

Risk factors for diarrhoea and respiratory illness and the impact of water and hygiene interventions

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A thesis submitted for the degree of Doctor of Philosophy



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List of abbreviations, terms and definitions

AF	Attributable Fraction
BDM	Becker-DeGroot-Marschak
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
DSK	Dustha Shasthya Kendra
EED	Environmental Enteric Dysfunction
GI	Gastrointestinal
icddr,b	International Center for Diarrhoeal Disease Research, Bangladesh
ICVB	Introduction of Cholera Vaccine in Bangladesh
IVI	International Vaccine Institute
IBM-WASH	Integrated Behavioural Model for Water Sanitation and Hygiene
PDA	Personal Digital Assistant
POU	Point Of Use
PID	Patient Identification Number
RCT	Randomised Control Trial
RR	Risk Ratio
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WTP	Willingness to Pay

Abstract

Diarrhoea and respiratory diseases are common and cause substantial morbidity and economic loss globally. The objectives of this thesis are to identify risk factors for diarrhoea and respiratory illness, to understand the usage and impact of a range of interventions for prevention of these illnesses and to understand consistency of reported health data to assess the impact of interventions.

To address the specific objectives, data were used from three different studies:

a) A follow-up study of an RCT conducted in low-income communities of Bangladesh in 2010 which assessed motivators and barriers of the sustained use of a CrystalPUR siphon water filter;

b) A non-blinded RCT with three different groups [cholera-vaccine-only; vaccine-plus-behaviour-change (promotion of hand-washing with soap plus chlorination of drinking water at compound level); and control], conducted from 2011-2013 in Bangladesh among >60,000 households, which examined the impacts of water treatment and hygiene interventions on diarrhoea-associated hospitalisation and on reported respiratory illness, and which also examined the consistency of reported diarrhoea data used to assess impact of interventions on health. In this third study, reported diarrhoea data were collected through two different surveys and were compared: ‘census’ data were collected every six months from each household, and ‘monthly-survey’ data were collected every month from a different subset of randomly selected households. Reported data were also compared with objectively measured diarrhoea associated-hospitalisation in the same study.

c) A double-blinded randomized controlled trial (RCT) which prospectively and concurrently assessed risk factors for diarrhoea, respiratory and dermal illnesses in South Australia from June-2007 to August-2008;

The key findings of this thesis and their interpretations are summarised below:

- From the follow-up study of the RCT conducted in 2010 in Bangladesh, approximately a quarter of households were using the CrystalPur siphon water filter regularly during the three-month follow-up visit, but regular usage decreased to approximately one-fifth during the six-month follow-up visit. The positive predictors of regular filter usage were: willingness to pay >US\$1 for filters, positive attitude towards filter use, reporting boiling drinking water at baseline and Bengali ethnicity. Frequently reported barriers to regular filter use were considering filter use an additional task, filter breakage and time required for water filtering. Given the low regular usage rate and the hardware-related problems reported, the contribution of siphon filters to improving water quality in low-income urban communities in Bangladesh is likely to be minimal.
- In the large scale RCT that was conducted in Bangladesh from 2011 to 2013, no impact of interventions was observed on objectively assessed diarrhoea-associated hospitalisation or reported respiratory illness. However, those who actually had a hand-washing station with soap and water had less respiratory illness. One of the most important underlying reasons for lack of intervention impact on diarrhoea and respiratory illness was low uptake of behavioural interventions in this large scale trial. This indicates the difficulty of bringing behaviour change interventions to scale. Additionally from this non-blinded RCT it was found that rates of reported diarrhoea data collected through two different surveys were inconsistent. Lower reported diarrhoea prevalence was reported by the group which received vaccine-plus-

behaviour-change compared to the control group when the monthly survey data were analysed, but this difference in prevalence between the groups was not found using the 6 monthly census data. This emphasizes the importance of assessing objective outcomes along with reported outcomes from non-blinded trials.

- The study conducted in South Australia identified that the risk of having diarrhoea and respiratory illness was similar among childcare/kindergarten attendees.

Swimming in public pools/spas in the current or previous week was associated with diarrhoea, respiratory and dermal symptom complexes, conferring similar risk for each. Household clustering of diarrhoea and respiratory symptoms was common, and clustering of respiratory symptoms correlated with number of individuals per household. This simultaneous examination of risk factors for three health outcomes provided novel comparative results useful for prioritizing prevention strategies.

Cost effective water, sanitation and hygiene (WASH) interventions such as treating water at point-of-use or improving hygiene behaviour are still not adequately reaching the poor who need them the most. Upscaling effective low-cost interventions is essential if WASH targets are to be met by 2030. Findings from this thesis could potentially help future researchers to improve selection and implementation of water treatment and hygiene interventions at the community level and could also help to better facilitate allocation of resources in preventing diarrhoea and respiratory illness. Further research is necessary to understand the reasons for poor uptake of the pre-tested effective interventions and how behaviour change interventions with high quality could be delivered at a larger scale. Community-level interventions that are affordable and prevent infection from multiple pathogens by reliably separating faeces from the environment, food and water remain important areas for future research.

General Declaration

Monash University

Declaration for thesis based on published work

In accordance with Monash University Doctorate Regulation 17.2 Doctor of Philosophy and Research Master's regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes five original papers published in peer reviewed journals. The core theme of the thesis is to understand the risk factors for diarrhoea and respiratory illness and the impact of water and hygiene interventions on prevention of these illnesses. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the Department of Epidemiology and Preventive Medicine, Monash University under the supervision of Professor Karin Leder, Professor Andrew Forbes and Professor Stephen P. Luby. The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

Signed:

Print Name: Nusrat Najnin

Date: 15/07/2019

Publications during enrolment

Listed below are the publications that are relevant to the period of candidature.

Publications relevant to the thesis

I have published the following papers during my candidature

- 1 **Najnin, N.**, Forbes, A., Sinclair, M., & Leder, K. (2014). Risk factors for community-based reports of gastrointestinal, respiratory, and dermal symptoms: findings from a cohort study in Australia. *Journal of Epidemiology*, 24(1), 39.
- 2 **Najnin N**, Arman S, Abedin J, Unicomb L, Levine DI, Mahmud M, et al. Explaining low rates of sustained use of siphon water filter: evidence from follow-up of a randomised controlled trial in Bangladesh. *Tropical Medicine & International Health*. 2015;20(4):471-83.
- 3 **Najnin N**, Leder K, Qadri F, Forbes A, Unicomb L, Winch PJ, et al. Impact of adding hand-washing and water disinfection promotion to oral cholera vaccination on diarrhoea-associated hospitalization in Dhaka, Bangladesh: evidence from a cluster randomized control trial. *International Journal of Epidemiology*. 2017;46 (6):2056-66.
- 4 **Najnin N**, Leder K, Forbes A, Unicomb L, Winch PJ, Ram PK, et al. Impact of a Large-Scale Handwashing Intervention on Reported Respiratory Illness: Findings from a Cluster-Randomized Controlled Trial. *Am J Trop Med Hyg*. 2019;100 (3):742-9.
- 5 **Najnin N**, Leder K, Forbes A, Unicomb L, Qadri F, Ram PK, et al. Inconsistency in Diarrhea Measurements when Assessing Intervention Impact in a Non-Blinded Cluster-Randomized Controlled Trial. *Am J Trop Med Hyg*. 2019;101(1):51-8.

Additional peer-reviewed publications from collaborative work during candidature period (not related to thesis; papers have been included in appendix 1)

1. Amin, N., Pickering, A. J., Ram, P. K., Unicomb, L., **Najnin, N.**, Homaira, N., ... Luby, S. P. (2014). Microbiological Evaluation of the Efficacy of Soapy Water to Clean Hands: A Randomized, Non-Inferiority Field Trial. *The American Journal of Tropical Medicine and Hygiene*, 91(2), 415–423. <http://doi.org/10.4269/ajtmh.13-0475>
2. Smith BJ, Cheung NW, **Najnin N**, Bauman A, Razee H, Blignault I, et al. Reliability and Validity of Measures for Investigating the Determinants of Health Behaviors Among Women With a History of Gestational Diabetes. *Health Education & Behavior*. 2018;45(1):43-51.
3. Wichaidit W, Biswas S, Begum F, Yeasmin F, Nizame FA, **Najnin N**, et al. Effectiveness of a large-scale handwashing promotion intervention on handwashing behavior in Dhaka, Bangladesh. *Tropical medicine & international health: TM & IH*. 2019. [doi: 10.1111/tmi.13277. [Epub ahead of print]]

Thesis including published works declaration

In the case of Chapters 4, 5, 6, 7 and 8 my contribution to the work involved the following:

Thesis Chapter	Publication Title	Publication Status	Nature and extent of candidate's contribution
4	Explaining low rates of sustained use of siphon water filter: evidence from follow-up of a randomised controlled trial in Bangladesh.	Published Tropical Medicine & International Health 2015	80% Study design, literature review, statistical analysis and interpretation of results, development and writing the manuscript.
5	Impact of adding hand-washing and water disinfection promotion to oral cholera vaccination on diarrhoea-associated hospitalization in Dhaka, Bangladesh: evidence from a cluster randomised control trial	Published International Journal of Epidemiology 2017	80% Study design, literature review, statistical analysis and interpretation of results, development and writing the manuscript.
6	Inconsistency in diarrhoea measurements when assessing intervention impact in a cluster randomised trial	Published American Journal of Tropical Medicine and Hygiene 2019	80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript

Thesis Chapter	Publication Title	Publication Status	Nature and extent of candidate's contribution
7	Impact of a large-scale hand washing interventions on reported respiratory illness: findings from a cluster randomised control trial	Published American Journal of Tropical Medicine and Hygiene 2019	80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript.
8	Risk factors for community-based reports of gastrointestinal, respiratory, and dermal symptoms: findings from a cohort study in Australia.	Published Journal of Epidemiology 2014	80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript.

Student signature:

Date: 15/07/2019

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature:

Date: 22/07/2019

Dedication

This thesis is dedicated to Dr. Stephen P Luby. He is a blessing in my life. His mentorship has been an invaluable gift for me for more than a decade. Without his inspiration and continuous support, I would have given up a long time ago.

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I express my deepest appreciation and gratitude to my supervisors Professor Karin Leder, Professor Andrew Forbes and Professor Stephen P. Luby for their suggestions, continued support with statistical analysis, constructive comments and valuable inputs in accomplishing my research thesis.

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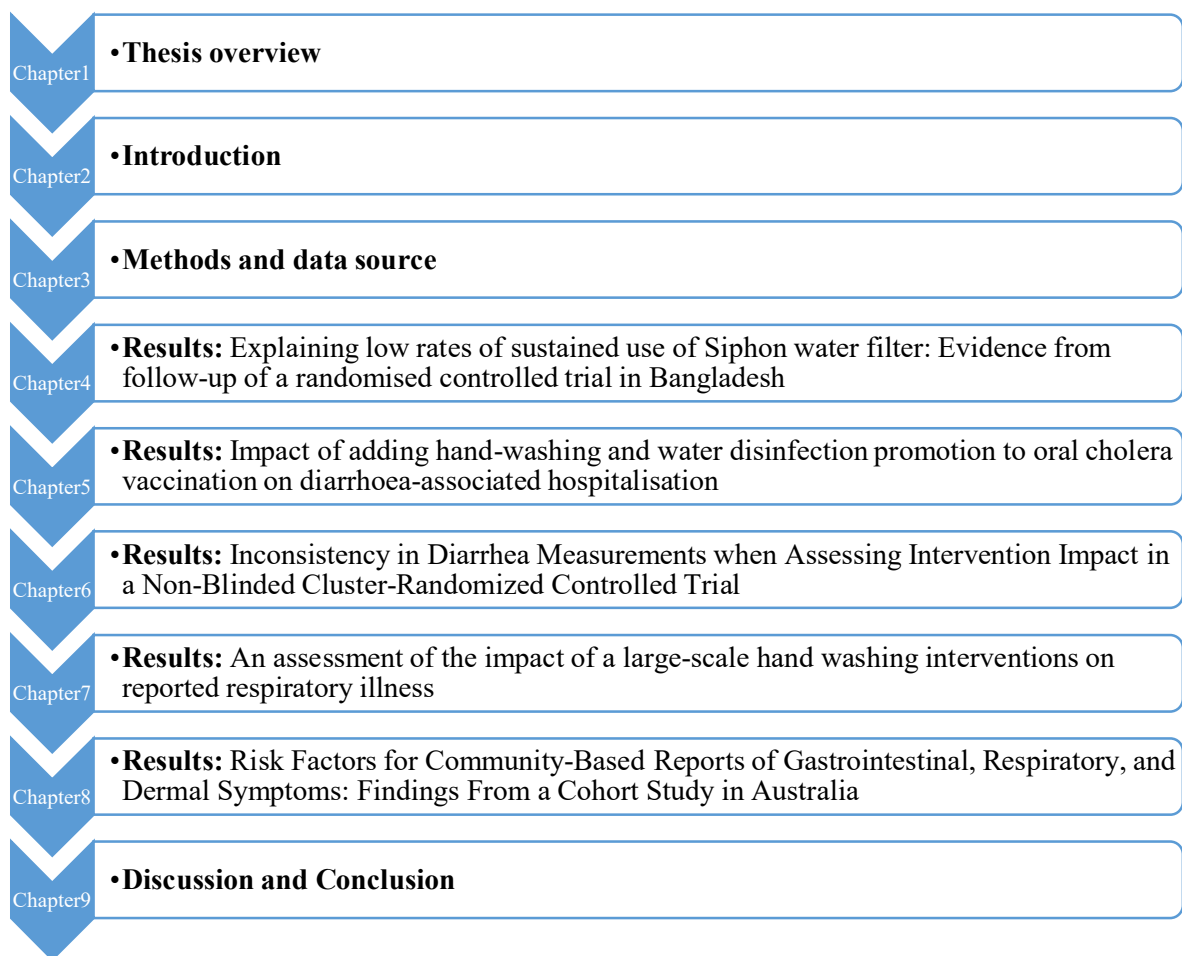
Furthermore, I am thankful to the staff and post-graduate students in the Department of Epidemiology and Preventive Medicine of the School of Public Health of the Monash University for their ongoing support.

