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RESEARCH ARTICLE

The effect of a large-scale water, sanitation and hygiene intervention in Bangladesh on knowledge, behaviour and health: Findings from an endline programme evaluation

Kelly Zhang Aluri[1] | Amal K. Halder[2] | Mahfuza Islam[2] | Jade Benjamin-Chung[1] | Monirul Alam[3] | Abul Kasham Shoab[2] | Mahbubur Rahman[2] | Leanne Unicomb[2] | Stephen P. Luby[1,4]

[1]Department of Epidemiology and Population Health, Stanford University School of Medicine, Stanford, California, USA

[2]International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Dhaka, Bangladesh

[3]United Nations Children's Fund Bangladesh, Dhaka, Bangladesh

[4]Department of Medicine, Infectious Disease, Stanford University School of Medicine, Stanford, California, USA

Correspondence
Kelly Zhang Aluri, Department of Epidemiology and Population Health, Stanford University School of Medicine, 300 Pasteur Dr., Stanford, CA 94305, USA.
Email: kellyaluri@stanford.edu

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Abstract

Objectives: The Sanitation, Hygiene Education and Water Supply in Bangladesh Programme (SHEWA-B) was a 5-year intervention aiming to improve water, sanitation and hygiene (WASH) practices among 20 million rural residents through community hygiene promoters. This analysis evaluates the impact of SHEWA-B on knowledge, behaviour and childhood diarrhoea outcomes.

Methods: The evaluation included repeated cross-sectional surveys and health surveillance in matched cohorts in intervention and control clusters. Cross-sectional surveys and structured observations at baseline, midline, and endline assessed the availability of WASH technology, caregiver knowledge and behaviour. Fieldworkers collected monthly health data in a subset of control and intervention households to determine the prevalence of diarrhoea.

Results: Of 5091 households surveyed, participants residing in intervention clusters showed minimal improvements in knowledge, reported behaviour, or use of WASH technology compared to the control clusters. During structured observations, intervention households increased more than control households at handwashing before preparing food and after cleaning a baby's anus when comparing endline to baseline, but these changes were not seen when comparing endline to the midline. The prevalence of childhood diarrhoea remained similar in both groups before (10.2% in intervention, 10.0% in control) and after (8.8% in intervention, 11.7% in control) midline changes were made to improve the intervention. Intervention clusters showed no improvement in diarrhoea over time compared to control clusters.

Conclusions: SHEWA-B's community-based WASH promotion did not yield the intended impact on knowledge, behaviour or health. Greater priority should be given to approaches that have demonstrated effectiveness. Including rigorous evaluations would broaden the evidence base to support and improve large-scale programmes.

KEYWORDS
Bangladesh; child health; diarrhoeal disease; large-scale programme evaluation; water, sanitation and hygiene intervention

Sustainable Development Goals: Good Health and Wellbeing, Sustainable Cities and Communities, Clean Water and Sanitation.

INTRODUCTION

Diarrhoea is a leading cause of death worldwide, responsible for killing nearly 500,000 children under 5 years old in 2016 [1]. In Bangladesh, diarrhoea kills thousands of children annually, contributes to malnutrition, and has serious economic impacts [2–4]. While water, sanitation and hygiene (WASH) are important to preventing disease, Bangladesh has low uptake of WASH technology and handwashing practices, with 18%–27% of adults washing hands after contact with faeces [3,5–7].

Small-scale WASH interventions involving intensive education through community health workers (CHWs) have been shown to reduce diarrhoea in low- and middle-income countries (LMICs) [8–12]. As a result, organisations and governments have scaled up hygiene promotion programmes. During the 2020–2021 fiscal year, the Bangladesh government allocated over $1 billion USD to WASH [13].

However, it is unknown whether large government-run WASH programmes can achieve the benefits seen in smaller interventions. There are few long-term evaluations of large-scale WASH promotion programmes in rural communities, and studies including a contemporaneous control group are especially rare. Existing studies have mixed results, so the health impact of large-scale interventions remains unclear [14–18]. In a systematic review, of 138 studies describing a WASH intervention, only 21 reported outcomes over 6 months after the intervention and three evaluated behaviours at multiple time points [19].

This study evaluates the impacts of one of the largest WASH programmes ever attempted in a low-income country, the Sanitation, Hygiene Education and Water Supply in Bangladesh Programme (SHEWA-B). SHEWA-B was a 5-year programme that launched in 2007 and targeted 20 million rural people, aiming to improve hygiene practices, sanitation and safe water supply. SHEWA-B received $100 million in funding, which amounted to less than $1 per target individual per year. A key component of SHEWA-B was training community hygiene promoters (CHPs) to deliver WASH messages to households. CHPs are distinct from hired CHWs in that they are considered volunteers with a modest stipend. After 18 months, a midpoint evaluation revealed no significant effects on most behaviours or childhood illness [18].

In response to the failure to achieve midline targets, the SHEWA-B implementers made changes to the health promotion intervention, including: (1) focusing on households with children <5 years, (2) assigning CHPs to specific wards, and (3) rewarding high-performing CHPs.

In addition, the team added a nationwide mass media campaign to deliver radio and television messages across both SHEWA-B control and intervention areas in 2011 and 2012 [20]. An evaluation of the mass media intervention comparing the households before and after the campaign reported an increase in recall of WASH messages, use of soap and water during handwashing, and availability of soap and water at handwashing stations [20].

