result in a reduced incidence of diarrhoeal disease, suggesting that these safe water management practices provide some degree of protection against diarrhoea. In light of this, and the very high burden of diarrhoeal disease in Bangladesh (WHO 2006), the Bangladeshi charity BRAC has educated millions

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of rural inhabitants about the causes of diarrhoea, safe water management and good hygiene as part of its water, sanitation and hygiene (WASH) programme.

The BRAC WASH initiative is an intensively supported hygiene education-based approach which aims to encourage lasting behaviour change by targeting the rural inhabitants at multiple levels. These include the *household* level, through individual and group education or interaction, the *institutional* level, through educational and social institutions, and the *community* level, by involving village WASH committees (IRC International Water and Sanitation Centre & Water Aid 2008).

At the initiation of the BRAC WASH programme in each village, BRAC staff spend three days providing classic hygiene education and facilitating participatory rural appraisal involving social mapping in order to promote hygiene and sanitation, and to mobilize the villagers to improve their own situation. Following this, a village WASH committee is elected for a period of two years to promote WASH activities within the village and to identify problems, mobilize resources and take actions to ensure that every household has access to a sanitary latrine and safe water. The advisers and committee members create a specific yearly plan to ensure safe water and ensure adherence to BRAC's vision of total sanitation in the village (IRC International Water and Sanitation Centre & Water Aid 2008).

As part of BRAC's WASH programme, trained fieldworkers provide water, sanitation and hygiene education to separate clusters of men, women, adolescents and children at a frequency of at least once every three months. The education provided within cluster group meetings is centred on a pictorial flipchart which communicates a total of 39 messages covering multiple aspects of cleanliness, clean water and sanitation. In addition, villagers are encouraged to learn the '19 Messages to Remember', concerning handwashing, sanitation and safe water. This intervention is continuous, aiming to continually encourage and maintain this positive behaviour change.

This educational component of BRAC's WASH intervention is clearly based on the assumption that, through successful education of their target communities, BRAC will be able to evoke a positive change in health-related behaviour and, in so doing, lessen the burden of diarrhoeal disease, particularly among children. These ideas are supported by Fishbein & Ajzen's (1975) theory of reasoned action, which states that a person's behavioural intention depends both on the subject's attitude towards that behaviour and on subjective norms. Hale *et al.* (2003) have argued that the theory of reasoned action, while focusing on intentional behaviour, accounts less well for behaviour that is more habitual or impulsive. MacLachlan (2006) has suggested that such individually focused theories may not be valid across culturally or contextually diverse situations. However, according to the theory, if BRAC is able to alter participant's attitudes towards safe water management or good hygiene through its education programme, then this will have an impact on that person's behavioural intention and potentially lead to behaviour change. As the contexts and cultures in which BRAC operate are quite different from those in which many other theory of reasoned action investigations have been undertaken, this research explores a potentially useful extension of the theory.

Publications in the literature which address the relationship between knowledge and changes in health-related behaviour vary in their conclusions. Graf *et al.* (2008) demonstrated that, in Kenya, a greater knowledge of proper handling of water was associated with a greater likelihood of using solar disinfection, a point-of-use treatment method that has been shown to significantly reduce diarrhoeal disease. For rural India, Gosh *et al.* (1998) showed that mothers' knowledge about five diarrhoeagenic behaviours was associated with a reduction in their performance of these behaviours, and also with a reduction in their child's risk of diarrhoea. However, knowledge of the ways in which a mother or caregiver might be able to reduce her child's risk of diarrhoea is not always necessary, or on other occasions sufficient. Hoque *et al.* (1996) showed that, five years after their integrated water supply, sanitation and hygiene education intervention project, the women they surveyed from both the control and intervention areas had very poor knowledge of disease transmission and made no connection between improved health and WASH practices. The women from the intervention area did, however, have a lower level of contamination of their hands, suggesting better hygiene practices than were performed in the non-intervention area, and that knowledge of disease transmission is not strictly necessary for an alteration in practice. Quick *et al.* (1996), however, found that campaigns in Peru educating the population about cholera prevention measures were very successful in so far as they resulted in high overall scores in

questionnaires designed to assess knowledge, but that these high levels of knowledge were not translated into practice, and that comparatively few adopted the preventive behaviours about which they had learnt.

The purpose of this investigation therefore was to assess, using a case study approach, the impact of the BRAC WASH programme on the knowledge and practices of caregivers of children under five years of age in two rural Bangladeshi villages, by comparing them with equivalent women from a comparable nearby village not subject to the intervention, and to study the link between knowledge and practice among the respondents. Where there appeared a mismatch in knowledge and practice, explanations were sought. Furthermore, this study sought to ascertain the impact of the intervention on the burden of diarrhoeal disease of the under-fives in the intervention villages, and to establish the main risk factors for diarrhoeal disease in the study area. In this way, the effectiveness of the BRAC WASH programme's educational component could be assessed in these two villages, and potentially modified for greater impact.