I would like to convey my deepest thanks and gratitude to my parents, and all members of my family for their attention and support. Last but not least, I am grateful to my husband Dr. Enayet Karim Chowdhury for his generous contribution, encouragement, love and understanding in completing this mammoth task.

Chapter 1: Thesis overview

This thesis comprises of nine chapters to address the objectives. The chapters are outlined in Figure 1, followed by brief overview of each of the chapters.

Figure 1: Outline of thesis structure



Chapter 1 provides the outline and the overview of the thesis

Chapter 2 discusses the rationale and objectives of this thesis.

Chapter 3 provides a brief description of the sources of the data that I have used in the thesis to address different objectives. In this chapter, I include description of the study settings, study designs and enrolment participants in the study. This chapter also provides a brief description of different statistical methods used for data analysis. In addition, detailed analysis processes to address different objectives are discussed in the relevant chapters.

Chapter 4 presents findings from a study that revisited households that bought or were provided with a siphon water filter at the end of a randomised controlled trial to measure the filter's sustained use and to understand motivators and barriers to sustained use in the medium term (up to six months).

Chapter 5 reports finding of a pre-specified secondary outcome from a large scale randomised trial (conducted among ~60,000 low-income households of metropolitan Dhaka, Bangladesh), namely to examine effects of an intervention to promote hand-washing with soap and drinking water disinfection in addition to oral cholera vaccination on diarrhoea-associated hospitalization. This study provided us an opportunity to understand impact of a large scale hygiene behaviour change intervention in combination with cholera vaccine on an observable health indicator, namely diarrhoea-associated hospitalisation.

Chapter 6 aims to compare reported diarrhoea data collected through two separate survey methods, each of which was conducted on the same study population throughout the study period. The study explores whether data collected by two different data collection teams at different time points, from different households, using a similar but non-identical question substantially affects the overall measured reported diarrhoea for children aged ≤ 5 years. In this chapter, I also present comparisons of reported diarrhoea data with observed diarrhoea-

associated hospitalization rate for children ≤ 5 years to explore the consistency of reported data within a study in assessing intervention impact.

Chapter 7 presents findings of an assessment of impact of less intense hand-washing promotion on reported respiratory illness as a secondary outcome from among >60,000 low-income households enrolled in a cluster-randomised trial conducted in Bangladesh. In this study, I also examine whether the presence of soap and water at primary hand-washing stations is associated with a reduction in respiratory illness, irrespective of the intervention assignment of participants.

Chapter 8 aims to identify risk factors associated with diarrhoea, respiratory and dermal symptoms concurrently at the community level among a prospective cohort in a high-income country, Australia.

Chapter 9 is the final chapter which brings together the findings of Chapter 4 to 8. This chapter discusses the key results and conclusion from this research, strengths and limitations, implication of the findings for policy and practice, and scope for future research.

Chapter 2: Introduction

2.1 Chapter overview

Chapter 2 discusses the rationale and objectives of this thesis. In brief, this chapter gives an overview of the burden of diarrhoea and respiratory illness globally and especially in low-income countries such as Bangladesh. In this chapter, I also discuss usage and impact of a range of interventions on diarrhoea and respiratory illnesses in low-income communities and consistency of reported health data to assess the impact of interventions. For preventive measures to be effective in reducing diarrhoea and respiratory diseases, the design of interventions must be context specific, and it is crucial to understand relevant risk factors in varying settings. Consequently, to broaden my understanding about the risk factors for diarrhoea and respiratory illness in high-income countries, I also assessed risk factors for these diseases in the Australian context. Finally, in this chapter I discuss the specific objectives of the thesis.

2.2 Burden of diarrhoea and respiratory infections globally and in low-income countries

Diarrhoea and respiratory illnesses are common and cause substantial mortality, morbidity and economic loss globally (1-5). Over the last few decades there has been substantial reduction in diarrhoea related mortality globally (6, 7). The systematic analysis for the Global Burden of Disease Study 2017, published in the Lancet recently, shows that from the year 2007 to 2017 the age standardised deaths from diarrhoea has reduced by 30.2% (8). A systematic review of diarrhoea incidence in low and middle income countries in 1990 and 2010 showed that the estimated incidence declined from 3.4 episodes/child year in 1990 to 2.9 episodes/child year in 2010 (3). The authors concluded that that diarrhoea

incidence rates have declined slightly over time, but the total burden on the health of each child is still tremendous due to multiple episodes per year. Similarly mortality from lower respiratory infections in all age groups between the year 2007-2017 has reduced by 21.1% and from upper respiratory infections by 42.1% (8). Mortality from pneumonia in children <5 years of age has reduced from 1.7 million cases globally in 2000 to 1.3 million cases in 2011 (9). Nevertheless, respiratory infections remains as the major cause of death in children worldwide. In 2016, globally, the five leading causes of total years of life lost included diarrhoea and lower respiratory infections (10).

A higher proportion of these diseases and case fatalities occur in low-income countries compared to middle and high income countries (9, 11). For example, the incidence of pneumonia in low- and middle-income countries is estimated at 0.22 episodes per child year, compared to 0.015 episodes per child year in high-income countries (12). A cross sectional survey conducted during April and September 2010 in Dhaka Bangladesh among a population at high risk of diarrhoea reported that the prevalence of diarrhoea was 44.2 per 1000 persons among children <5 years of age (13). The burden of acute respiratory infection, particularly pneumonia, is also high in Bangladesh, where >10 million new cases of pneumonia occur in children <5 years of age annually (14).

Both of these infectious diseases, especially when recurrent, can contribute to under-nutrition and can adversely influence child development and human capital through different pathways (15, 16). Evidence from observational studies suggest that recurrent episodes of diarrhoea is associated with higher risk of stunting among children (15, 17-20), and this subsequently can lead to cognitive deficits later in life (21-23). The underlying pathophysiology could be that recurrent enteric infections reduce absorption of nutrients

through the intestinal tract and lead to growth faltering. Another major cause of growth faltering of children in low-income countries is environmental enteric dysfunction (EED). EED refers to an incompletely defined syndrome of inflammation, reduced absorptive capacity, and reduced barrier function in the small intestine (24-26). EED develops in early infancy presumably from ingestion of faecal microbes because of living in an environment with poor access to water, sanitation, and hygiene (WASH) services.

2.3 Pathogens causing diarrhoea and respiratory infections and the disease transmission pathways

Diarrhoea is usually a symptom of an infection in the intestinal tract. The World Health Organization (WHO) defines diarrhoea as the passage of three or more loose or liquid stools per day (27). Diarrhoea can be caused by different microorganisms (28). The Global Enteric Multicenter Study (GEMS), which was a 3-year, prospective, age-stratified, matched case-control study of moderate-to-severe diarrhoea in children aged 0–59 months residing at four sites in Africa and three in Asia aimed to identify the aetiology and population-based burden of paediatric diarrhoeal disease (29, 30). The study reported that the commonest causes of moderate-to-severe diarrhoea were due to four pathogens: rotavirus, *Cryptosporidium*, enterotoxigenic *Escherichia coli* producing heat-stable toxin (ST-ETEC; with or without co-expression of heat-labile enterotoxin), and *Shigella*. Other pathogens were important in selected sites (eg, *Aeromonas*, *Vibrio cholerae* O1, *Campylobacter jejuni*). The GEMS study assessed sanitation and hygiene at the household level and not at individual level. The sanitation and hygiene indicators in this study were of access, not behaviour (except child faeces disposal) and access does not always equate with use. The study concluded that interventions such as vaccination targeting specific pathogens and zinc supplementation could substantially reduce burden of moderate to

severe diarrhoea. However, non-severe diarrhoea episodes occurring at the community level are also of substantial public health importance because of their high prevalence and associated health consequences. The Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health and Development Project (MAL-ED) study, a multisite birth cohort study at eight sites in South America, sub-Saharan Africa, and Asia, aimed to estimate pathogen-specific burdens of non-severe diarrhoea in children aged 0–24 months at the community level between the year 2009-2014 (31, 32). In this study, stool samples were analysed for a broad range of enteropathogens using culture, enzyme immunoassay, and PCR. The study reported that Norovirus GII [Attributable Fraction (AF) 5·2%], rotavirus (AF: 4·8%), *Campylobacter* spp (AF: 3·5%), astrovirus (AF: 2·7%), and *Cryptosporidium* spp (AF: 2·0%) exhibited the highest attributable burdens of diarrhoea in the first year of life. The major pathogens associated with diarrhoea in the second year of life were *Campylobacter* spp (AF: 7·9%, 3·1–12·1), norovirus GII (AF: 5·4%, 2·1–7·8), rotavirus (AF: 4·9%, 4·4–5·2), astrovirus (AF: 4·2%, 3·5–4·7), and *Shigella* spp (AF: 4·0%, 3·6–4·3). The study reported that rotavirus diarrhoea burden was substantially decreased at sites where rotavirus vaccine had been introduced. However based on their overall findings on the number and diversity of pathogens associated with community diarrhoea, the authors concluded that single pathogen interventions might not have a substantial impact on total diarrhoeal incidence across multiple populations.

Diarrhoea-associated pathogens can be transmitted through multiple complex environmental pathways such as contaminated food or drinking water, contaminated environment, flies or from person-to-person as a result of poor hygiene (33-36). A recent study conducted in rural Bangladesh aimed to identify faecal transmission pathways in the household environment associated with prospectively measured child diarrhoea and found

that higher levels of *E. coli* on child hands are strongly associated with subsequent diarrhoeal illness rates among children (37). Another study conducted in rural Bangladesh in 2013-2014 reported that faecal transmission of pathogens in the domestic environment occurred despite having ~97% coverage with on-site sanitation (38). This could be due to contamination of the environment with animal faeces (39) and/or underutilization of existing sanitation facilities and on-going open defecation (40). A recent comparison of respondent-reported and sensor-recorded latrine utilisation measures in rural Bangladesh shows that the reported latrine use was exaggerated (40). A retrospective analysis of data from 145 low- and middle-income countries concluded that in 2012 an estimated 502,000 diarrhoea-associated deaths were due to inadequate drinking water, 280,000 deaths were due to inadequate sanitation and 297,000 deaths were due to inadequate hand hygiene (41).