While the mass media campaign showed promise as a scalable strategy for promoting WASH, it is not known how the changes to the in-person health promotion intervention impacted knowledge, behaviour and health outcomes [20,21]. The objective of this analysis is to determine the effect of the in-person SHEWA-B intervention and changes made after the mid-line evaluation on (1) knowledge of WASH topics, (2) compliance with WASH recommendations, and (3) the prevalence of childhood diarrhoea.

METHODS

SHEWA-B intervention

Based on a 3-year pilot study, the SHEWA-B programme aimed to promote safe water usage, environmental sanitation and hygiene behaviours among poor populations [18,22]. SHEWA-B was implemented by the Government of Bangladesh with support from a creative professional team from United Nations Children's Fund (UNICEF) and funded by the United Kingdom's Department for International Development, now known as the Foreign, Commonwealth & Development Office.

TABLE 1 Key messages of the SHEWA-B health promotion component

Original hygiene messages (2007–2010)	Revised hygiene messages (2010–2012)
1. Wash both hands with water and soap before eating/handling food	1. Handwashing after defecation/using toilet
2. Wash both hands with water and soap (or ash) after defecation	2. Handwashing before feeding children
3. Wash both hands with water and soap (or ash) after cleaning baby's bottom	3. Handwashing after washing child bottom
4. Manage menstruation period safely	4. Handwashing before eating
5. Use hygienic latrine by all family members including children	5. Use of latrine
6. Dispose of children faeces into hygienic latrine by men and women	6. Cleanliness of la trine
7. Clean and maintain latrine by men and women	7. Drink arsenic safe water
8. Construct a new latrine if the existing one is full and fill the pit with soil (or ash). The top ring and the slab may be used for the new latrine	8. Cover water container
9. Safe collection and storage of drinking water	
10. Draw drinking water from arsenic safe water point by men and women	
11. Wash raw fruits and vegetables with safe water before eating and cover food properly by men and women	

To promote WASH in communities, SHEWA-B recruited over 10,000 local residents with at least 10 years of schooling to serve as CHPs. CHPs received 10 days of training on behaviour change communication and were assigned specific areas to cover. To make their incentive affordable to local governments, CHPs were provided approximately $42 USD per month, which is around one-half of what an unskilled labourer would earn for working full-time.

The primary goal of CHPs was to increase local awareness of key messages (Table 1). CHPs visited households and organised activities, including courtyard meetings, WASH fairs, theatre, and discussions in tea stalls. CHPs used visual aids such as flip charts and flashcards to deliver key messages. The messages and graphics were designed to alert people to the presence of unobservable 'germs' in the home and practices that would minimise the impact of germs on their health. During Phase 1, each CHP was expected to reach 2000 individuals every 2 months through these activities.

A secondary goal was to encourage the adoption of WASH technology. CHPs held meetings for community members to develop community action plans, which involved identifying appropriate technology for their area and ensure installation in accessible locations. Community members were taught a systematic 'AAA' method—Assessment, Analysis and Action—to arrange improvements in latrine usage, access to arsenic-free water, and better hand hygiene practices.

Due to the lower-than-expected impact during Phase 1, Phase 2 of SHEWA-B included changes such as limiting the number of messages, making teaching more engaging, focusing on mothers of children under 5 years, assigning CHPs to specific wards within their area, and rewarding high-performing CHPs (Table 1). A mass media campaign not evaluated in this study was also added in response to the Phase 1 results [20].

Study and sample population

During Phase 1 (2007–2009), SHEWA-B targeted 20 million people in rural communities across 68 sub-districts in 19 districts. In Phase 2 (2010–2012), the number of rural beneficiaries was recalculated to 21.4 million. Intervention clusters were groups of 17 households in a village chosen randomly within sub-districts with perceived need and lack of active WASH programmes in the area. Matched control clusters were selected based on characteristics, such as local geography and infrastructure. For more information on the sampling procedures, see Appendix A2.

A new sample was drawn from intervention and control areas each time structured observations and the cross-sectional survey were conducted, at baseline, midline and endline (Figure 1). Subdistricts with new WASH programmes outside of SHEWA-B were excluded, then clusters were chosen using the same process described in Appendix A2.

At each time point, 17 households per cluster were selected for the cross-sectional survey, then a subset of those households was chosen for structured observation and/or health surveillance. Eligibility criteria included having a child <5 years of age, permanently residing in the community and a guardian of the child providing written consent. To enrol households, the field team began at the village centre and enrolled the closest eligible household. To enrol the next household, the team skipped the next two closest households and enrolled the next closest eligible household. The process was repeated until the sample size for the village was met.

In each cluster, the first 10 eligible households participating in the cross-sectional survey were chosen for monthly health surveillance. During Phase 1, surveillance households were selected from participants of the 2007 survey. Households were eligible if they had at least one child less than 3 years old, so that the child would remain under 5 years old during the 2-year surveillance period.

During Phase 2, 10 surveillance households per cluster were selected from the 2009 survey participants. This time, households were eligible if they had a child less than 4 years of age, so the child would remain under 5 during the intended 12-month surveillance period. The surveillance was later extended to 18 months, but all households remained in the sample.