METHODOLOGY

The study area

The study was conducted in three rural villages, selected using purposive sampling, in the Mymensingh District of the Dhaka Division of Bangladesh. The villages, Kuchundhora, Boyalmara and Makiar Knda, which were within 7 km of each other, were chosen because of their geographical proximity, and their similarity in terms of accessibility, socio-economic status, employment, education, and use of tubewell water. They are however split across two sub-districts; Kuchundhora and Boyalmara are situated within the Haluaghat *upazila* (sub-district) and Makiar Knda is situated within the Dhobaura *upazila*. The Haluaghat *upazila* is one of the 150 *upazilas* in which the BRAC WASH programme operates, but the Dhobaura *upazila* is not. Accordingly, the villages of Kuchundhora and Boyalmara are subject to the BRAC WASH intervention, and have been for precisely the same length of time, while the village of Makiar Knda has not received WASH equipment or education from BRAC or indeed any other NGO.

Data collection and analysis

By going door-to-door within the three study villages, every caregiver of a child under five years old (who was in most cases the mother, and in every case a woman) was invited to answer a pre-piloted 35-question survey conducted in the Bangla language by a BRAC fieldworker from the area. With the exception of one mother from Kuchundhora who was sick and therefore unable to partake, and one mother from Makiar Knda who was deemed insane and therefore excluded from the study, every caregiver of an under-five took part; a total of 107 women, 80 from the BRAC WASH villages and 27 from Makiar Knda. The questionnaire explored the caregiver's knowledge of the causes of diarrhoea, her knowledge, attitude and practices of household water management, her water, sanitation and hygiene practices, and her child's burden of diarrhoeal disease during the month prior to data collection. Wherever possible, the answers given concerning her water source and latrine type and cleanliness were verified by observation. Diarrhoea was defined according to the WHO definition, as three or more loose or watery stools within a 24-hour period.

The impact of the BRAC WASH programme on the variables covered in the survey was determined using Fisher's exact test (for qualitative answers), the Student's t-test (for quantitative parametric answers) and the Mann–Whitney test (for quantitative non-parametric answers) to explore which answers were associated with the presence or absence of the intervention. A comparison between the two BRAC WASH villages was then performed in order to verify that any differences found to be significant by the first analysis were more likely to be due to the presence/absence of the intervention rather than some intrinsic difference between the three villages being studied.

The same tests that were used to examine the impact of the intervention were then used to examine associations between the survey answers and the respondent's child having suffered from diarrhoea within the previous month. Having found the factors associated with incidence of diarrhoeal disease among the under-fives, backward stepwise multiple logistic regression was used to eliminate those variables which did not play a significant role in predicting whether or not the child had suffered from diarrhoea, leaving only those which had a significant impact on the incidence of

diarrhoea. All statistical calculations were performed using the computer programme SPSS Statistics 17.0.

In addition, in each of the three villages, a focus group discussion was conducted among eight of the questionnaire respondents, selected using convenience sampling by the BRAC WASH fieldworkers. The focus group discussions were carried out in order to explore their answers, beliefs and attitudes in a greater depth than enabled by questionnaire. The discussion, facilitated by a BRAC fieldworker or interpreter with a note-taker present, was recorded using a digital voice recorder. Following the focus group, the recording was transcribed and translated by the interpreter present at the discussion. The three translated transcripts were analysed by identifying emerging themes and patterns in order to support, expand upon or dispute the results already obtained from the questionnaire.

Free and informed consent of the participants was obtained for all aspects of the methodology, and the study protocol was approved by the Faculty of Health Sciences Ethics Committee, Trinity College, Dublin, on 2 April 2009.

RESULTS AND DISCUSSION

Impact of the BRAC WASH programme on knowledge and practice

As shown in Table 1, statistical analysis revealed that the respondents from the BRAC WASH villages Kuchundhora and Boyalmara had better knowledge and superior practices to the participants from Makiar Knda when it came to 16 of the 37 variables that had been covered in the BRAC WASH curriculum and investigated here. The intervention villages' total scores for the multiple choice knowledge questions also proved significantly greater (Mann–Whitney test statistic 255.00, p-value <0.001). There is no guarantee that the intervention alone was responsible for this knowledge and these practices, but since they were covered by the intervention, and were significantly associated with the presence/absence of the intervention, it is reasonable to assume that the intervention was at least in part responsible for their significance, and that the education component of the BRAC WASH programme was indeed somewhat successful.