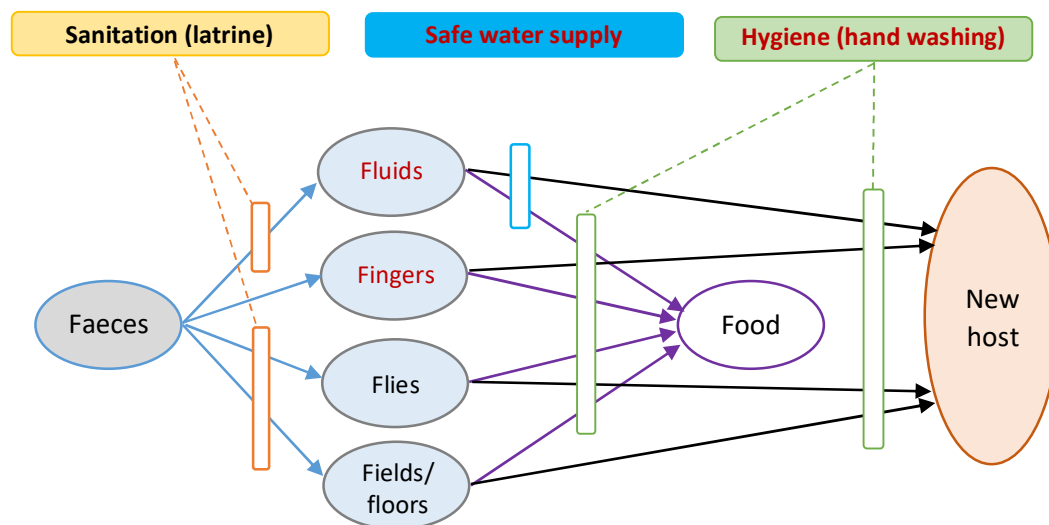


Figure 2: Modified F diagram showing disease diarrhoea pathogen transmission pathways (the red highlighted areas are the focus of interventions in this thesis)

Pathogens causing respiratory illness include both bacteria and viruses. Predominant pathogens causing severe respiratory infection globally among children <5 years

include *Streptococcus pneumoniae* (causes an estimated 18% of severe cases and 33% of deaths) (9, 42); *Haemophilus influenzae* type b (Hib) (estimated to account for 4% of severe episodes and 16% of deaths) and influenza virus (causes approximately 7% of severe episodes and 11% of deaths) (9, 43). Additionally, globally an estimated 100 million cases of viral pneumonia occur in children annually. The most common viruses that have been identified as causative agents both in developed and developing countries are, respiratory syncytial virus (RSV), influenza virus, rhinovirus, human metapneumovirus, human bocavirus, and parainfluenza viruses (42, 44). Other less common viruses include, adenovirus, enterovirus and coronaviruses (44).

In Bangladesh, after introducing the *Haemophilus influenzae type b* (Hib) conjugate vaccines in the national immunization programme 2009, the burden of bacterial pneumonia reduced significantly (45). The pneumococcal (PCV) vaccine has also been introduced in the national immunization programme in Bangladesh. The impact of this vaccine on childhood pneumonia in Bangladesh is yet to be assessed (46). However, severe respiratory infections caused by other pathogens remains high in this country. For example a study was conducted prospectively at the community level and in the hospitals of 67 villages in Bangladesh during June to October, 2010 among children <5 years of age to understand incidence of severe acute respiratory virus infections (47). The researchers tested swabs for respiratory syncytial virus (RSV), influenza viruses, human metapneumoviruses, adenoviruses and human parainfluenza viruses 1–3 (HPIV) by real-time reverse transcription polymerase chain reaction. The study reported that respiratory viruses and particularly RSV (RSV was associated with 7.9 hospitalizations/100,000 person week; among non-hospitalised cases, RSV was associated with 10.8 illnesses/100,000 person week), were commonly associated with severe acute respiratory infections. This suggests

that similar to diarrhoeal diseases, interventions targeting single respiratory pathogen may not be enough to have substantial impact on preventing total burden of respiratory illness incidence globally.

Respiratory infections are predominantly transmitted via infected droplets, but some viruses infecting the respiratory tract can also be spread from one person to another by hand contact (48, 49). Risk factors that have been identified for severe respiratory infections include poor nutrition, lack of breastfeeding, exposure to indoor air pollution, HIV infection, premature birth, overcrowding and poor living circumstances (50-53).

2.4 Diarrhoea and respiratory infections in high-income countries

Both diarrhoea and respiratory infections are more prevalent but not limited to low-income countries. Scallan *et al* reported on cross-sectional telephone surveys conducted in Australia, Canada, Ireland, and the United States over 12 month periods between the year 2000 and 2002. In the four weeks prior to interview, at least one episode of diarrhoea was reported by 7.6% of respondents in Canada, 7.6% in the United States, 6.4% in Australia, and 3.4% in Ireland in all age groups (54). Diarrhoea prevalence was highest among children <5 years of age and lowest among adults ≥ 65 years of age (54). Chen *et al* reported that in 2008-2009 the incidence of acute respiratory infection in Australia was 3.2 cases/person per year in all age groups and was highest in young children and lowest in older people (55). The risk factors for these infections and disease transmission pathways can vary according to contexts and therefore the preventive measures have to be context specific. In high-income countries, some of the risk factors for these diseases include

young age, attending an educational institution outside the home, and having another household member who is unwell (56-62). In the United States 31 major pathogens cause ~9.4 million episodes of foodborne illness each year (63). Most illnesses are caused by norovirus (58%), followed by nontyphoidal *Salmonella* spp. (11%), *Clostridium perfringens* (10%), and *Campylobacter* spp. (9%) (63). Burden of waterborne diseases are relatively light in high-income countries but continue to exist due to deteriorating public drinking water distribution system, a limited, passive waterborne disease surveillance system and increasing numbers of unregulated private water systems (64). For respiratory infections, factors such as air pollution and smoking are also important (65). Exploration of epidemiological associations for symptomatic episodes of diarrhoea, respiratory or dermal complaints via a prospective, community-based approach has been performed infrequently, and no previous study has examined risk factors for all three morbidity outcomes concurrently. Identifying and assessing these risk factors for all three disease symptoms from the same cohort within the same time period enables comparison of the strengths of associations and thus provides a new and useful public health perspective. In **Chapter 3.3**, I have discussed a study methodology that helped me to address this knowledge gap.

2.5 Interventions to reduce burden of diarrhoea and respiratory infections

There is a range of interventions available worldwide for prevention of diarrhoea and respiratory illness. While discussion of all these interventions is beyond the scope of this thesis, two main aspects of intervention are Water, sanitation and hygiene (WASH) promotion and vaccination.

The choice of vaccines for preventing moderate to severe diarrhoea and respiratory infections for a context depends on the incidence and prevalence of the specific microorganism in that particular context. In low-income countries including Bangladesh, one of the major bacterial pathogens causing moderate to severe diarrhoea is *V. cholerae* O1. In Bangladesh an estimated 300,000 severe cases and 1.2 million infections occur each year (66). In cholera-endemic areas, including Bangladesh, cholera vaccine has been demonstrated to reduce morbidity and mortality from cholera disease including all-cause diarrhoea-associated hospitalisation when the burden of cholera was high (67-69).

However, considering the evidence of substantial heterogeneity in pathogen-specific burdens of non-severe diarrhoea at the community level, the effect of vaccination against a single pathogen such as cholera on total diarrhoeal incidence at the community level might be limited (36). Besides, in the areas where cholera is not endemic, the vaccine may have little to offer. For example the 2010 cholera epidemic in Haiti by *Vibrio cholerae* O1 after more than a century reminds us of the importance of management of water and sewage to prevent cholera spread (70). Therefore, one aspect of the focus of my work is the prevention of diarrhoeal disease in low-income communities of Bangladesh using the cholera vaccine with or without simultaneous education regarding hand washing behaviour and promotion of water treatment. I have also focused on assessing the impact of hand

hygiene interventions on respiratory illness at the community level, which until recently has been poorly studied (71, 72).

2.5.1 Cholera vaccine

Over 30 years ago a study in Matlab, Bangladesh demonstrated that oral cholera vaccine which contains whole cells of *Vibrio cholerae* O1 together with recombinant B subunit (WC/rBS now commercially known as Dukoral) could prevent cholera (69). This vaccine is licensed in over 50 countries including Bangladesh. Analyses of the herd protective effects of this killed oral cholera vaccine trial showed that a greater than 90% reduction in cholera disease burden can be achieved despite having only moderate (~50% - 60%) level of coverage (73). The identification of the herd protective effect renewed interest in identifying affordable cholera vaccine delivery strategies that could reach those in the greatest need, such as the rural poor and urban slum dwellers. The WHO now recommends Dukoral for both endemic and epidemic cholera (74). However, two disadvantages limit broader use of Dukoral. First, it is prohibitively expensive, for example in Bangladesh it is sold for the equivalent of ~US\$15 per dose (75). Second, Dukoral needs to be administered with a buffer, which complicates large-scale deployment. Another whole killed cholera vaccine, which is based on somewhat similar bacterial components as Dukoral (excluding cholera toxin) but also contains *V. cholerae* O139 is produced in Vietnam and is used extensively there for public health practice (76). The vaccine production specialists at the International Vaccine Institute (IVI), working with VaBiotech, reformulated the vaccine so that it meets WHO guidelines. The reformulated vaccine, which contains different strains from the original Vietnamese vaccine and uses different production techniques and analytical assays, has proven to be safe and immunogenic in both children and adults. The technology for vaccine manufacturing has been transferred by the IVI to Shantha

Biotechnics in India, a company with WHO-prequalified products. The vaccine was licensed in India in February 2009 and is now available for general use in the country (77). Advantages of the Shantha vaccine (ShanChol™) include that its cost is lower (US\$1.85 in India), and does not require administration with buffer thus making it more feasible for use in mass vaccination programs in resource poor settings. This newer whole killed cholera vaccine has proven to be safe and effective, but the Government of Bangladesh spends only 26 dollars per person per year on health (78). Thus, a vaccine that costs US\$1.85 per dose and requires two doses for protection that lasts only a few years, and would have to be given outside of the standard childhood vaccine schedules, may not be sufficiently cost effective for the Government of Bangladesh to implement. The cost-effectiveness of the vaccine could be markedly improved by providing the vaccine to those persons who are at highest risk of cholera, rather than dispensing it to the whole population. By focusing on the highest risk population defined by geographic location, which may have a incidences of cholera three or more times higher than the general population, the overall cost of the program will decrease and the cost-effectiveness of the intervention will improve. A study was designed by the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) researchers in the year 2011 in Bangladesh for evaluating the feasibility and effectiveness of a mass cholera vaccination program (by using the ShanChol™) in a high incidence urban area in reducing diarrhea due to *Vibrio cholera* 01 (68). I used data from that study to address some of the objectives relevant to my thesis, which I have elaborated later (Chapters 5-7).

2.5.2 Water treatment, sanitation and hygiene interventions and their impact on health

To prevent transmission of infectious diseases the optimum long-term solution in low-income countries would be to build and maintain water and sanitation infrastructure that

consistently separates faecal waste from environment, water and food supplies. But for complex reasons, including limited supply, poor governance, and low water tariffs leading to lack of funding, achieving this goal in the short-term is infeasible (79). McIntosh *et al* identified poor governance and low water tariffs as core problems (79). These lead to failure to invest in wastewater collection and treatment and implement legislation pertaining to pollution, overexploitation of groundwater, low water supply and sanitation service coverage, intermittent water supply, poor construction etc. They suggest that these problems cannot be solved in isolation and can only be addressed after the core problems have been resolved (79). Considering these complexities in achieving the long-term goal, interim approaches for immediate implementation to reduce infectious disease burden would be useful in these countries.

Many impact evaluations examine the effects of water, sanitation and hygiene interventions on health outcomes in low-income countries. A number of reviews have been done to examine the results of these studies systematically, using literature review, meta-analysis and/or meta-evaluation (80-87). Systematic review and meta-analysis of efficacy studies have demonstrated that in settings where diarrhoea is a leading cause of death, persons who live in households that regularly treat their drinking water with a microbiologically effective approach or who are encouraged to regularly wash their hands with soap have less diarrhoea than persons living in non-intervention households (88, 89). A recent systematic review of 44 studies evaluating the effects of WASH interventions on childhood diarrhoea in children 0–5 years old showed that various WASH interventions reduced diarrhoea risk between 27% and 53% (90). A meta-analysis and meta-regression of 135 systematic reviews (done between 1970 to 2016) shows that household connections of water supply and higher levels of community coverage for sanitation was particularly

impactful in reducing diarrhoea (91). In another recent systematic review and meta-analysis it was found that sanitation is protective against diarrhoea, active trachoma, schistosomiasis, and height-for-age, but had no protective effect for other anthropometric outcomes (92). However, a systematic review investigating the impact of sanitation on indicators of faecal-oral transmission of enteric pathogens (faecal pathogens in drinking water, hand contamination, sentinel toys, household and latrine surfaces and soil, flies and observation of human faeces around home) found little or no effect of sanitation interventions on the transmission pathways (93). The underlying reason could be that the faecal indicators were not specific enough to identify the sources of pathogens and there was no correlation of the indicators with the presence of pathogens.