Measurement of outcomes: Structured observation

At baseline, midline and endline, the field team conducted structured observations of handwashing behaviour in intervention and control clusters. The observation tool was designed based on literature and revised through feedback

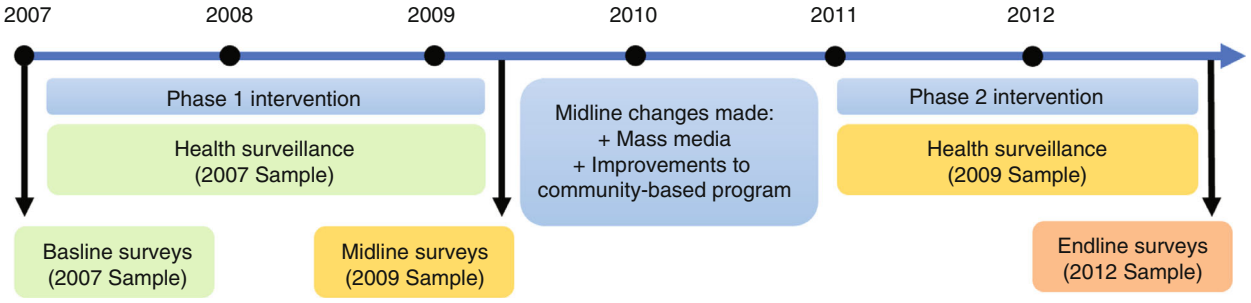

FIGURE 1 Timeline of Sanitation, Hygiene Education and Water Supply in Bangladesh Programme interventions and data collection

TABLE 2 Characteristics of intervention and control groups at baseline, midline and endline, *N* (%)

	Baseline (2007)		Midline (2009)		Endline (2012)	
	Intervention (*N* = 848)	**Control (*N* = 844)**	**Intervention (*N* = 849)**	**Control (*N* = 850)**	**Intervention (*N* = 850)**	**Control (*N* = 850)**
Head of household Male	815 (96%)	777 (92%)	806 (95%)	810 (95%)	803 (94%)	824 (97%)
Age of respondent, Mean (SD)	26.9 (7.0)	27.1 (7.3)	26.7 (6.9)	27.3 (6.6)	27.4 (6.9)	27.1 (6.6)
Household size, Mean (SD)	5.7 (2.2)	5.3 (2.0)	5.6 (2.3)	5.4 (2.1)	5.5 (2.1)	5.4 (2.2)
Education level of father						
No education	298 (35%)	316 (37%)	305 (36%)	363 (43%)	308 (36%)	292 (34%)
Up to primary	273 (32%)	246 (29%)	224 (26%)	261 (31%)	257 (30%)	233 (27%)
Up to secondary	202 (24%)	213 (25%)	244 (29%)	173 (20%)	234 (28%)	264 (31%)
Above secondary	75 (9%)	69 (8%)	76 (9%)	53 (6%)	51 (6%)	61 (7%)
Education level of mother						
No education	277 (33%)	248 (29%)	243 (29%)	267 (31%)	212 (25%)	195 (23%)
Up to primary	279 (33%)	286 (34%)	277 (33%)	302 (36%)	292 (34%)	275 (32%)
Up to secondary	274 (32%)	286 (34%)	297 (35%)	261 (31%)	327 (38%)	340 (40%)
Above secondary	18 (2%)	24 (3%)	32 (4%)	20 (2%)	19 (2%)	40 (5%)
Number of children under 5, Mean (SD)	1.3 (0.5)	1.2 (0.5)	1.3 (0.5)	1.2 (0.5)	1.2 (0.5)	1.2 (0.5)
Wealth quintile						
Poorest	164 (19%)	174 (21%)	152 (18%)	187 (22%)	180 (21%)	160 (19%)
Lower middle	179 (21%)	160 (19%)	133 (16%)	207 (24%)	174 (20%)	166 (20%)
Middle	167 (20%)	171 (20%)	174 (20%)	166 (20%)	177 (21%)	163 (19%)
Upper middle	163 (19%)	176 (21%)	188 (22%)	152 (18%)	164 (19%)	176 (21%)
Richest	175 (21%)	163 (19%)	202 (24%)	137 (16%)	155 (18%)	185 (22%)
Occupation						
Daily wage labour	150 (18%)	207 (25%)	189 (22%)	250 (29%)	161 (19%)	194 (23%)
Other	20 (2%)	17 (2%)	14 (2%)	18 (2%)	31 (4%)	24 (3%)
Farmer/Cultivator/ Homemaker	197 (23%)	212 (25%)	167 (20%)	164 (19%)	233 (27%)	219 (26%)
Service	89 (10%)	72 (9%)	103 (12%)	57 (7%)	78 (9%)	99 (12%)
Skilled worker	87 (10%)	76 (9%)	89 (10%)	94 (11%)	81 (10%)	97 (11%)
Rickshaw/Van puller	81 (10%)	62 (7%)	69 (8%)	82 (10%)	61 (7%)	44 (5%)
Trade/Business	179 (21%)	133 (16%)	162 (19%)	129 (15%)	133 (16%)	126 (15%)
Staying abroad	45 (5%)	65 (8%)	56 (7%)	56 (7%)	72 (8%)	47 (6%)
Proportion of households who own						
House	801 (94%)	783 (93%)	778 (92%)	783 (92%)	786 (92%)	781 (92%)
Electricity	353 (42%)	409 (48%)	420 (49%)	345 (41%)	405 (48%)	465 (55%)
Radio	179 (21%)	185 (22%)	109 (13%)	108 (13%)	35 (4%)	47 (6%)
Television (b/w)	168 (20%)	154 (18%)	160 (19%)	136 (16%)	92 (11%)	103 (12%)
Television (colour)	65 (8%)	82 (10%)	90 (11%)	76 (9%)	137 (16%)	161 (19%)
Refrigerator	17 (2%)	22 (3%)	29 (3%)	28 (3%)	41 (5%)	61 (7%)
Mobile phone	246 (29%)	252 (30%)	428 (50%)	325 (38%)	654 (77%)	672 (79%)
Number of rooms in house, Mean (SD)	2.1 (1.3)	2.1 (1.3)	2.0 (1.3)	1.8 (1.2)	2.8 (0.7)	2.8 (0.8)
Amount of homestead land, Mean (SD)	0.2 (0.5)	0.2 (0.5)	1.3 (34.3)	0.1 (0.3)	1.6 (2.0)	1.7 (2.2)
Amount of non-homestead land, Mean (SD)	0.8 (2.1)	0.9 (2.5)	0.7 (1.5)	1.8 (34.3)	1.4 (2.1)	1.8 (2.4)