However, the corollary to this assumption is that 21 of the 37 variables investigated were not shown to be significantly different between the intervention and non-intervention villages. As the counts shown in Table 2 reveal, however, many of these appear to have failed to reach significance not because the respondents from the BRAC villages were lacking in knowledge or performing unsafe practices, but because the practices of those in Makiar Knda were equally good. The notable exceptions to this trend, however, where the intervention villages did not perform well, were the frequency with which the respondents used soap when washing their hands and the consumption of unsafe water or water-based products (such as juice or ice-cream) outside the home; the inhabitants of the BRAC WASH villages used soap less frequently and drank potentially unclean water more frequently than might be expected, given the teaching provided by the programme on these points.

The relationship between knowledge and practice

Although the intervention villages did demonstrate both superior knowledge and safer or more hygienic practices in general, it is a separate question as to whether the two were linked. The questions aimed at exploring the participants' knowledge were restricted to those concerning the causes of diarrhoea, and those related to safe water management. As such, the comparisons between knowledge and practice were limited to the issues of household water collection, storage and treatment, but still revealed some interesting discrepancies, as shown in Figure 1.

Respondents in both Kuchundhora and Boyalmara had very good knowledge of the causes of diarrhoea and of safe water management, and performed good water management practices. In both Kuchundhora and Boyalmara, the only instance in which knowledge did not lead to good practices was with regard to water treatment. Every participant from Kuchundhora and 96.55% of respondents from Boyalmara were able to provide a correct answer as to why people treat water, and in both villages the respondents could name on average 2.00 methods of water treatment. However, not a single respondent from either village did actually treat her or her child's water. It later became apparent, in answer to the question 'Do you consider it necessary to treat your water?' that all but one respondents did not consider it necessary to

Table 1 | Variables covered by BRAC WASH's education that proved to differ significantly between the intervention and non-intervention villages

Variable	Answers	BRAC WASH villages Count (%)	Non-intervention village Count (%)	Test statistic†	P-value
Knowledge					
If the water is free from obvious dirt, then it is definitely safe to drink	True	17 (21.3)	25 (92.6)	43.090	0.000
	False	63 (78.8)	2 (7.4)		***
There are ways that you can treat water to make it safer to drink	True	80 (100.0)	14 (51.9)	37.631	0.000
	False	0 (0.0)	10 (37.0)		***
	Don't know	0 (0.0)	3 (11.1)		
As long as I treat my water most of the time then it doesn't matter if I don't do so every now and then	True	4 (5.0)	15 (55.6)	35.330	0.000
	False	76 (95.0)	12 (44.4)		***
If the water does not make me sick, then it will not make my child sick	True	15 (18.8)	13 (48.1)	9.030	0.005
	False	65 (81.3)	14 (51.9)		**
It is possible to die from diarrhoea	True	79 (98.8)	23 (85.2)	8.339	0.014
	False	1 (1.3)	4 (14.8)		*
You can get diarrhoea for supernatural reasons such as punishment from God or breaking norms	True	2 (2.5)	5 (18.5)	8.472	0.011
	False	78 (97.5)	22 (81.5)		*
Adding newly collected water to water already in the storage container will…	Decrease water quality	75 (93.8)	18 (66.7)	13.263	0.000
	Prevent a decrease in water quality	4 (5.0)	9 (33.3)		***
	Have no effect	1 (1.3)	0 (0.0)		
Practices					
Where is the storage container kept?	On the ground	12 (22.2)	13 (61.9)	10.714	0.002
	Raised off the ground	42 (77.8)	8 (38.1)		**
In the past month, have YOU drunk unclean water within your home?	Yes	0 (0.0)	5 (18.5)	15.541	0.001
	No	80 (100.0)	22 (81.5)		***
In the past month, have you given YOUR CHILD /children unclean water to drink within your home?	Yes	3 (3.8)	5 (18.5)	6.365	0.023
	No	77 (96.3)	22 (81.5)		*
How frequently do you eat cold leftovers?	Always	1 (1.3)	0 (0.0)	29.818	0.000
	Almost always	0 (0.0)	4 (14.8)		***
	Sometimes	28 (35.0)	20 (74.1)		
	Never	51 (63.8)	3 (11.1)		