The recent WASH Benefits randomised control trial that was conducted among 5551 households enrolled from 720 clusters in rural Bangladesh, aimed to assess whether water quality, sanitation, and hand washing interventions alone or combined with nutrition interventions had any impact on reported diarrhoea and linear child growth (94). The authors concluded that with high adherence to the assigned interventions, hand washing intervention alone and combined with water and sanitation interventions reduced diarrhoea in young children (95, 96). Nutritional supplement improved linear growth in this study but there was no benefit of adding water, sanitation, and handwashing interventions with nutrition (95). However, the WASH Benefits randomised trial conducted in Kenya, having similar interventions, did not reduce childhood diarrhoea or improve growth, even when adherence was at least as high as has been achieved by other programmes (97). A recent review of both of these studies argued that in both countries, most trial participants already had access to basic latrines and most participants already had an improved drinking water source at baseline (98). The reviewers argued that the tested WASH interventions might

have a much greater effect on pathogen transmission among populations where open defecation and poor water supply are widespread (98). The results of these two well designed trials raised the question whether reducing environmental contamination through WASH might be key to tackling the persistent challenge of childhood stunting.

Two studies were examining the effect of WASH interventions on growth in populations with high baseline levels of open defecation in Zimbabwe (99) and Mozambique (100) at the time the results of the WASH Benefits trials were published. The findings from the MapSan health impact trial that was conducted in Mozambique is yet to be published. The Sanitation Hygiene Infant Nutrition Efficacy (SHINE) trial, which is a cluster-randomized, community-based trial in two rural districts of Zimbabwe with high baseline levels of open defecation, investigated the independent and combined effects of protecting babies from faecal ingestion and optimizing nutritional adequacy of infant diet on length and haemoglobin at 18 months of age (99). In this study, faecal ingestion was minimised by providing WASH interventions consisting of construction of ventilated improved pit latrine, provision of handwashing stations, liquid soap, drinking water treatment with chlorine, and play space plus hygiene counselling. The results showed that optimising nutritional adequacy of infant diet improved the primary outcomes of interest. However, the WASH interventions did not have any impact on the primary outcomes and neither intervention reduced prevalence of diarrhoea at 12 or 18 months (101). The researchers concluded that implementation of elementary WASH interventions (i.e. provision of point-of-use water chlorination, handwashing stations not connected to water supply, and improved pit latrines, with promotion of hygiene behaviour) together with nutritional interventions will not reduce stunting more than implementation of nutritional interventions alone in rural areas of low-income countries (101). Pickering *et al* reviewed

the results of WASH Benefits and SHINE trial and recommended that future research in the WASH sector should focus on developing and evaluating interventions that are radically more effective in reducing faecal contamination in the domestic environment than the interventions that were implemented in these trials (96).

Following the WASH Benefits trials, Johri *et al* studied whether a water quality intervention could improve child growth in a rural Indian setting with higher levels of circulating pathogens than the original WASH Benefit trial sites (102). In this study 40.6% of the households received drinking water meeting the Sustainable Development Goal (SDG) # 6.1 quality standards (no *E. coli* in 100 ml of drinking water based on microbiological testing). The evidence on the relationship of drinking water meeting SDG 6.1 norms to length-for-age and weight-for-age was inconclusive, and there was no apparent relationship with stunting or wasting (102). However, indicator organisms such as *E. coli*/coliform may not correlate with pathogen occurrence and could be present in a water sample when there is no risk and vice versa.

In 2011, a cluster-randomised trial assessed the effect of community-led total sanitation programme implemented by the Government of Mali on child health (103). The study reported that access to toilets substantially increased after implementation of programme and child growth improved, particularly in children <2 years (103). A recent systematic review on impact of WASH interventions in children (age <18 years) on growth, non-diarrheal morbidity and mortality shows that there is low- to very-low quality of evidence to suggest decrease in prevalence of wasting, stunting and underweight in children from low- and middle-income countries (71). However, there is very low to moderate quality evidence that WASH interventions (especially hygiene intervention) are associated with

lower risk of non-diarrhoeal morbidity (fever, respiratory infections, intestinal helminth infection and school absenteeism). The reasons for low to moderate evidence for WASH interventions could be due to paucity of randomised controlled trials in the area of environmental research and the inability to blind most environmental interventions, rather than interventions actually not being effective. Additionally, the important reasons why a microbiologically effective POU water treatment product may not prevent disease could be due to exposure to pathogens through multiple pathways other than the one that is addressed by the POU water treatment product and poor compliance to use the product (104). The authors concluded that the potential health benefits supports the ongoing efforts for provision of safe and adequate water supply, sanitation and hygiene (71).

The WHO recognizes the health contribution that household water treatment and safe storage can make in prevention of waterborne diseases and recommends integration of it along with other water, sanitation and hygiene interventions for the vulnerable groups including children who are at risk of having pneumonia and diarrhoea (104).

Combined vaccination and WASH interventions to combat diarrhoea

To date it is unclear whether combining vaccination for a specific pathogen such as cholera or rotavirus with WASH interventions (specifically POU water treatment interventions and improving hand-washing behaviour) incrementally increases health benefits. In **Chapter 3.2** of this thesis, I have discussed a study methodology that I used to address this gap in the knowledge.

POU water treatment interventions

There is a variety of POU water treatment products available on the market. For example some of the chemical products that rely on chlorine for disinfection, include: liquid sodium hypochlorite, sodium dichloroisocyanurate tablets (branded as Aquatabs by Medentech, Ltd.), a combined flocculant-disinfectant powdered mixture (branded as PUR® Purifier of Water by the Procter & Gamble Company) etc. Non-chemical based water treatment products/methods include solar irradiation, varieties of water filters such as a siphon-driven porous ceramic filter (branded as the CrystalPur Filter by Enterprise Works/VITA), ceramic candle filters, bio-sand water filters and boiling. A meta-analysis of 31 studies conducted on POU water treatment products yields a pooled estimate of 42% (95% CI: 33–50%) reduction in diarrhoeal disease risk (105). However much of the evidence is from efficacy trials conducted among small population over short time periods. Besides, household water treatment products such as chlorine based products or a water filter are very rarely used by the global poor (106). For example, a study conducted in urban Dhaka in 2009 promoting chlorine-based products detected residual chlorine in only ~8% of households (107). The taste and smell of chlorine-treated water is a commonly reported barrier (108). Other barriers include problem with supply chain of the water treatment products leading to not having access, unavailability of replacement parts for filters etc. Even with continued promotional activities and having access to products, most users do not sustain use (109-111).

Only a few studies have reported good uptake of POU water treatment products. For example a non-blinded randomised controlled trial conducted in rural Bangladesh in 2011-2012 aimed to assess whether improving the microbiological quality of tube well drinking water by household water treatment and safe storage would reduce diarrhoea in children <2

years (112). In this study, sodium dichloroisocyanurate tablets were promoted as the water disinfection product at the point of use. The study reported that 83% of the households in the chlorine arm that had water in the intervention container at the time of the visit, had free chlorine residual over the minimum CDC (Centres for Disease Control and Prevention) recommended value of 0.2 mg/L (112). Another recent study that reported good uptake of POU water treatment intervention is the WASH Benefits Bangladesh trial (94). In this study the water technologies that were used as intervention product, comprised of household-level chlorination with sodium dichloroisocyanurate tablets (Aquatabs™ Medentech, Wexford, Ireland) coupled with 10 L safe storage in a covered, narrow-mouth container. The hand-washing intervention households received hand-washing stations and soapy water bottle with a regular supply of detergent sachets to make soapy water.

Residual chlorine was detected in 76% of the intervention households (113). Observed hand-washing with soap was more common after toilet use (range: 67%–74% of events, $p < 0.05$) and after cleaning a child's anus (range: 61%–72%, $p < 0.05$) compared to other intervention (range 34–39%) and control households (range 26–29%) (113). In this efficacy trial, the intervention products were supplied to study participants free of charge and community health workers promoted the behavioural recommendations intensely. The health workers visited the intervention households at least once weekly in the first 6 months and then once in every two weeks throughout the study period to promote behavioural interventions. Such intense behaviour promotion may not be feasible for larger scale promotion of WASH interventions.

The behavioural recommendations in the WASH Benefit trial were developed based on the Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH) model,

which is a theory and evidence based behavioural framework (114). Adoption of evidence based behavioural research and theories are still scarce in developing and promoting WASH behavioural interventions. A systematic review of behaviour change research on POU water treatment interventions in middle and low income countries reported that only 1.7% (26/1551) of their reviewed papers described behaviour research on POU water treatment adoption; most of the research often lacked intervention descriptions and seldom used behaviour theories (115). The authors recommended that more behavioural research is necessary to understand factors that motivate or inhibit water treatment behaviour change. A recent study conducted within a cluster randomised controlled trial in Amhara, Ethiopia, discussed the importance of assessing collective efficacy (CE) when implementing WASH interventions to change behaviour of study participants (116). CE is a combination of cognitive and socio-structural aspects which facilitate people's shared beliefs in their collective ability to execute actions related to a common goal (117). The authors discussed that one possible explanation for low uptake and sustained adoption of WASH interventions could be due to low CE. They developed and validated a metric to assess factors related to CE, which could be applied for better designing and targeting community level interventions in the future (116).

To date, few studies have explored the reasons contributing to and reducing sustained use of POU water treatment products (118-121). Understanding motivators and barriers to sustained use is crucial to designing effective future programs for household safe water products. In **Chapter 3.1** of this thesis, I elaborate on a study methodology that was aimed at assessing motivators and barriers for sustained use of a water filtration device that was popular among the study participants of a low-income community of Bangladesh at the time of the study.

Handwashing interventions

Even though the focus of many hand-hygiene interventions has been to reduce diarrhoea, data from a systematic review and two meta-analyses show that hygiene behaviour change including hand-washing with soap has also been effective in reducing respiratory illness (72, 84, 122). However, similar to POU water treatment interventions, hand-hygiene practices (washing hands with soap) are sub-optimal, despite benefits for both diarrhoea and respiratory infection prevention. A systematic review of 42 studies estimated that 19% of the world population washes hands with soap after contact with excreta (123).

Structured observations of residents of rural Bangladesh found that only 1% of people washed their hands with soap before eating and before feeding a child and only 14% washed their hands with soap after defecation (124). Wolf *et al* recently reported global, regional and country estimates for hand-washing with soap after potential faecal contact (125). Data from 77 countries shows that one in four persons does not have a designated hand washing facility, but even among those with access, hand washing with soap is poorly practiced. People with access to designated handwashing facilities are about twice as likely to wash their hands with soap after potential faecal contact as people who lack a facility (125).

A study conducted in both urban and rural areas of Bangladesh reported that in 81% of the observed events the participants coughed or sneezed into air (i.e uncovered) and in 11% into their hands. No one washed their hands after coughing or sneezing into their hands (126). Another study developed and implemented cough etiquette intervention at four elementary schools. The study reports that 92% (n=58) of the students coughed/sneezed into open air at baseline (127). Five (8%) students coughed/sneezed in their hands, which they did not subsequently wash with soap and water.

Most previous efficacy studies reporting the impact of intense implementation of hygiene behaviour change on respiratory illness have been small, involving up to 6,000 people (84, 122). However, the impact of implementing hygiene promotion programs on respiratory illness on a large scale is still unclear (128, 129). Accurately assessing hand-washing behaviours is problematic. Self-reported hand-washing consistently overestimates observed behaviour (124, 130, 131). Direct observation of hand-washing by trained staff is both highly resource-intensive and also biased, as the presence of an observer alters hand-washing behaviour (132, 133). Assessment of hand-washing behaviour through a low cost proxy measure such as presence of soap and water in a designated hand-washing station is a practical alternative, and has been associated with lower rates of respiratory illness in some settings, but not in others (134-137).