TABLE 3 Water, sanitation, and handwashing indicators at baseline (2007), midline (2009), and endline (2012), with adjusted DID estimates[a]

	Intervention			Control			Adjusted		Adjusted	
	2007 ($N = 848$)	2009 ($N = 849$)	2012 ($N = 850$)	2007 ($N = 844$)	2009 ($N = 850$)	2012 ($N = 850$)	DID, 2012 vs 2007	95% CI	DID, 2012 vs 2009	95% CI
Water										
Recalls being taught messages about clean water use and storage	72%	80%	76%	70%	66%	63%	0.16	0.01 to 0.32	0.02	−0.14 to 0.18
Uses covered container to store water	31%	39%	20%	38%	41%	23%	0.07	−0.3 to 0.44	−0.11	−0.47 to 0.25
Uses improved water sources for preparing food	77%	77%	75%	84%	82%	82%	0.03	−0.17 to 0.24	−0.01	−0.22 to 0.2
Sanitation										
Uses improved latrine	45%	38%	44%	39%	38%	40%	−0.02	−0.22 to 0.19	0.25	0.02 to 0.47
Latrine is clean	31%	42%	51%	35%	43%	49%	0.14	−0.09 to 0.37	0.15	−0.06 to 0.37
Handwashing and hygiene										
Recalls being taught messages about hygiene	72%	77%	78%	71%	64%	63%	0.19	0.04 to 0.34	0.04	−0.12 to 0.2
Recalls it is important to wash hands before preparing food	42%	36%	37%	47%	33%	33%	0.23	0.01 to 0.46	0.08	−0.16 to 0.32
Reports washing hands before preparing food	9%	14%	14%	7%	11%	12%	−0.01	−0.52 to 0.49	−0.08	−0.55 to 0.39
Has a handwashing station within 10 ft of toilet	59%	61%	52%	60%	49%	55%	−0.01	−0.18 to 0.16	−0.19	−0.37 to −0.01
Soap and water available at handwashing station	40%	31%	34%	42%	27%	30%	0.22	−0.0 to 0.48	0.14	−0.15 to 0.43
Has soap in the house	25%	36%	32%	22%	34%	31%	−0.05	−0.3 to 0.2	0.07	−0.16 to 0.31

[a]For additional outcomes and unadjusted DID values, see Appendix Table B1.

TABLE 4 Rate of participants washing both hands during structured observation at baseline, midline and endline

	Intervention			Control			Adjusted DID estimate (95% CI)	Adjusted DID estimate (95% CI)
	2007 ($N = 10,348$)	2009 ($N = 11,996$)	2012 ($N = 8616$)	2007 ($N = 10,038$)	2009 ($N = 11,904$)	2012 ($N = 8138$)	2012 vs 2007	2012 vs 2009
Before preparing food	243/1003 (24%)	375/1238 (30%)	254/788 (32%)	227/831 (27%)	346/1168 (30%)	215/800 (27%)	0.33 (0.04 to 0.62)	0.21 (−0.06 to 0.47)
Before serving food	195/872 (22%)	282/1103 (26%)	241/808 (30%)	163/845 (19%)	253/1035 (24%)	204/730 (28%)	−0.05 (−0.31 to 0.22)	0.09 (−0.16 to 0.33)
Before eating	174/3472 (5%)	300/4162 (7%)	277/2801 (10%)	156/3563 (4%)	277/4314 (6%)	227/2636 (9%)	0.04 (−0.29 to 0.38)	0.05 (−0.23 to 0.33)
After eating	246/2795 (9%)	297/2438 (12%)	293/2010 (15%)	190/2633 (7%)	283/2581 (11%)	236/1981 (12%)	0 (−0.3 to 0.3)	0.13 (−0.13 to 0.39)
Before feeding a child	49/813 (6%)	98/1264 (8%)	99/1004 (10%)	41/871 (5%)	96/1255 (8%)	125/998 (13%)	−0.44 (−0.97 to 0.09)	−0.09 (−0.52 to 0.33)
After cleaning a defecated baby	87/208 (42%)	113/191 (59%)	92/139 (66%)	101/199 (51%)	97/183 (53%)	67/131 (51%)	0.41 (0.12 to 0.7)	0.21 (−0.07 to 0.5)
After defecation	55/172 (32%)	73/151 (48%)	85/191 (45%)	72/177 (41%)	61/152 (40%)	58/121 (48%)	0.22 (−0.24 to 0.67)	−0.02 (−0.46 to 0.41)
After returning from outside compound	228/1013 (23%)	264/1449 (18%)	195/875 (22%)	195/919 (21%)	246/1216 (20%)	152/741 (21%)	0.11 (−0.21 to 0.42)	0.25 (−0.03 to 0.53)

from experts at the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), UNICEF, University at Buffalo-USA and University of Southampton-UK [23].