Table 1 | *(Continued)*

Variable	Answers	BRAC WASH villages Count (%)	Non-intervention village Count (%)	Test statistic†	P-value
How frequently do you feed your child cold leftovers?	Always	1 (1.3)	0 (0.0)	33.690	0.000
	Almost always	0 (0.0)	1 (3.7)		***
	Sometimes	9 (11.4)	18 (66.7)		
	Never	69 (87.3)	8 (29.6)		
How frequently do you wash fruit and vegetables that you eat raw?	Always	75 (96.2)	19 (70.4)	15.235	0.000
	Almost always	2 (2.6)	5 (18.5)		***
	Sometimes	0 (0.0)	3 (11.1)		
	Never	1 (1.3)	0 (0.0)		
How frequently do you wash fruit and vegetables that your child eats raw?	Always	77 (96.3)	20 (74.1)	13.211	0.001
	Almost always	2 (2.5)	4 (14.8)		***
	Sometimes	0 (0.0)	3 (11.1)		
	Never	1 (1.3)	0 (0.0)		
If you use a toilet or latrine to defecate, is it…	Clean and hygienic	36 (45.0)	4 (14.8)	14.534	0.001
	Clean	41 (51.3)	16 (59.3)		***
	Unclean/unhygienic	3 (3.8)	7 (25.9)		
The last time your youngest child defecated, what was done to dispose of the stools?	Child used latrine	24 (30.0)	2 (7.4)	42.135	0.000
	Put/rinsed into the latrine	39 (48.8)	3 (11.1)		***
	Put/rinsed into hole in ground	9 (11.3)	2 (7.4)		
	Thrown into garbage	7 (8.8)	19 (70.4)		
	Thrown into pond	1 (1.3)	0 (0.0)		
	Thrown into river	0 (0.0)	1 (3.7)		

Percentages might not add to 100 due to rounding

NS > 0.05,* P ≤ 0.05,** P ≤ 0.01,*** P ≤ 0.001

† For all 2 × 2 tables, the χ^2 test statistic is stated instead of that for the Fisher's exact test, since SPSS only provides the Fisher's exact statistic for contingency tables of 2 × 3 or larger

treat the tubewell water since the BRAC WASH programme had taught them that it was already safe to drink. Only one respondent actually thought it necessary to treat her tubewell water (while explaining that it had not been tested for arsenic or bacteria so she did not know whether or not it was actually safe). Hence the lack of treatment was not so much due to a mismatch between knowledge and practice, but more due to the possession of additional information (*via* the BRAC programme) which had rendered such practices unnecessary. These results were strongly supported by the focus group discussions conducted in both of these villages, which confirmed the participants' knowledge of the causes of diarrhoea and of safe water management, and their belief that their water was 'safe' and 'pure'. In both villages, however, the discussion also revealed that, were it necessary, most of the respondents did not have the materials to treat their

Table 2 | Variables covered by BRAC WASH's education that did not prove to differ significantly between the intervention and non-intervention villages

Variable	Answers	BRAC WASH villages Count (%)	Non-intervention village Count (%)	Test statistic†
Covering the water storage container will…	Decrease water quality	1 (1.3)	0 (0.0)	0.341
	Prevent a decrease in water quality	79 (98.8)	27 (100.0)	
Washing the storage container regularly will…	Decrease water quality	1 (1.3)	1 (3.7)	0.663
	Prevent a decrease in water quality	79 (98.8)	26 (96.3)	
The quality of water can decrease once it has been collected from the source	True	65 (81.3)	18 (66.7)	4.299
	False	15 (18.8)	8 (29.6)	
	Don't know	0 (0)	1 (3.7)	
You can get diarrhoea from drinking unclean water	True	79 (98.8)	27 (100.0)	0.341
	False	1 (1.3)	0 (0.0)	
Germs in drinking water cause diarrhoea and sickness	True	79 (98.8)	27 (100.0)	0.341
	False	1 (1.3)	0 (0.0)	
Rinsing the collection vessel before collecting the water will…	Decrease water quality	1 (1.3)	1 (3.7)	0.663
	Prevent a decrease in water quality	79 (98.8)	26 (96.3)	
Touching the water with your hands will…	Decrease water quality	67 (83.8)	22 (81.5)	0.074
	Prevent a decrease in water quality	13 (16.3)	5 (18.5)	
Practices				
When filling the storage container, do you…	Only collect water when the water stored in the storage container runs out	29 (70.7)	12 (70.6)	2.288
	Empty any remaining water from the container before re-filling with new water	12 (29.3)	4 (23.5)	
	Add the new water to the water remaining in the storage container	0 (0.0)	1 (5.9)	