Assessing impact of hand-washing interventions on respiratory illness is problematic too. The commonly used indicator to assess impact of hand-washing interventions in most of the studies is self-reported or carer-reported respiratory illness and therefore study findings may be subjected to reporting bias. Only a few studies have objectively measured the impact of hand-washing on confirmed respiratory infections (138, 139). For example, Cowling *et al* objectively measured transmission of respiratory infection by using reverse-transcription polymerase chain reaction (RT-PCR) of nasal and throat swabs and reported that hand hygiene interventions prevented household transmission of influenza virus (139). In **Chapter 3.2**, I discuss a large scale randomised controlled trial that attempted to understand the impact of hand hygiene interventions on carer or self-reported respiratory illness.

2.6 Scaling up of water, sanitation and hygiene interventions to combat diarrhoea and respiratory infections

The 2030 Agenda for Sustainable Development, adopted by the 193 members states of the United Nations, include Sustainable Development Goal (SDG) #6 which is to ensure availability and sustainable management of drinking water, sanitation and hygiene services for all (140). This reflects the increased attention on water and sanitation issues in the global political agenda. According to the report, globally an estimated approximately 2.1 billion people still need improvement of water quality services who lack water accessible on premises, available when needed and free from contamination (140). The least developed countries have the lowest coverage for hand washing facilities. An estimated only ~27% of the population in least developed countries has access to soap and water for hand-washing on premises (140). A systematic review and meta-analysis on impact of latrine coverage and latrine use showed only modest impact of interventions in increasing coverage and use (141). Upscaling of known effective and affordable water, sanitation and hygiene interventions is essential for improving global health (142). It is therefore important to understand the impact of water treatment and hygiene behaviour change interventions on diarrhoea and respiratory illness implemented at larger scale (142), as whether these approaches are effective when implemented on a larger scale is still unclear (143, 144).

A project, Sanitation, Hygiene Education and Water Supply in Bangladesh (SHEWA-B) aimed to improve hygiene, sanitation and water supply for 20 million people in rural Bangladesh (128). During the first two years of the intervention period, the focus was to improve water sanitation and hygiene behaviour through interpersonal communication and group discussions. By the end of this two years the presence of water, soap or ash in

convenient hand-washing location had increased from a baseline level of 47% to 63% post intervention (145). The national hand washing promotion program in Peru, targeting ~28 million people, found no effect of a mass media intervention on hand washing behaviour. Combining the mass media campaign with more intense training and promotional activities at the community level increased the share of households with hand washing facilities by 4.9% (129). Importantly, neither SHEWA-B nor the Peru national hand-washing program resulted in a measurable reduction in childhood diarrhoea or respiratory illness (128, 129). Poor uptake of behaviour change interventions may be related to difficulties of delivering the behaviour change intervention with high quality at a large scale (146, 147). Another problem is that efficacy studies are artificial experiments conducted, with study participants generally being given the intervention materials free of cost and with regular encouragement given to use them. In real world situations, scaling up of WASH interventions without providing the intervention materials to people for free and without prompting them on use, the sustainable uptake of WASH interventions is often poor. Highlighting this point is an efficacy study conducted in rural Guatemala to understand the impact of flocculant-disinfectant on diarrhoea. In this study, the intervention households had 39% less diarrhoea compared to the control. Three weeks after the study was complete, national marketing of the flocculant-disinfectant was extended in the region where the efficacy study was conducted. Six months later the researchers returned to the study households and found that only 5% of the study households had purchased the flocculant-disinfectant within the preceding two weeks of interview, despite efficacy of the product being demonstrated in that community (146). Another evaluation of one of the longest running national POU water treatment programme on liquid sodium hypochlorite in Zambia showed that among the households in the districts that received considerable social

marketing and had the highest per capita sales at the time of evaluation, only 13% of the households had residual chlorine in drinking water (148).

In this thesis in **Chapter 3.2**, I discuss a study methodology that I used to explore whether WASH interventions that are known to be effective in reducing diarrhoea and respiratory illness in small-scale efficacy trials had an impact on these illnesses when these were implemented at a larger scale.

2.7 Difficulty in assessing impact of behavioural interventions on health outcomes

Assessing the impact of behavioural interventions on health outcomes such as diarrhoea is difficult. One of the commonly used indicators to assess effectiveness of these behavioural interventions is 'reported' health outcomes (83, 149). For example a systematic review of 45 cluster randomized controlled trials for assessing effectiveness of improving water quality to reduce diarrhoea found that the primary outcome in most of these studies was reported diarrhoea (150). Concerns raised regarding reliability of reported diarrhoea include courtesy bias (151, 152), imperfect and biased recall (153-158), and surveillance fatigue (159-161). Additionally there is concern about the reliability of measuring subjective health outcomes in non-blinded trials due to observer bias (162). Due to these concerns, in some non-blinded trials a reduction of diarrhoea by even 50% may not necessarily be due to a true intervention effect (87). To overcome this, it is now recommended that in studies where blinding is not possible, there should be at least one objectively assessed outcome - for example, complementing disease reporting with microbiological testing of stool for specific micro-organisms or observing diarrhoea-

associated hospital admissions - even if the primary outcome is subjective (163).

Alternatively, validation studies for estimating the degree of bias should be incorporated to improve data interpretation (85). Epidemiologists are now also proposing routine use of negative controls in observational studies to detect bias due to unmeasured confounding (164). However, there are difficulties associated with application of this recommendation in large-scale behavioural intervention trials aimed at reducing diarrhoea. Additionally, no large scale behavioural trial has assessed the same reported health outcome through two different types of survey data collected concurrently from the same study population, and compared results with an objectively measured outcome. In this thesis in **Chapter 3.2**, I have discuss a study methodology that I used to understand if reported health outcome data is reliable in assessing intervention impact and consider optimal ways of collecting reported health outcome data to minimise reporting bias.

2.8 Objectives

The objectives of this thesis are to understand the usage and impact of a range of interventions on diarrhoea and respiratory illnesses in low-income communities in Bangladesh, and to understand whether reported health data can be used to assess the impact of interventions. Additionally I have examined the risk factors for diarrhoea, respiratory and dermal diseases in the Australian context, to contrast with those observed in a low-income country such as Bangladesh.

More specifically the objectives of this thesis are:

- a) To measure the sustained use of a POU water treatment intervention product (siphon water filter) and study motivators and barriers to sustained use in the medium term (up to six months)

- b) To examine the effects of an at-scale intervention to promote hand-washing with soap and drinking water disinfection in addition to oral cholera vaccination on diarrhoea-associated hospitalisation
- c) To examine the effects of an at-scale intervention to promote hand-washing with soap on reported respiratory illness.
- d) To explore the consistency in intervention impact evaluation based on reported diarrhoea. More specifically, to compare whether reported diarrhoea data among children aged ≤ 5 years using similar case definitions and collected over the same time period in the same study population but via two separate surveys, by different data collection teams, at different specific time points, and from different households affected the overall interpretation of intervention effects on measured health outcomes.
- e) To identify risk factors associated with diarrhoea, respiratory and dermal diseases concurrently at the community level among a prospective cohort in Australia

Chapter 3: Methods and data sources

This chapter provides an overview of the study settings, study design and methods used in this research. The chapter also provides a brief description of the data sources, and the statistical methods used to analyse the data to address the research objectives. Of note, I discuss further details of the methods for each of the objectives in the relevant chapters (Chapter 4-8).

It is important to clarify that, in this thesis I used data from three different studies. Thus, a brief description of the methodology of each of these studies and my contribution to each is given below:

3.1 Research objective 1: Measuring siphon water filter's sustained use and study motivators and barriers to sustained use in the medium term (up to six months)

Water treatment to reduce microbial contamination is considered important to reduce the burden of diarrhoea in low-income settings where source or stored water can be commonly contaminated. However, there is evidence that household water treatment products such as chlorine based products or a water filter are very rarely used by the global poor despite its proven benefits (106). To date, limited information is available on the reasons contributing to and reducing sustained use of POU water treatment products (118-121). Understanding motivators and barriers to sustained use is crucial to designing effective future programs for household safe water products.

In this chapter, I have discussed about a study that was designed to follow up participants of a randomised control trial that ended in 2009 to assess siphon water filter's sustained use and to identify motivators and barriers to sustained use.

I designed this study with the help of my colleagues in icddr,b (International Centre for Diarrhoeal Disease Research Bangladesh) and implemented the study in the field. I also prepared the data collection tools, supervised data collection, ensured data safety, analysed the data and finally published the paper. I have briefly mentioned about the methodology of this study below:

3.1.1 Data source and methods:

These are described in detail in the published paper (165).

Briefly, a randomised trial conducted in 2009 enrolled 800 mothers, each having at least one child <5 years of age, from a low-income urban community of the Mirpur area of urban Dhaka, Bangladesh. In that study 600 households were given randomly-ordered two-month free trials of four water treatment products: dilute liquid chlorine (sodium hypochlorite solution, marketed locally as Water Guard), sodium dichloroisocyanurate tablets (branded as Aquatabs), a combined flocculant-disinfectant powdered mixture (the PUR Purifier of Water), and a silver-coated ceramic siphon filter. Consumers also received education on the dangers of untreated drinking water. Details of the education and marketing interventions can be found in our previous publication (107).

In the final survey round of the randomised trial, the researchers measured willingness-to-pay (WTP) for each of the four water treatment products using a Becker-DeGroot-Marschak (BDM) procedure (166). Within two weeks of the end of the randomised trial,

the researchers revisited the households that were willing to buy the filter. Based on their previously reported willingness-to-pay information that was collected through the BDM procedure, researchers gave these participants the opportunity to buy the product at their stated price. Thus, some participants received the siphon filter free of cost (if the envelope had zero as its price) and others paid up to US \$5.

In March 2010, three months after receiving the filter and then again in June 2010, six months after receiving the filter, follow-up surveys were conducted among the households which received siphon filters. In August 2010 field workers collected qualitative data through group discussions and in-depth interviews to understand the motivators and barriers of sustained filter usage. During the follow-up period, there were no promotion activities to encourage filter use.

The data set that I used for the purpose of addressing the objective included information from both the randomised controlled trial (final survey round), the two follow up surveys that were conducted after the final survey round of the randomised trial and the qualitative data that were collected through group discussions and in-depth interviews.

3.1.2 Intervention device:

The CrystalPur siphon filter is an economical (expected retail US\$7) and microbiologically effective POU water treatment product (Figure 3) (167).



Figure 3: The CrystalPur Siphon filter



Figure 4: Study participant using CrystalPur Siphon filter

In a laboratory environment, this silver-impregnated filter removes $\log_{10}$ 4.4 – 5.5 of *E. coli* bacteria. The filter has a flow rate of approximately 3-5 litres per hour (168, 169). The filter requires two water vessels. Users place the ceramic candle filter inside the upper vessel and fill it with water. Filtered water then flows to a lower vessel (Figure 4 and 5) (170).

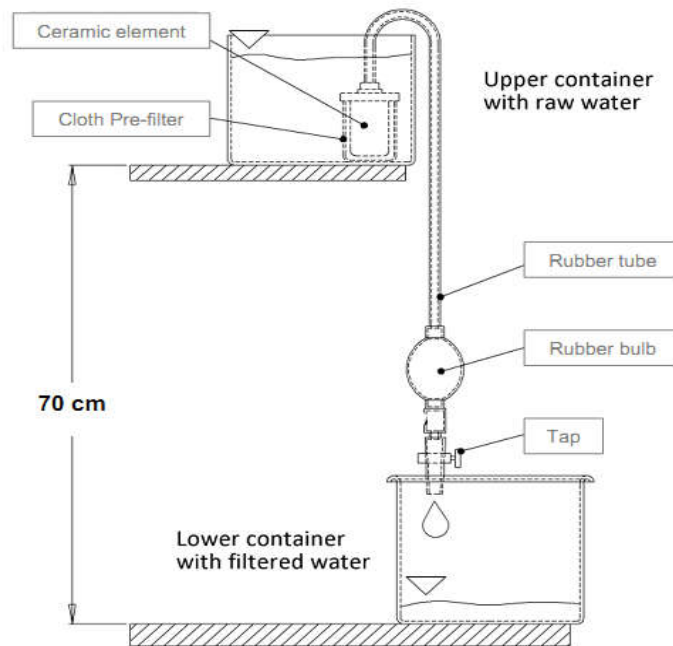


Figure 5: The CrystalPur Siphon filter set-up (source: Tanzaniaqua, 2008)

We did not provide these water vessels with the filter, so users had to provide their own. When the bulb is pumped, water starts to flow. The cloth pre-filter catches large particles before they reach the ceramic element, and this cloth filter can be washed by hand (171). When debris builds up within the ceramic filter element, the flow rate decreases. The study participants were provided instructions explaining how both backwashing and scrubbing can clean the ceramic element and restore the flow rate. To prevent recontamination of the filtered water, the intervention staff also recommended that users collect treated water in clean pots with clean hands and, at the end of each day, that they empty any extra water from the lower container into the upper container to avoid long-term storage.