Households were observed for 5 h, from 8:00 or 9:00 AM until 1:00 or 2:00 PM. Field workers observed all household members and noted handwashing at key times: before preparing food, before eating or feeding a child, after defecating, and after cleaning a child's anus.

Measurement of outcomes: Cross-sectional survey

At baseline, midline and endline, after the structured observation had been conducted, the field worker team administered a face-to-face survey which included questions on demographics, physical assets, handwashing, water usage, and familiarity with WASH messages. After the interview, the field worker performed a spot check on observable items. Classification of WASH indicators is detailed in Appendix A1.

Measurement of outcomes: Monthly health surveillance

Trained enumerators visited households to administer a health questionnaire in the first week of every month. Data were collected for 24 months during Phase 1 and for 18 months from a separate sample of households during Phase 2. The questionnaire inquired about episodes of diarrhoea in each child <5 years of age during the last 2 days and last 2 weeks. Diarrhoea was defined as three or more loose or watery stools in one 24-h period.

Sample size selection

Sample size calculations are detailed in Appendix A2 and the midline evaluation [18]. From the calculations, the team aimed to enrol 1700 households for cross-sectional surveys, 1000 for structured observations and 1000 for health surveillance.

Statistical analysis

To assess changes in knowledge, reported behaviour, and structured observation, the analysis used difference-in-differences (DID) with generalised estimating equations (GEE) to account for intra-cluster correlation. This DID analysis was conducted separately for baseline versus endline data, as well as midline versus endline data.

To account for the repeated observations in the sentinel health surveillance, we used GEE to calculate the cluster-adjusted rate ratios (RR) and 95% confidence intervals (CI). Separate analyses were run on each intervention phase and on diarrhoea within the past 2 days and past 2 weeks.

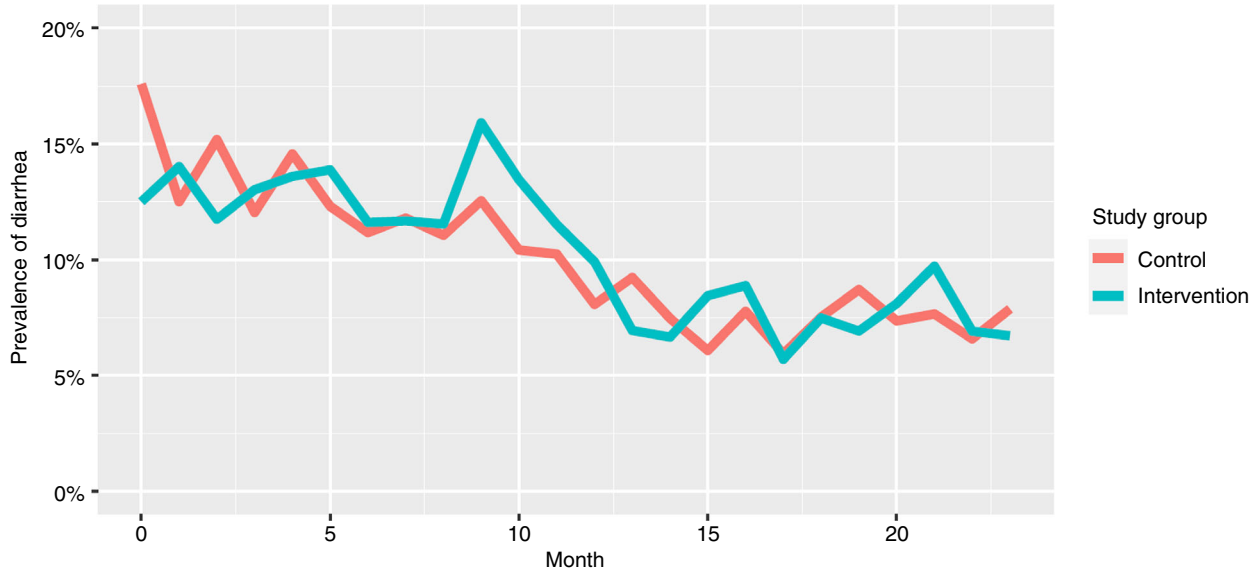

FIGURE 2 Prevalence of diarrhoea in the past 2 days in intervention versus control groups, 2007–2009. Figures with point-wise confidence intervals included in Appendix Figures B1–B4.