Table 2 | *(Continued)*

Variable	Answers	BRAC WASH villages Count (%)	Non-intervention village Count (%)	Test statistic†
When filling the storage container, do you rinse it first?	Yes, with water from the same source as the drinking water	40 (97.6)	17 (100.0)	0.422
	Yes, with non-drinking water	1 (2.4)	0 (0.0)	
Does the storage container have a lid?	Yes	54 (100.0)	19 (90.5)	5.284
	No	0 (0.0)	2 (9.5)	
How do you remove water from the storage container?	By pouring	53 (98.1)	21 (100.0)	0.394
	Through a tap on the container	1 (1.9)	0 (0.0)	
In the past month have YOU consumed any water or water-based item from a source outside of your home that might have been unclean?	Yes	9 (11.3)	3 (11.1)	0.000
	No	71 (88.8)	24 (88.9)	
In the past month has YOUR CHILD consumed any water or water-based item from a source outside of your home that might have been unclean?	Yes	32 (40.0)	12 (44.4)	0.585
	No	47 (58.8)	15 (55.6)	
	Don't know	1 (1.3)	0 (0.0)	
How frequently do you wash your hands after defecating?	Always	80 (100.0)	26 (96.3)	2.991
	Sometimes	0 (0.0)	1 (3.7)	
How frequently do you wash your hands after cleaning up your child's faeces?	Always	80 (100.0)	26 (96.3)	2.991
	Sometimes	0 (0.0)	1 (3.7)	
How frequently do you wash your hands after cleaning your child's bottom?	Always	80 (100.0)	25 (92.6)	5.243
	Almost always	0 (0.0)	1 (3.7)	
	Sometimes	0 (0.0)	1 (3.7)	
How frequently do you wash your hands before preparing food?	Always	50 (63.3)	21 (77.8)	1.817
	Almost always	26 (32.9)	6 (22.2)	
	Sometimes	3 (3.8)	0 (0.0)	
How frequently do you wash your hands before eating food?	Always	80 (100.0)	27 (100.0)	NT
How frequently do you use soap when washing your hands?	Always	19 (23.8)	8 (29.6)	5.054
	Almost always	44 (55.0)	9 (33.3)	
	Sometimes	16 (20.0)	10 (37.0)	
	Never	1 (1.3)	0 (0.0)	

Table 2 | *(Continued)*

Variable	Answers	BRAC WASH villages Count (%)	Non-intervention village Count (%)	Test statistic†
How frequently do you wash cooking and eating utensils?	Always	77 (96.3)	26 (96.3)	0.863
	Almost always	2 (2.5)	1 (3.7)	
	Sometimes	1 (1.3)	0 (0.0)	
How frequently do you use a latrine to defecate?	Always	79 (98.8)	26 (100.0)	0.328
	Almost always	1 (1.3)	0 (0.0)	

Percentages might not add to 100 due to rounding

NT, no test

†For all 2×2 tables, the χ^2 test statistic is stated instead of that for the Fisher's exact test, since SPSS only provides the Fisher's exact statistic for contingency tables of 2×3 or larger

water, or indeed the means with which to purchase these materials.

Another potentially good practice that was not rigorously adopted within these two intervention villages was that of storing drinking water in a metal or plastic storage container as opposed to a clay one (Ahmed *et al.* 1998; Trevett *et al.* 2005*a*). This, however, is not actually taught as part of the BRAC WASH programme, and was clearly not something of which the villagers were generally aware, as can be seen from Figure 1. Thus, for these two intervention villages, practice did appear to follow knowledge closely, and in the instances where safer practices were not performed, lack of appropriate knowledge seemed to be the cause.

The non-intervention village of Makiar Knda, as has been discussed above, had inferior knowledge to both of the intervention villages. Despite this inferior knowledge, the inhabitants of Makiar Knda did still perform good water storage practices with a similar frequency to the inhabitants of Kuchundhora and Boyalmara. When, in the focus group discussion, the women were asked from where they obtained their knowledge about water storage and treatment (since this village has not been subject to any WASH or WATSAN intervention by any NGO), three of the six respondents replied that they had never been taught ('nobody did tell us about it', 'we do not have radio and TV, so from where will we learn this?', 'people do not tell us anything, so we do not