3.1.3 Data collection and analysis

The data collection tool that we used in this study has been included in **appendix 2.1**.

The data collection methods included both quantitative (face-to-face interviews using paper-based questionnaires) and qualitative methods (focus group discussions). Please see **Chapter 4** that includes the published paper for detailed descriptions of the survey methods used in this study.

We used STATA statistical software (Version 10) for the quantitative analysis. For qualitative data analysis the qualitative team of this study made summaries of each interview after transcribing the audio recordings into English. They then manually analysed the data by compiling them under themes, such as the barriers and motivators related to filter use. They then examined the similarities, differences and connections between each theme. Details of these surveys and how data were analysed could be found in the published paper included in **Chapter 4** (165).

3.1.4 Ethics approval

The researchers obtained informed consent from an adult study participant from each household. De-identified data were used for the analysis. The study protocol was reviewed and approved by the Ethical Review Committee of icddr,b (Research protocol number: 2008-032). I applied for and received an ethics application exemption from the Monash University.

3.1.5 Funding

This study was funded by the Blum Center for Developing Economies and the Institute for Research on Labor and Employment at the University of California, Berkeley, SIDA, and the P&G Fund of the Greater Cincinnati Foundation.

3.2 Research objectives 2 to 4:

Data from the ‘Introduction of cholera vaccine in Bangladesh’ (ICVB) study was used. I was one of the lead research investigators in this study. My main role was to oversee the quantitative data collection for assessing uptake of the behavioural intervention in this study. I also participated in designing the behavioural interventions that were implemented in the study, prepared the data collection instruments, provided feedback in data collection procedure, performed data analysis for addressing some the pre-specified secondary objectives of this study. I have provided a brief description of method of this study below.

3.2.1 Study setting

The study was conducted in Mirpur area of urban Dhaka, Bangladesh. Mirpur has an estimated population of 2.5 million persons. icddr,b’s Dhaka hospital treats more patients from Mirpur than from any other part of Dhaka. Mirpur is divided into 16 wards of the Dhaka City Corporation. Of those wards 2, 4, 5, 6, 14 and 16 had the highest incidence of cholera (Figure 6). In low-income communities in Mirpur, households are commonly organised into compounds where individual households rent a small room and several households share a common water source, kitchen and toilets.

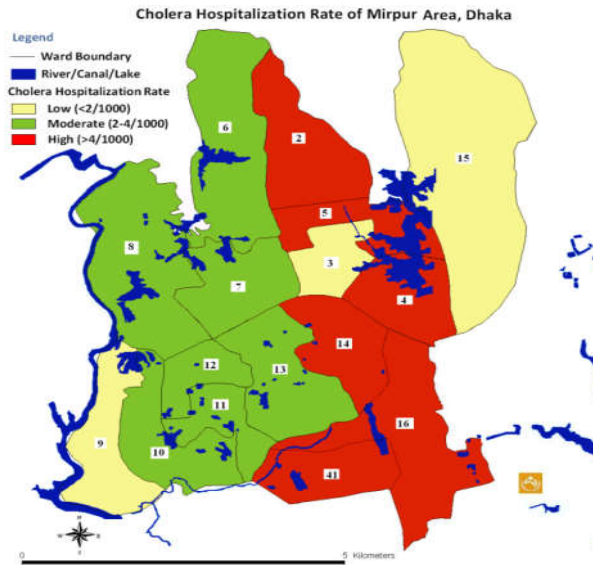


Figure 6. Cholera hospitalization rate at the icddr,b hospital, from different wards in Mirpur, Dhaka (2008-2010)

The icddr,b researchers observed that most of the cholera patients were coming from overcrowded households with low per capita income, poor sanitation, unsafe water use, sharing of source of water and poor living conditions (Figure 7). People meeting these criteria of living condition were indicated as ‘high risk group’ for having cholera in the rest of the thesis.



Figure 7: Study context (low-income communities of Mirpur area of urban Dhaka)

The researchers commissioned a census of the high cholera incidence wards in Mirpur using a personalized software program in the personal digital assistant (PDA) system. First, the census team purchased high resolution (0.6m) satellite images of Mirpur and used those images to create digital maps of buildings and other structures in the target wards. The digitized maps were updated by ground truthing. The census team visited each building and ascertained whether or not people were living in the building. If people resided in the building the census team assessed whether the residential structures were overcrowded, had poor sanitation and drainage, unhealthy living conditions, shared water among several families to assess high risk groups. Based on this survey, the team assessed whether the people living in the building/structure were a high risk group or not. If the residence met these criteria, the census team collected verbal consent from the respondent and other information of the household. Finally, the research team enumerated over 310,000 high risk residents from the target wards (Figure 8).

Study participants for both objective 1 and 2-4 were selected from Mirpur area of urban Dhaka. There is a possibility that some of the study participants from study/objective-1 were selected in the ICVB study. However, the original RCT for objective/study-1 had only 400 participants compared to the ICVB study, which had ~310,000 participants. Besides, these studies were conducted a few years apart. Therefore, even if there was some overlap of selection of study participants in these studies, it is unlikely to have affected the results of objectives 2-4 of the ICVB study.

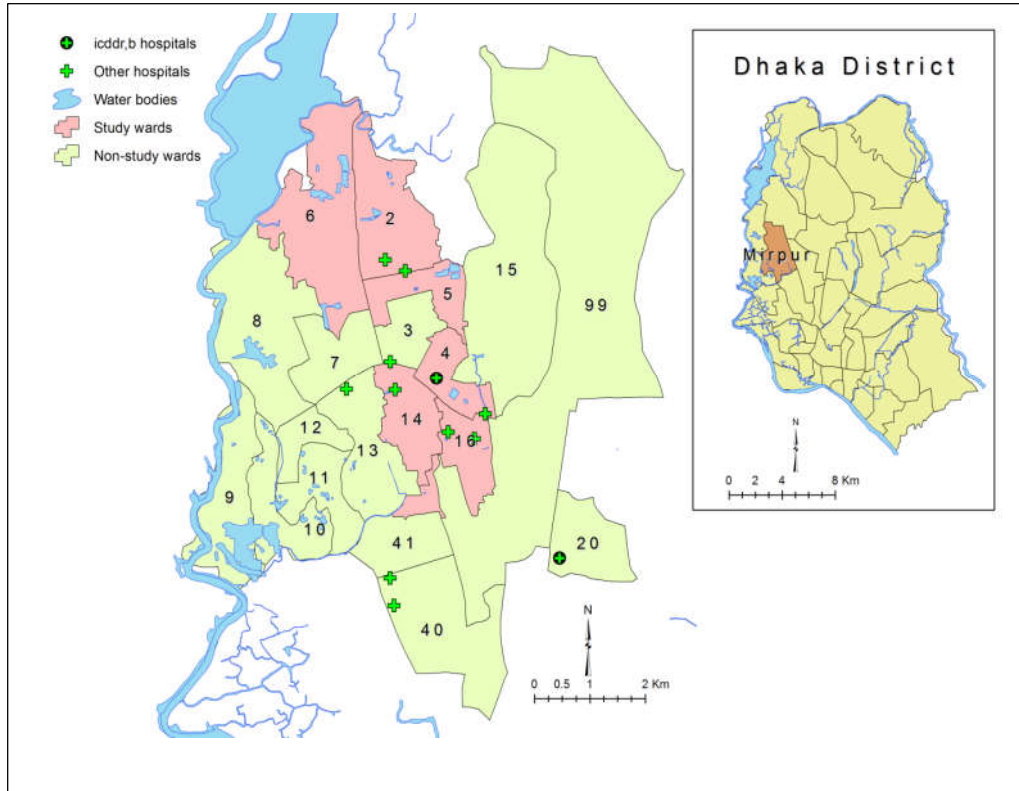


Figure 8: The study area in Mirpur in the Dhaka City, Bangladesh. The ward numbers are given inside the ward boundary.

3.2.2 Cluster formation and randomisation

The study population included 90 clusters (neighbourhoods) in these areas of high cholera incidence in Mirpur. A 30 meter buffer zone was created around each cluster which was equivalent to several buildings or space in most of the maps from the adjoining cluster to avoid contamination. An estimated 20% of the people were excluded in the buffer zone from the initially selected 310,000 population, thus the study retained about 240,000. Using the GIS maps the researchers drew clusters with approximate populations of 2700. Within the cluster, the study team identified potential vaccination sites.

Once the clusters were identified, they were randomly assigned to group 1, group 2, and group 3. A statistician from outside icddr,b used a random number generator to assign group 1, group 2, and group 3 to the 3 study groups (Figure 9):

- a) cholera vaccine alone;
- b) cholera vaccine and behaviour change (water treatment and handwashing promotion); and
- c) control group that continued standard habits and practices.

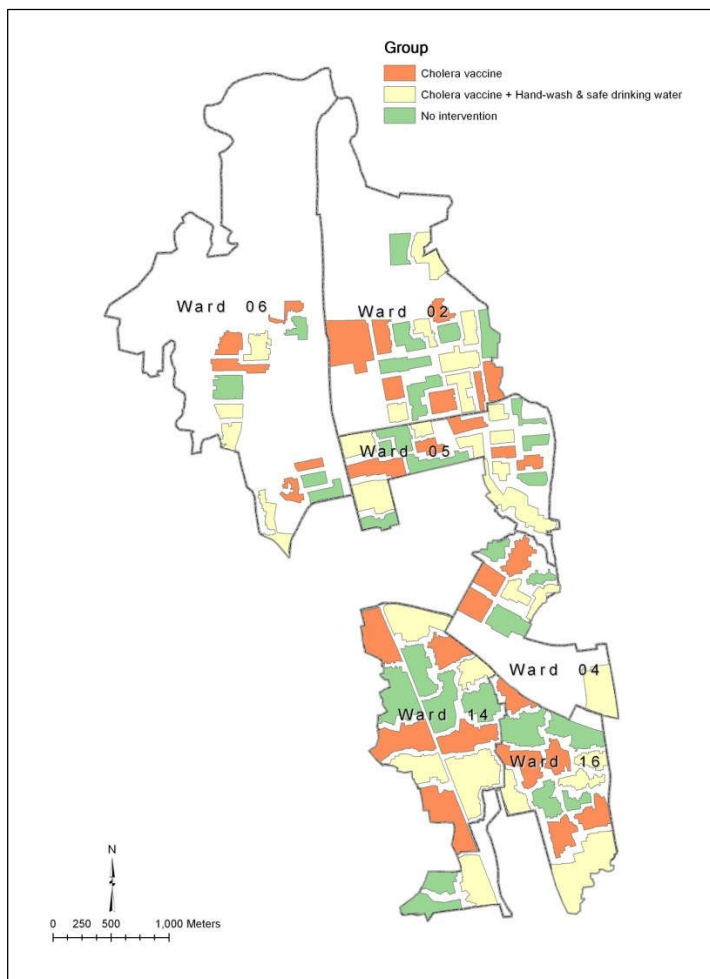


Figure 9: The geographic clusters of the three groups of study

3.2.3 Interventions

a) Cholera vaccine

The researcher used the killed whole cell oral cholera vaccine, ShanChol manufactured by Shantha Biotechnics for the study (172, 173). The vaccine was registered in India and was prequalified by WHO. Vaccine was transported from the manufacturer to a designated cold room arranged for this study where it was stored. Temperature for the vaccine was maintained at 2-8°C for the study. During vaccination, vaccinators shook the vial well to disperse the cellular contents and then opened it to feed all its content to the recipient. Each participant over the age of one year and non-pregnant females living in communities randomized to receive vaccine was offered two doses of the vaccine in two rounds at least 14 days interval at no charge.

b) Behaviour change interventions (Water treatment and handwashing promotion)

The hand washing and water treatment intervention included distribution of enabling hardware and interpersonal counselling aided by support print materials. The behaviour change strategy was guided by the Integrated Behavioural Model for Water Sanitation and Hygiene (IBM-WASH) theoretical framework (Figure 10) (114, 174). In the study area, several households often shared a common water source, kitchen and toilets, therefore the hand-washing and water treatment intervention hardware were mostly provided at the compound level, though the behavior change communication messages were delivered both at compound and household levels.