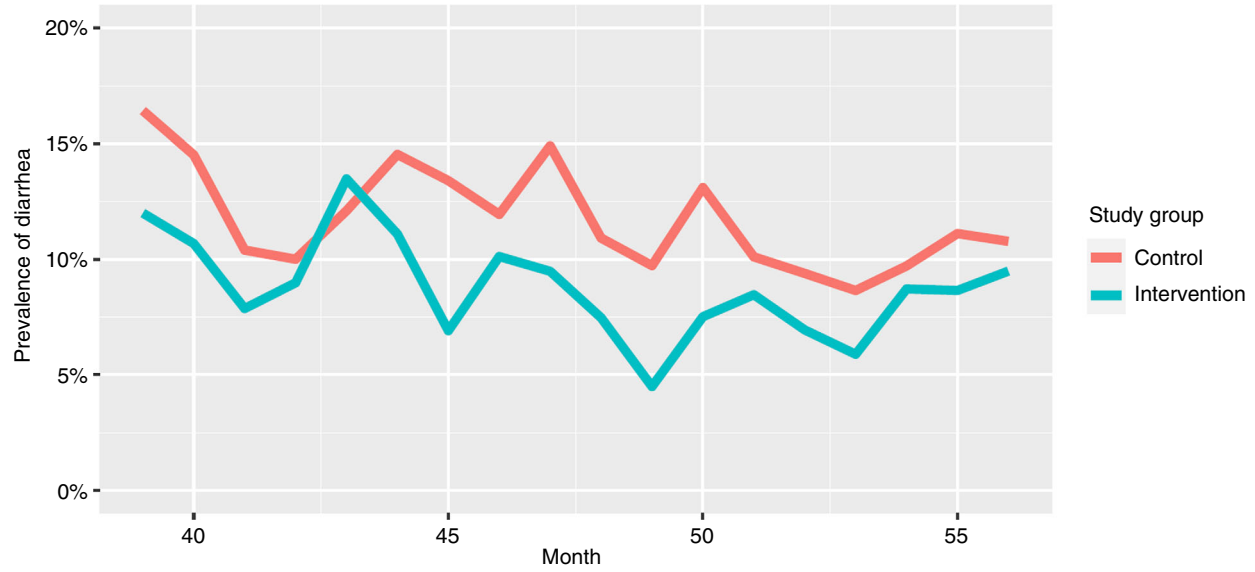

FIGURE 3 Prevalence of diarrhoea in the past 2 days in intervention versus control groups, 2011–2012. Figures with point-wise confidence intervaβls included in Appendix Figures B1–B4.

Adjusted models for both DID and health surveillance models accounted for the child's age and sex, household wealth, mother's education, and a number of children in the household, which have been previously associated with childhood diarrhoea [24–31]. All analysis was conducted using RStudio Version 1.4.1106.

Human subject protection

All participants provided written informed consent. The Government of Bangladesh Department of Public Health Engineering, UNICEF, and icddr,b administration approved the study protocol.

RESULTS

The field team visited a total of 2547 intervention and 2544 control households. There were minimal differences in household characteristics between intervention and control groups at each time point (Table 2). About one-third of parents received no education, one-third attended some primary school, and one-third attended some secondary

TABLE 5 The effect of SHEWA-B intervention on rates of diarrhoea in rural Bangladesh, Phase 1 and Phase 2

	Unadjusted RR (95% CI), *p-value*	Adjusted[a] RR (95% CI), *p-value*
Phase 1 (2007–2009)		
Diarrhoea in past 2 days	1.01 (0.99–1.03), 0.502	1.00 (0.97–1.03), 0.985
Diarrhoea in past 2 weeks	1.01 (0.99–1.03), 0.208	1.01 (0.99–1.03), 0.228
Phase 2 (2011–2012)		
Diarrhoea in past 2 days	1.00 (0.97–1.03), 0.953	1.00 (0.97–1.03), 0.985
Diarrhoea in past 2 weeks	1.00 (0.97–1.02), 0.776	1.00 (0.97–1.02), 0.844

Abbreviation: RR, rate ratio.
[a]Adjusted model includes child's age and sex, household wealth quintile, mother's education, and number of children in the household, which have been previously associated with childhood diarrhoea.

TABLE 6 Adjusted models for effect of SHEWA-B on childhood diarrhoea in the past 2 days, Phase 1 and Phase 2

	Rate ratio (95% CI)	*p*-Value
Phase 1 (2007–2009)		
Intervention × Month of intervention	1.01 (0.99–1.03)	0.496
Intervention	1.06 (0.74–1.51)	0.746
Month of intervention	0.97 (0.95–0.98)	<0.001
Child is <24 months of age	1.25 (1.12–1.39)	<0.001
Child is male	1.1 (1–1.21)	0.04
Wealth quintile		
1st quintile (poorest)	Ref	0.077
2nd quintile	1.17 (0.98–1.4)	0.379
3rd quintile	1.08 (0.91–1.29)	0.335
4th quintile	0.9 (0.74–1.11)	0.868
5th quintile (richest)	0.98 (0.79–1.22)	
Mother had at least 4 years of education	0.86 (0.77–0.97)	0.013
Number of children in the household	1.08 (0.97–1.2)	0.151
Phase 2 (2011–2012)		
Intervention × Month of intervention	1.00 (0.97–1.03)	0.985
SHEWA-B I = intervention	0.78 (0.21–2.95)	0.064
Month of intervention	0.98 (0.96–1)	0.029
Child is <24 months of age	1.27 (1.12–1.44)	<0.001
Child is male	1.01 (0.9–1.13)	0.828
Wealth quintile		
1st quintile (poorest)	Ref	Ref
2nd quintile	1.11 (0.93–1.33)	0.236
3rd quintile	1.04 (0.85–1.27)	0.728
4th quintile	1.01 (0.84–1.21)	0.939
5th quintile (richest)	1.1 (0.9–1.34)	0.368
Mother had at least 4 years of education	0.95 (0.83–1.1)	0.502
Number of children in the household	0.95 (0.86–1.04)	0.278

Abbreviation: RR, rate ratio.

school. Access to electricity, television, and mobile phones was low, but increased in both groups over the study period.