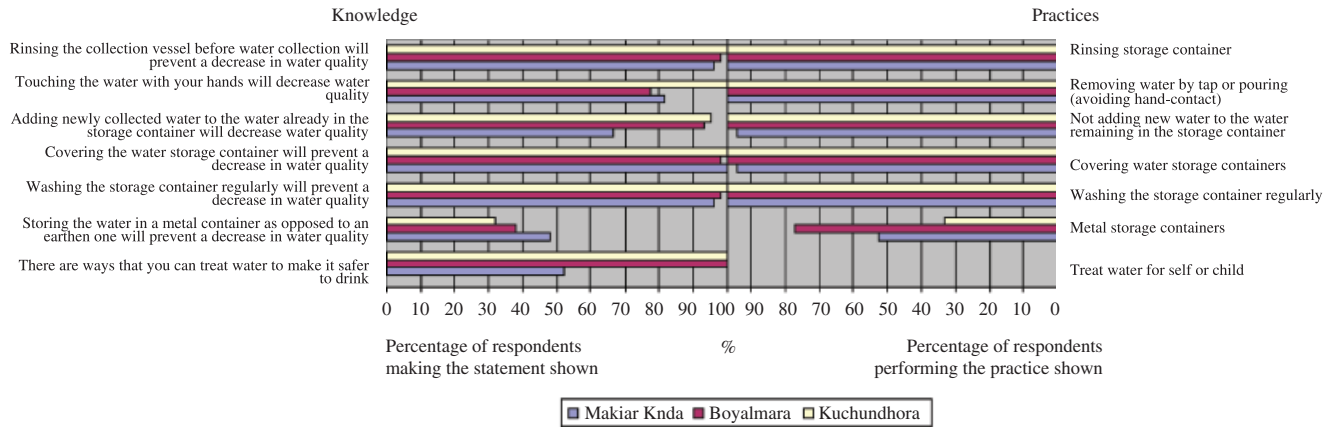

Figure 1 | Percentage of participants in the three villages who had the correct knowledge, and the percentage of participants who performed the corresponding safe practices concerning drinking water storage and treatment.

know anything about it'). This suggests that perhaps many of the inhabitants of Makiar Knda were performing practices based on traditional norms without fully realizing the rationale behind them, and that perhaps the knowledge imparted by BRAC simply allowed the inhabitants of Kuchundhora and Boyalmara to explain, in formal terms, what culture and tradition had instructed them to do. Indeed, one of the remaining three respondents answered that she had 'heard it from general people (from our villagers)', which suggests that this above supposition may be true. Of the two remaining respondents, one replied that she had heard about water storage and treatment from schoolteachers, and the other that she had learnt this information from the research team conducting this investigation.

The above findings from the three villages appear to follow the theory of reasoned action, which states that a person's behavioural intention depends both on the subject's attitude towards that behaviour and on subjective norms. In Kuchundhora and Boyalmara, it appears as if, by increasing the individuals' knowledge of the benefits of the behaviour, BRAC has altered their attitudes and increased the frequency with which the behaviours are performed. In Makiar Knda, however, it appears as if the behavioural performance is much more a result of behavioural norms than of personal attitudes towards the behaviours.

Just like the respondents from the intervention villages, those from Makiar Knda did not treat their water. However, unlike the respondents from the BRAC WASH villages, several of those respondents from Makiar Knda ought to have done so in light of the water sources used. When their tubewells ran dry, five inhabitants of Makiar Knda drank river water which they did not treat. Three of these women were unaware of the existence or importance of point-of-use treatment, and did not treat their water because they did not believe that it was necessary, since they had consumed such water in the past without subsequently suffering from diarrhoea. However, it is questionable as to whether this knowledge would have been of any benefit, since neither of the two who *were* aware of the need for treatment acted on this knowledge. The reasons given for this were that they had insufficient firewood or cooking pots for boiling, and that it was too hot to want to do so anyway.

There appear to be two separate issues here: the motivation to act on the knowledge and the inability to do so due to limited means and materials. Lack of motivation to treat the water was not only raised in the questionnaire but also in the focus group discussion in Makiar Knda ('No, it is not very expensive to treat water but we are very lazy. That is why we do not want to do it.'). Graf *et al.* (2008) also looked at the issues of motivation and practice, and found that beliefs in the important role of water in causing diarrhoea were linked to practice, suggesting that they also govern the motivation to treat water. If this is indeed the case, and knowledge of the important role of water in causing diarrhoea does reflect motivation to treat by influencing the subject's attitude towards the behaviour in accordance with the theory of reasoned action, then the BRAC intervention could potentially overcome this lack of motivation by providing the relevant knowledge. This supposition is supported by the response of one woman from Boyalmara (one of the two BRAC WASH villages) in the focus group discussion; in answer to the question 'are the materials [for treating water] affordable?' she replied, 'if needed, we have to manage money to buy these materials because if children drink unsafe water, children will get diarrhoea'. This implies that the woman's knowledge of the importance of water treatment would motivate her to find the resources to treat her child's water if it became necessary.

However, even with the knowledge of the importance of water treatment, and the motivation to treat, both of which could be imparted through a WASH intervention, many of the women of Makiar Knda would still be unable to treat the water for want of the necessary materials, or money with which to buy these materials. Since the BRAC WASH programme provides no materials for water treatment or money to purchase such materials, it is likely that, were their tubewells to run dry, many of the inhabitants of Kuchundhora and Boyalmara would be equally unable to treat their water. Indeed, while the one mother from Boyalmara (mentioned above) replied in the focus group discussion that she would try to manage her money so that she could treat her water if it became necessary, the other four women who replied all answered that they could not afford water treatment. The results from the focus group discussion in Kuchundhora were very similar, with the women responding that they do not have the money to buy the necessary materials.