Figure 10: The Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH)

Levels	Contextual factors	Psychosocial factors	Technology factors
Societal/Structural	Policy and regulations, climate and geography	Leadership/advocacy, cultural identity	Manufacturing, financing, and distribution of the product; current and past national policies and promotion of products
Community	Access to markets, access to resources, built and physical environment	Shared values, collective efficacy, social integration, stigma	Location, access, availability, individual vs. collective ownership/access, and maintenance of the product
Interpersonal/ Household	Roles and responsibilities, household structure, division of labour, available space	Injunctive norms, descriptive norms, aspirations, shame, nurture	Sharing of access to product, modelling/demonstration of use of product
Individual	Wealth, age, education, gender, livelihoods/employment	Self-efficacy, knowledge, disgust, perceived threat	Perceived cost, value, convenience, and other strengths and weaknesses of the product
Habitual	Favourable environment for habit formation, opportunity for and barriers to repetition of behaviour	Existing water and sanitation habits, outcome expectations	Ease/Effectiveness of routine use of product

Dushtha Shasthya Kendra (DSK), a non-governmental organization with considerable experience working on water, sanitation and hygiene in Mirpur and other areas of Dhaka, delivered the water treatment and handwashing promotion intervention. Community health workers visited each of the compounds and discussed the objectives of the intervention

within one month of the time of cholera vaccination. The community health worker offered a hand washing station that is a 30 L water tank with a tap and soap/soapy water (Figure 11 and 12). The idea of the handwashing station was to bring together soap and water that people need to wash their hands and to put this in a place that makes it convenient for handwashing, especially for handwashing after defecation. A formative research was conducted prior to designing the handwashing station for this trial with an aim to identify a locally feasible and acceptable handwashing station that enabled frequent handwashing (174). The community health worker negotiated with compound residents to decide where the handwashing station would be set up and how they would manage refilling the reservoir when it becomes empty.

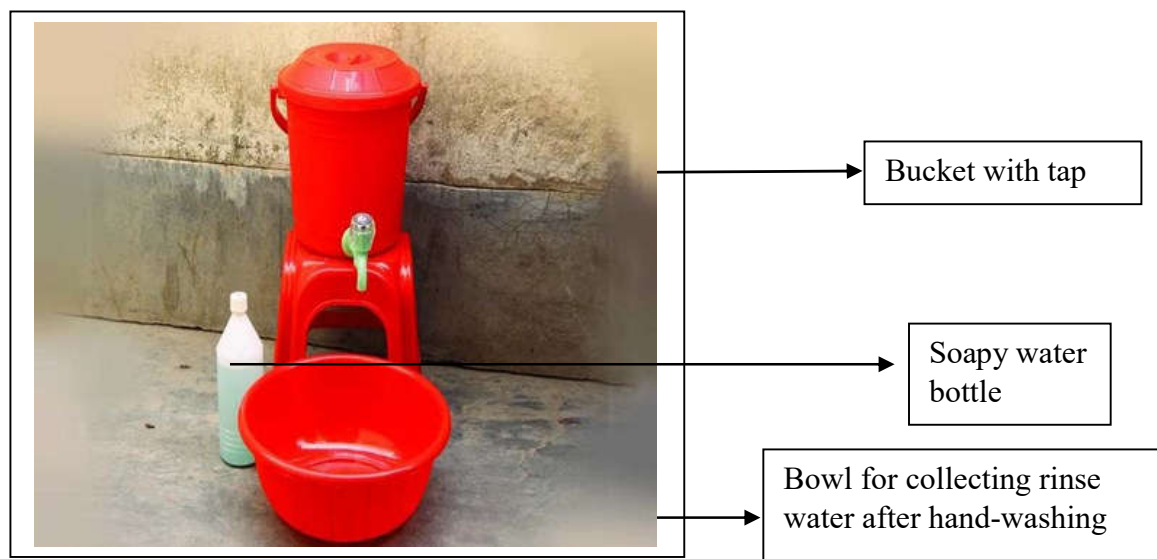


Figure 11: Hand-washing station (includes bucket with tap, bowl, and soapy water bottle)



Figure 12: Study participant washing hands using soapy water

Community health workers showed residents how to make soapy water (175). A half centimetre diameter hole was drilled into the top of an empty 750 ml to 1.5 L plastic water or soda bottle. These bottles could be purchased for 2 to 3 Taka. Half of a sachet of powdered detergent would be added to the bottle, and the bottle would be filled $\frac{3}{4}$ full with water. The hole at the top of the cap would then be plugged with the thumb and the bottle shaken to dissolve the detergent. Soapy water could be made inexpensively in the communities. Each of the households in the compound were be given a soapy water bottle and a first sachet of soap to demonstrate its use. All households in the compound were encouraged to either make soapy water or purchase bar soap for regular handwashing. The compound members were responsible for refilling the water in handwashing station, and purchasing soap or detergent for making soapy water.

Hand-washing communication messages encouraging handwashing after defecation and before preparing food were delivered to compound residents. Messages included the health

benefits of hand-washing with soap, hand-washing as a way to avoid missing days at work because of illness, hand-washing as a way to nurture the healthy development of children, religious importance of personal cleanliness and hand-washing as a way to be a clean person (Figure 13 shows example of hand-washing behaviour change communication materials used in the study). Community health workers visited each compound at least three times during each of the first two months to troubleshoot any difficulties with the hand-washing station and to encourage adoption of the handwashing habit.



Page-17



Page-21

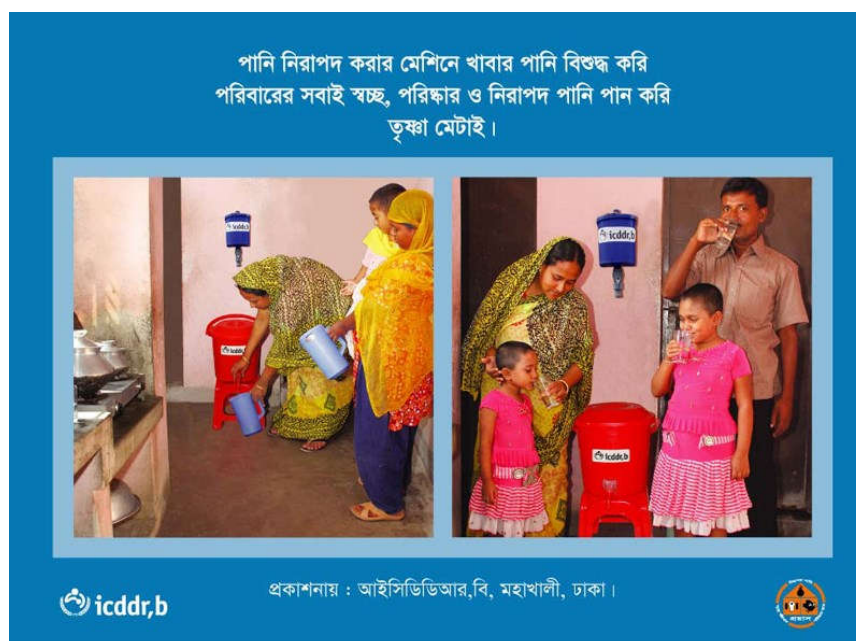
Figure 13: Example of hand-washing behaviour change communication materials used in the study

Two months after the handwashing promotion was initiated community health workers returned to each compound to promote household water treatment. The researchers phased in the behaviour change interventions, because in the pilot studies this was more effective than simultaneously presenting all interventions. The hand-washing intervention was quite popular in the study, and helped to build relationship with the intervention compounds, a relationship that was helpful when working on the somewhat more difficult water treatment intervention. The water treatment included both hardware and a software component. The hardware for water treatment was a chlorine dispenser (Figure 14) that is a reservoir which contained liquid sodium hypochlorite and dispensed a measured dose of the dilute sodium hypochlorite into a 10 litre water vessel. The study participants were instructed to keep the water vessel covered after treating it with liquid sodium hypochlorite. In pilot studies, over half of household members living in compounds where the chlorine dispenser was installed had detectable free chlorine in their drinking water on unannounced follow-up visits. The community health workers identified and marked the 10 litre water storage vessels in the original study households to minimise any confusion of the study participants. The desired chlorine residual to be maintained in household drinking water was between 0.2-0.5 mg/L. Presence of residual chlorine in stored drinking water was tested in randomly selected households every month using colorimetre (HACH LANGE GmbH, USA). Each drinking water station in a compound included one chlorine dispenser. The community health workers negotiated with compound residents on the location for the chlorine dispenser. The community health workers explained that the water taste different when it is treated with chlorine, but this was an indicator of safe water. The community health worker encouraged all members of the compound to drink the treated water.



Figure 14: Point-of-use water treatment hardware (Chlorine dispenser)

Community health workers used messages and approaches that were developed in the pilot project before the main study started. Messages included the health benefits of water treatment including avoiding cholera, drinking treated water as a strategy to avoid missing days at work because of illness, providing treated water to your children as a way to nurture their healthy development, and treating drinking water as a way to avoid drinking other people's germs (Figure 15 shows example of behaviour change communication material used in the study). Community health workers visited each compound at least three times during each of the first two months after placement of the chlorine dispenser to troubleshoot any difficulties with the chlorine dispenser and to encourage regular use of treated water.



Page-1 Cover-Front

Figure 15: Example of POU water treatment behaviour change communication intervention material used in the study

Within 4 weeks of vaccination, hand washing and water treatment interventions were implemented, hand washing in the first two months followed by water treatment in the next two months. After the initial four months of water and hygiene intervention, the community health worker reduced the frequency of compound visits to once per month. Community health workers refilled chlorine dispensers with sodium hypochlorite every one or two months depending on consumption.

3.2.4 Data sources

a) Census update

After cluster formation and randomisation, a team of approximately 30 data collectors, recruited by icddr,b, collected census data every six months from each house in the study area. During census updates, workers went to every household in the cluster and took consent from the family to participate in the study. The primary aim of the census was to collect information on births, deaths and in-and-out migration of individuals in the study area. During each visit, data collectors also asked respondents about each family member, including children ≤ 5 years, to ascertain whether anyone had had ‘diarrhoea within last 48 hours’. Interviewers explained that ≥ 3 loose stools within 24 hours would be considered as an episode of diarrhoea. Then the workers updated PDA based census information. At the time of the census update or when a new household moved into the study community, a verbal consent for participation in the surveillance was obtained and documented in the PDA questionnaire. On average, each data collector visited ~ 30 households each day, usually requiring ~ 15 minutes for completion of data collection from each household. During the census survey every resident in the households included in the study in different clusters was given a bar coded ‘ICVB card’ to track them during their icddr,b hospital visits for diarrheal incidence.

During the census update, card distribution and also during vaccination sessions, informed written consent was taken from the study population in the vaccine clusters for their participation in the vaccination program and study activities.

i) Disease Surveillance

a) Surveillance at the icddr,b hospitals in Mohakhali and Mirpur

All patients admitted to the hospital with diarrhoea were included in routine hospital surveillance. A diarrhoeal visit was defined as a visit by a patient who had in the 24 hour before presentation, three or more loose or liquid stool (self-reported/caregiver-reported), according to WHO criteria (27). The diarrhoeal disease surveillance for the ICVB project was conducted at icddr,b hospitals at Mohakhali and Mirpur for the patients coming from Mirpur study areas (wards # 2, 4, 5, 6, 14, 16). Clinical staff at each of the two hospitals evaluated each patient at the hospital triage area and provided treatment as is the routine procedure.