WASH knowledge and technology at home were low across all time points (Table 3). Of the 5091 households surveyed, 38% of participants recalled that it is important to wash hands before preparing food and 11% of participants reported handwashing before preparing food. Just 34% of households had a handwashing station with soap and water available near their toilet. Less than one-third reported soap available in the house.

Overall, residing in a SHEWA-B intervention cluster was not associated with major changes in knowledge, reported behaviour, or use of WASH technology compared to the control cluster (Table 3). This was the case when comparing the endline to either baseline or midline. Comparing endline to baseline, intervention clusters showed a greater increase in the proportion of participants who recalled being taught messages about clean water and recommended hygiene and that handwashing before preparing food is important. However, they did not show improvements in the use of covered water containers, use of improved water sources, other handwashing knowledge, or availability of soap at critical locations, compared to control clusters. Comparing the endline to the midline, intervention clusters showed a greater increase in the use of improved latrines, but there were no differences in changes to any other indicators.

During structured observation, the rates of handwashing before preparing food, before eating and before feeding a child were low at all time points (Table 4). Comparing endline to baseline, living in an intervention cluster was associated with a modest improvement in handwashing before preparing food (adjusted DID 0.33, CI [0.04–0.62]) and after cleaning a baby who had defecated (adjusted DID 0.41 [0.12–0.70]) when compared to living in a control cluster. However, residing in a SHEWA-B intervention cluster was not associated with improvements in any other handwashing domain. Further, intervention households showed no greater improvements compared to control households when comparing endline to midline observations. All unadjusted DID estimates are reported in Appendix Tables B2–B4.

During Phase 1, the longitudinal prevalence of diarrhoea among children in the past 2 days was 10.2% in the intervention group and 10.0% in the control. The prevalence remained similar in both intervention and control communities throughout Phase 1 (Figure 2). During Phase 2, with a new study sample, intervention households started with a lower diarrhoea prevalence at 8.8% compared to 11.7% in control households. However, the intervention group showed no improvement over time compared to the control (Figure 3). Living in an intervention cluster was not associated with a greater decrease over time in child diarrhoea in

the past 2 days, even after accounting for the child's age and sex, household wealth, mother's education and the number of children in the household (Phase 1 RR 1.00 [0.97–1.03], Phase 2 RR 1.00 [0.97–1.03]) (Table 5). Results were similar to the outcome of diarrhoea in the past 2 weeks (Appendix Figures B2 and B4).

In both phases, the prevalence of diarrhoea decreased over time in months (Phase 1 RR 0.97 95% CI [0.96–0.98], Phase 2 RR 0.98 [0.97–0.99]) (Table 6). Children under 24 months of age were more likely to have diarrhoea than older children (Phase 1 RR 1.25 [1.12–1.39], Phase 2 RR 1.27 [1.12–1.44]). During Phase 1, children were less likely to have diarrhoea if their mother had at least 4 years of education (RR 0.86 [0.77–0.97]).

CONCLUSIONS

After 5 years, the SHEWA-B community-based WASH promotion intervention did not have the intended effect on knowledge, behaviour or childhood diarrhoea despite changes made to the intervention at the midline. Comparing endline to baseline, the intervention group showed minimal improvement compared to the control group in WASH knowledge. The intervention group showed an increase in observed handwashing before preparing food and after cleaning a child's anus at the endline compared to baseline, but not when compared to the midline. The analysis found no reduction in diarrhoea among children in intervention households in either phase. Thus, the modifications to the CHP component of SHEWA-B after the midline evaluation were ineffective at achieving the programme's goals.

SHEWA-B's lack of impact on knowledge, behaviour, or health may reflect sub-optimal implementation. An evaluation of SHEWA-B implementation demonstrated that only 47% of intervention households surveyed in 2011 and 2012 had met a CHP, suggesting that the programme was not available to everyone in intervention clusters as intended [32]. When asked, only 47% of CHPs could recall all key programme messages [32].

CHWs, the government- or NGO-hired counterparts to SHEWA-B's CHPs, tend to be more effective when they have a manageable workload, organised tasks, reasonable goals, supportive supervisors and community respect [33]. A qualitative study in Bangladesh found that financial incentives and feeling needed by the community were among the top factors cited for continuing as a CHW [34]. In contrast to the ideal CHW set-up, SHEWA-B's CHPs had a considerable workload, with a target of reaching 2000 individuals every 2 months. They were paid approximately one-half the payment of an unskilled labourer working full time [18]. Thus, the sub-optimal quality of CHPs could be due to insufficient training, supervision, targets or incentives for performance [32].

There is limited evidence on how to best scale WASH promotion interventions to achieve health outcomes. While current evidence is mixed, evaluations of large programmes have generally failed to show health benefits. The Global Scaling Up Handwashing Project in Peru improved knowledge, availability of soap, and handwashing, but did not improve diarrhoea or pathogen prevalence [14]. Similarly, studies on the Total Sanitation Campaign in India did not show changes in child health outcomes, including diarrhoea, parasitic infections, anaemia or growth [35, 36].