The restrictions imposed by such lack of financial resources are not limited to the practices of safe water

management. As mentioned above, one of the lessons taught by BRAC that was not fully adopted was the necessity of using soap. It was beyond the scope of this study to investigate the reasons for this under-use of soap, but it appears likely that the failure to adopt this practice while most other practices were rigorously followed is due to the cost of soap and the reluctance of the households to spend their limited money on its purchase. There could, however, be other non-financial factors influencing the use of soap, but the suggestion that its non-use is due to limited disposable income is supported by the findings of Hoque *et al.* (1995) who found that, in a different area of rural Bangladesh, soap was reported as unaffordable by 81% of non-users. This is, therefore, a shortcoming of the BRAC WASH programme; the programme seems to have a significant impact on knowledge and on practices that do not involve the households' use of their own resources, but seems to be rather less effective where personal (especially financial) resources are required. Indeed it is possible that limited resources might have played a role in the consumption of potentially unsafe water and water-based products outside the home as well, since safe, bottled water and safe, packaged water-based products are available in most areas of Bangladesh, but at a price.

Thus, it is clear that incorporated into the subject's attitude towards a behaviour is the importance that he or she attaches to its performance. BRAC can influence the programme recipients' attitudes towards certain behaviours, but if resources are limited then prioritization will take place to decide which behaviours are worthy of the limited resources. When the choice is between having food to eat or treating one's water, it is unlikely that BRAC will ever induce behaviour change unless it alleviates the need for such prioritization by reducing the drain on resources that the behaviour represents.

The impact of the BRAC WASH programme on diarrhoeal incidence among the under-fives

The women interviewed had between them a total of 129 children under five years of age. Of these children, 11 had suffered from diarrhoeal disease during the month prior to data collection; five in the BRAC WASH villages and six in the non-intervention village of Makiar Knda. None of the 11 had suffered more than one episode, and the episodes had been between one and five days inclusive in duration. Fisher's exact test revealed that the presence/absence of the BRAC WASH intervention was significantly associated with whether or not the child had suffered from diarrhoea within the previous month (test statistic 5.702, p-value 0.027). Furthermore, no significant difference was revealed in the incidence of diarrhoeal disease between the two BRAC WASH villages, Kuchundhora and Boyalmara (test statistic 0.257, p-value 0.634).

Factors predictive of diarrhoeal disease incidence

In order to ascertain what aspect of the multifaceted intervention might have been responsible for the reduced incidence of diarrhoea among the BRAC WASH villages, Fisher's exact test was used to examine the association between each of the variables and the occurrence of diarrhoea. Those factors shown to be significant are shown in Table 3. Those who experienced diarrhoea were more likely to have consumed unclean or potentially unclean water inside or outside of the home, to have come from a household with a more basic and less clean latrine, and to have mothers who washed their hands less frequently after cleaning the child's bottom, used soap less frequently and washed their child's fruit and vegetables less frequently. Additionally, the Mann–Whitney test was used to investigate whether either of the quantitative variables 'frequency with which the storage container is washed' or 'age of child' were significantly associated with diarrhoea, but neither were found to be so (test statistic 189.00 (p-value 0.541) and 547.00 (p-value 0.377), respectively).

The factors which proved to be significantly associated with the incidence of diarrhoea were all then used as independent variables in a multinomial logistic regression analysis which was able to identify those variables which influenced the incidence of diarrhoea to the greatest extent. The results of the analysis are shown in Table 4. Such analysis revealed three factors to be significantly associated with diarrhoea, those being the child's consumption of unclean water within the home, the child's consumption of potentially unclean water or water-based products outside the home, and the frequency with which the caregiver used soap when washing her hands. This result is of particular relevance in light of the finding discussed earlier, that, unlike most other

Table 3 | Factors significantly associated with the incidence of diarrhoea (as revealed by the Fisher's exact analysis (two-sided))

Variable	Answers	Diarrhoea within the previous month Count (%)	No diarrhoea within the previous month Count (%)	Test statistic †	P-value
In the past month, have you given your child/children unclean water to drink within your home?	Yes	5 (45.5)	6 (5.1)	21.023	0.001
	No	6 (54.5)	112 (94.9)		***
In the past month has your child consumed any water or water-based item from a source outside of your home that might have been unclean?	Yes	9 (81.8)	44 (37.3)	8.752	0.015
	No	2 (18.2)	73 (61.9)		*
	Don't know	0 (0.0)	1 (0.8)		
How frequently do you wash your hands after cleaning your child's bottom?	Always	9 (81.8)	117 (99.2)	9.540	0.019
	Almost always	1 (9.1)	0 (0.0)		*
	Sometimes	1 (9.1)	1 (0.8)		
How frequently do you use soap when washing your hands?	Always	0 (0.0)	32 (27.1)	10.161	0.012
	Almost always	4 (36.4)	60 (50.8)		*
	Sometimes	7 (63.6)	25 (21.2)		
	Never	0 (0.0)	1 (0.8)		
How frequently do you wash fruit and vegetables that your child eats raw?	Always	6 (54.5)	109 (92.4)	13.745	0.002
	Almost always	4 (36.4)	5 (4.2)		**
	Sometimes	1 (9.1)	3 (2.5)		
	Never	0 (0.0)	1 (0.8)		
What kind of toilet facility do members of your household usually use?	Flush/pour flush to septic tank	0 (0.0)	2 (1.7)	8.657	0.034
	Ring slab latrine	8 (72.7)	111 (94.1)		*
	Pit latrine without slab/open pit	2 (18.2)	2 (1.7)		
	Hanging toilet/hanging latrine	1 (9.1)	3 (2.5)		
If you use a toilet or latrine to defecate, is it…	Clean and hygienic	0 (0.0)	50 (42.4)	10.399	0.004
	Clean	8 (72.7)	58 (49.2)		**
	Unclean/unhygienic	3 (27.3)	10 (8.5)		