There are large CHW programmes that have improved health through community-level health promotion. Brazil adopted the Family Health Programme (FHP), which assigned a multidisciplinary team including CHWs to a geographic area to prevent and treat infectious diseases [37]. Areas with higher FHP coverage had a 31% reduction in diarrheal disease mortality [37]. In Bangladesh, Building Resources Across Communities (BRAC) employed CHWs to provide intensive WASH education, which lowered diarrhoea prevalence and increased the use of latrines [38, 39].

Unlike SHEWA-B, both FHP and BRAC employed full-time CHWs and set realistic, attainable goals. FHP paid CHWs approximately $190 USD per month and BRAC paid CHWs at least minimum wage [40, 41]. Higher pay suggests that these programmes invested more in CHWs than SHEWA-B did in its CHPs. FHP CHWs were limited to covering 150 families per month, compared to SHEWA-B's goal of each CHP targeting over 1000 individuals per month. Despite the changes made between Phase 1 and Phase 2, the task that the CHPs faced remained substantial in terms of the number of messages to deliver and the number of people targeted. The focused scope of FHP CHWs may have helped increase implementation quality compared to SHEWA-B CHPs who executed their tasks poorly [32]. These examples suggest that it may be possible for community-based WASH promotion to produce health outcomes, but adequate incentives and achievable goals may be critical to success. Further research should focus on the elements of successful programmes and implementation strategies.

Beyond the quality of CHWs, the implementation of large-scale WASH interventions may be influenced by political, economic and institutional constraints [42, 43]. A study on the effectiveness of WASH-related foreign aid suggested that in low-income countries, government ineffectiveness and regulatory quality were major constraints on the effectiveness of WASH aid [42].

Bangladesh is a low-middle-income country with consistently low government effectiveness scores and high perceived corruption. In 2020, Bangladesh's government effectiveness score was 0.79 standard deviations below the worldwide average [44]. Among 49 lower middle-income countries, Bangladesh ranked 38th in government effectiveness, and among 192 countries worldwide, it ranked 153rd [44]. On the corruption perception index, in which higher scores suggest lower perceived corruption, Bangladesh ranked 37th out of 46 lower middle-income countries and 144th out of 177 total countries [45]. These constraints may have contributed to SHEWA-B's implementation difficulties.

SHEWA-B's lack of successful behaviour change and health outcomes may have been surprising given the success of its 3-year pilot study [18, 22]. However, the pilot

evaluated effectiveness based on improvements in reported handwashing behaviour, a highly biased indicator [46, 47]. Thus, the pilot may have been thought to be highly effective, but the impact was likely a reflection of courtesy bias.

In contrast to the CHP component of SHEWA-B, the SHEWA-B mass media campaign launched in response to disappointing midline results improved recall of WASH messages and observed behaviour [20]. While mass media require a high skill investment in producing content, there is less variability in implementation and greater reach, since one message can be aired across a region. Mass media campaigns have improved many health behaviours, including tobacco use, alcohol use, and cancer screening [48]. In Ghana, a handwashing campaign utilising mass media increased reported handwashing with soap [49].

This evidence suggests that mass media could be a better investment for WASH promotion than interpersonal approaches in areas where in-person implementation quality may be limited. Unfortunately, some rural populations may not have access to radio, television, or the internet [49]. Furthermore, in Tanzania, households exposed to both mass media and in-person interventions had the most favourable outcomes, suggesting that a combination may be particularly effective [15]. Further research could clarify when multiple channels of communication are most effective and when interpersonal communication is more likely to be cost-effective.

This study has several limitations. First, a new sample was drawn for each cross-sectional survey and structured observation, limiting the comparison of individual households over time. However, demographics, including education, number of children and occupation, remained similar, suggesting that the populations were comparable (Table 2). Further, drawing new samples minimises measurement of behaviour change caused by learning from survey questions rather than the intervention.

Even when hearing survey questions for the first time, self-reported knowledge, behaviour, and health outcomes may be subject to reporting biases. Social desirability bias occurs when participants provide answers assumed to be more acceptable, such as reporting handwashing behaviours. To counter biases, the team conducted spot checks to confirm verifiable answers. While reported health may be subject to recall bias, using diarrhoea in the past 2 days minimises recall errors compared to longer time periods [50].

Third, associations may be confounded by unmeasured differences between intervention and control, especially because intervention locations were subjectively chosen through government identification of high-need sub-districts. To minimise differences, controls were matched to intervention clusters using geography, hydrogeology, infrastructure, agricultural productivity and household construction, but residual confounding is possible.

SHEWA-B was one of the largest WASH interventions implemented in an LMIC, yet its main WASH promotion component did not yield the expected effect on knowledge, behaviour, or health. In contrast, the SHEWA-B mass media intervention and other government-driven long-term WASH programmes have improved behaviour. SHEWA-B demonstrates that interpersonal communication to facilitate behaviour change is expensive and requires high-quality deployment to improve WASH behaviours. In settings where political, economic and institutional constraints increase the risk of poor implementation, mass media may be a better investment.

Given the lack of evidence to support the effectiveness of large-scale community-based WASH interventions in countries with such constraints, priority should be given to approaches that have demonstrated effectiveness. Unfortunately, most programmes are not vigorously evaluated by an independent external evaluator, making them difficult to learn from. The SHEWA-B evaluation provided definitive evidence that the interpersonal intervention did not induce behaviour change, while the mass media did. Prioritising critical evaluations of future WASH programmes will help broaden the evidence base to improve large-scale programmes.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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