Percentages might not add to 100 due to rounding

NS > 0.05, * P ≤ 0.05, ** P ≤ 0.01, *** P ≤ 0.001

† For all 2×2 tables, the χ^2 test statistic is stated instead of that for the Fisher's exact test, since SPSS only provides the Fisher's exact statistic for contingency tables of 2×3 or larger

practices covered by the educational component of the BRAC WASH programme, neither the child's consumption of potentially unclean water or water-based products outside the home, nor the frequency with which the caregiver used soap when washing her hands, appeared to be affected by the intervention.

Table 4 | Results of multiple logistic regression for factors associated with diarrhoea

Variable	Odds ratio	95% Confidence interval	P-value
In the past month, have you given your child unclean water to drink within your home?[a]	0.135	0.039–0.475	0.002
In the past month has your child consumed any water or water-based item from a source outside of your home that might have been unclean?[b]	0.137	0.026–0.722	0.019
How frequently do you use soap when washing your hands?[c]	5.358	1.899–15.119	0.002

[a]1 = yes, 2 = no
[b]1 = yes, 2 = no
[c]1 = always, 2 = almost always, 3 = sometimes, 4 = never

CONCLUSIONS

The results of this investigation suggest that the BRAC WASH programme has had a beneficial effect on the knowledge, practices and diarrhoeal incidence of the inhabitants of Kuchundhora and Boyalmara. The results suggest that BRAC's teaching can increase the participants' motivation to act, and imply that, where performing the water management or hygiene practice does not require the expenditure of personal finances, knowledge can be translated into practice, and that such practices can have a beneficial impact on the diarrhoeal disease burden. It also appears as if good practice can even occur in the absence of knowledge, if it is part of a long-standing tradition or has recently become integrated into the community norms, something that was also demonstrated by Hoque *et al.* in 1996. Unfortunately, however, it seems that for all three of the villages, a lack of disposable income represents a barrier between knowledge and practice where personal expenditure is required. The respondents in Makiar Knda who ought to have treated their water could not afford to do so, nor could most of the respondents from the BRAC villages were it to have been required. In all three villages, mothers frequently allowed their children to consume potentially unclean water (or water-based products) outside the home, where safe equivalents are available, but at a price. Likewise, in the context of this result, and the findings of Hoque *et al.* (1995) of the unaffordability of soap elsewhere in Bangladesh, it seems likely that lack of money was the cause of the inconsistent use of soap within the BRAC villages. Our findings also highlight that, while the theory of reasoned action has value in understanding the effects of BRAC's WASH programme, there are important and very basic limitations of the theory, such as available financial resources. As such we stress the importance of considering the context in which, and the process by which, interventions are delivered, especially in low-income settings (MacLachlan *et al.* 2010). Indeed enhancing the wish or intention to behave in a health-promoting manner, without providing the capability to enact, may only disempower and frustrate people.

As the child's consumption of unclean water inside the home, its consumption of potentially unclean water or water-based products outside the home, and the frequency with which the caregiver used soap when washing her hands, all proved strongly predictive of the child's incidence of diarrhoeal disease, it is recommended that BRAC continues to focus on these three points and to emphasize their importance in future community education programmes. Furthermore, it might be advisable for BRAC to promote the use of less costly alternatives to induce positive behaviour change. Potential alternatives could include the use of readily available soil or ash as an alternative to soap (Hoque *et al.* 1995), and the promotion of less expensive or more available methods of water treatment, such as potash, which is also readily available in Bangladesh (Islam *et al.* 2006). If such promotion were to be carried out alongside reinforcement of the importance of these factors, then the impact of the BRAC WASH programme might increase to an even greater extent, further lessening the preventable incidence of childhood diarrhoeal disease.

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