If the patient had an ICVB card, it was scanned using a bar code scanner. The front desk staffs also verified and confirmed his/her identity by asking name, age, family members, address etc. In case of unavailability of ICVB card, there was an option in the computer data management system of icddr,b to search a particular patient identification (PID) number for the study participants; this search was done on basic parameters such as name, age/date of birth, area of residence, police station, sex or village.

b) Surveillance at other health facilities in the ICVB study area in Mirpur

Even though the majority of severe diarrheal patients from Dhaka city seek care at the icddr,b hospitals, the researchers included Governmental and non-governmental hospitals/clinics with inpatient facilities in the Mirpur area which could be visited by the study population for diarrhoeal treatment. Health staff of these facilities were oriented /informed/motivated about ICVB study objectives and activities by the icddr,b clinicians. Two staffs from each of these facilities were directly responsible

for dealing with the patients from the ICVB sites and also were part of the ICVB field team. These persons were specially trained in completing the questionnaires. These hospitals/clinics were under surveillance by the ICVB study staff. One surveillance staff was present at each health facility throughout the day to facilitate proper reporting of diarrheal cases from the study area. Study patients were identified by use of ICVB cards. To ensure that the researchers were not missing any study participant, all patients from the study wards in addition had demographic and clinical data recorded in a structured questionnaire similar to the one used at the icddr,b hospitals. Data were checked and verified and entered into the computerized database of the ICVB study.

ii) Household water treatment and hand-washing assessment

A separate cadre of 11 icddr,b workers, with a separate supervisory structure from those who delivered the intervention or collected census data, evaluated hand-washing and home water treatment behaviour. Using the census data, 200 study participants in the behaviour change plus cholera intervention group, 100 study participants in the cholera intervention group and 100 study participants in the control non-intervention group were randomly selected each month for more detailed assessment. This assessment was unannounced and began 4 weeks before any water treatment and hand-washing intervention had been initiated. This monthly assessment of 200 intervention households was designed to be low enough to be logistically manageable, but to provide representative real-time trend data on intervention uptake. Measurements included the presence of soap and water in the most convenient place to wash hands (124, 176), the presence of residual chlorine in drinking water and microbiological water quality using low cost H₂S testing, and the occurrence of diarrhoea or respiratory disease among members of the household in the preceding two days. Interviewers also explained that

≥ 3 loose stools within 24 hours would be considered to constitute diarrhea. Data collectors were instructed to collect information on diarrhea at the beginning of the interview to reduce bias, as asking about diarrhea and intervention products occurred at the same visit.

Study timeline

Vaccination occurred between 17/02/2011 to 1/04/2011.

For data analysis, we defined the intervention start date as 24/09/2011 [midpoint between the start (19/06/2011) and end-dates (15/12/2011) of the hand-washing intervention rollout]. The POU water treatment interventions were rolled out between 19/09/2011 to 31/12/2011. The behaviour-change intervention and follow-up of all individuals ceased on 31/08/2013 (Figure 16); during this period vaccine-plus-behaviour-change group (including in-migrants) continuously received the behaviour-change interventions.

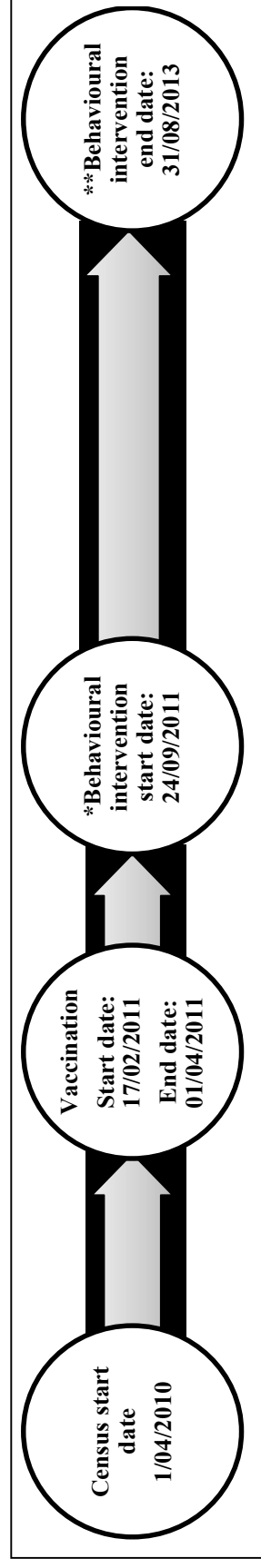


Figure 16: Study timeline[†]

[†] 6 monthly census data were collected throughout the study period

* Data collection on diarrhoea-associated hospitalisation and respiratory illness and handwashing intervention uptake started from September, 2011.

** We ceased follow-up of the diarrhoea-associated hospitalisation or respiratory illness assessment at this time point

3.2.5 Data Safety Monitoring Plan (DSMP)

An adverse event was defined as an untoward medical event (diarrhoea, vomiting, abdominal pain/cramps or any other local and systemic symptoms) with an onset up to 14 days after receipt of a vaccine dose which might or might not be associated with the vaccine. At the vaccination sessions after each dose, recipients were asked to wait for half an hour at the site, where one staff member monitored any immediate adverse event following vaccination. All vaccines were asked to consult the icddr,b hospital in Mirpur for any untoward effect after vaccination.

3.2.6 Data collections tools

I have attached the data collection tools used in this study in **Appendix 3**

3.2.7 Data analysis

I used Stata version 14 for analysing the data.

I have described analysis techniques in the relevant papers that were published and in the relevant chapters (**Chapter 5-7**).

3.2.8 Sample Size Calculation

The primary outcome of this study was assessing feasibility and effectiveness of oral cholera vaccine in cholera endemic area in low-income communities of Bangladesh.

Before the study began, it was estimated that ~100,000 patients were visiting the icddr,b Dhaka hospital per year, 17,000 were from Mirpur and 5,500 of these had cholera. There were about 2.5 million residents in Mirpur at the time of the study; thus, the incidence of cholera requiring hospitalization at icddr,b was 2.2 per 1,000 persons per year. However, the rate of cholera varies from year to year. The researchers conservatively considered the

rate of this slum area of Dhaka city similar to the rate in the slums of Kolkata, India that describe the rate is 1.6/1000/year (177). icddr,b previous hospital data showed that 6 wards in Mirpur had high cholera hospitalization rates (hospitalization rate in the 6 wards in the study area that have been chosen for the study ranges from 2-6/1000 for the last five years; 5 of the wards have rates of >4/1000 population per year).

Methods used

The sample size for the cluster design is computed based on the method described elsewhere (178). There were three groups in this study:

- a) cholera vaccine alone;
- b) cholera vaccine and behaviour change; and
- c) control group that continued standard habits and practices

Each group included k clusters of m individuals randomly assigned to each group i , where $i = 1$ denoted experimental group and $i = 2$ denoted control group. The aim was to test the hypothesis $H_0 : P_1 = P_2$ at the one-sided α level of significance with power $1 - \beta$, where P_1 and P_2 were estimated by $\hat{P}_1$ and $\hat{P}_2$, respectively, where these estimates were computed over all individuals in each group. Let Z_α , Z_β denoted the critical values of the standard normal distribution corresponding to the error rates α and β , respectively. Then the required number of subjects per intervention group was given approximately by

$$n = \frac{(Z_\alpha + Z_\beta)^2 [P_1(1 - P_1) + P_2(1 - P_2)][1 + (m - 1)\rho]}{(P_1 - P_2)^2}, \text{ where } \rho \text{ is the intracluster correlation (ICC).}$$

Alternative hypotheses for the sample size calculations were specified in terms of an “overall protective effect” (OPE) equal to one minus the incidence rate ratio versus the control group. This was meant to include all effects of the intervention and its implementation, including incomplete uptake and herd immunity. Each group included 30 clusters, so all estimated sample sizes had been rounded up to the nearest multiple of 30 before correction for attrition. Alternative hypotheses for the sample size calculations were specified in terms of an “overall protective effect” (OPE), which was equal to one minus the incidence rate ratio between intervention and control groups. This was meant to include all effects of the intervention and its implementation, including incomplete uptake and herd immunity. The sample size calculations are given in **Appendix 4**.

3.2.9 Ethics

Informed consent from an adult study participant was obtained from each household. The study protocol was reviewed by human subject committee at icddr,b, and the International Vaccine Institute.

3.2.10 Funding

This study was funded by the Bill & Melinda Gates Foundation.

3.3 Research objective 5: Identifying risk factors associated with diarrhoea and respiratory symptoms at the community level among a prospective cohort

My role in this study was to analyse secondary data that were collected from a double-blinded, randomized, controlled trial conducted in South Australia from June 2007 to August 2008 (179).

3.3.1 Data source and methods:

The details about the data source and methods of this study have already been published (179, 180). In short, in this trial weekly diaries were provided to 300 families to collect health data over a 12 month period. Eligibility criteria for inclusion was related to the main study hypothesis, which was to determine whether consumption of untreated rainwater contributed to gastroenteritis. The criteria included: using untreated rainwater from an above-ground tank as the usual drinking water source; having at least four eligible household members (including at least 2 children aged 1 to 15 years); home ownership or stable rental history (12 months or more in current home); and having a reasonable command of English. Households were randomly allocated to receive real or sham water treatment devices to treat rainwater for drinking; real devices removed microorganisms from the water, sham devices did not (180). The study families completed a health diary each week which included reporting of symptoms related to gastrointestinal (GI), respiratory and dermal complaints. They also provided exposure information regarding recreational swimming activities, pet ownership, and childcare/school attendance, as well as health-seeking behaviour.

Definitions

Having GI symptoms was defined as people reporting either passing a loose stool or vomiting at least once within 24 hours. People were considered to have respiratory symptoms if they had either sore throat or runny nose or cough. If people reported either rash, generalized itching or dermal infection, they were defined as having dermal symptoms.

Information of each of these symptom complexes were collected each week.

Recreational swimming settings were defined as a public pool/spa, a private pool/spa, an ocean/beach, or a river/lake/dam. Participants were asked to record whether they had swum during the week, and in which setting. No information was recorded regarding the length of swimming, how many times the participant had entered the water, or whether the participant had put his/her head underwater.

Clusters for GI, respiratory and dermal symptoms were defined as development of GI, respiratory or dermal symptoms in more than one household member in the same or consecutive weeks. Each cluster was considered to have ended if two weeks elapsed with no symptoms reported by any member of the household. Participants could appear in more than one cluster over the period of observation. Sporadic GI, respiratory and dermal symptoms were defined as cases that occurred outside of a cluster.

3.3.2 Data management:

Completed health diaries were mailed to the Study Centre (Monash University) every 4 weeks. Diaries were scanned, and the accuracy and completeness of data was verified using the Cardiff Teleform software (version 10.1, 2006; Vista, California, USA) before

data entry into a Microsoft Access® database. Reporting participants were telephoned for clarification if information was missing or ambiguous.

3.3.3 Data analysis:

All calculations were performed using Stata version 11.1.

Different statistical techniques such as descriptive analysis, linking data and log-binomial regression adjusted for clustering were used for analysing these data. I have described about how we analysed the data in details in the published paper and in **Chapter 8**.

3.3.4 Ethics Approval:

During enrolment, written informed consent was obtained from all adult household members and from parents and guardians on behalf of children. This study received approval from the Monash University Standing Committee on Ethics in Research Involving Humans (SCERH; 2006/555EA) and the South Australia Department of Health Human Research Ethics Committee.

Chapter 4: Explaining low rates of sustained use of Siphon water filter: Evidence from follow-up of a randomized controlled trial in Bangladesh

4.1 Chapter overview

Low-cost point-of-use (POU) drinking water treatment technologies such as filters or chlorine can substantially reduce reported diarrheal disease in low-income countries – when they are used. However, even with continued promotional activities, most users do not sustain use. To date, few studies have explored the reasons contributing to and reducing sustained use of POU products. Understanding motivators and barriers to sustained use is crucial to designing effective future programs for household safe water products. This chapter presents findings from a study that revisited households that bought or were provided with a siphon filter at the end of the randomized trial. In this study we measured the filter's sustained use and identified motivators and barriers to sustained use in the medium term (up to six months)

The findings from this study have been published in the **Tropical Medicine and International Health**.

4.2 Declaration for thesis chapter 4

Monash University

Najnin N, Arman S, Abedin J, Unicomb L, Levine DI, Mahmud M, et al. Explaining low rates of sustained use of siphon water filter: evidence from follow-up of a randomised controlled trial in Bangladesh. *Tropical Medicine & International Health*. 2015;20(4):471-83.

Declaration by candidate

In the case of Chapter 4, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Study design, literature review, statistical analysis and interpretation of results, and writing the manuscript.	80%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Shaila Arman	Contributed to study design, analysis of qualitative data, editing of the manuscript	N/A
Jaynal Abedin	Contributed to quantitative data analysis and editing of the manuscript	N/A
Leanne Unicomb	Critically reviewed and edited manuscript	N/A
David I. Levine	Contributed to study design, editing of the manuscript	N/A
Minhaj Mahmud	Reviewed and edited manuscript	N/A
Karin Leder	Contributed to the study design, statistical advice, review and editing of the manuscript	N/A

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Farzana Yesmin	Supervised data collections, reviewed and edited manuscript	N/A
Jill E. Luoto	reviewed and edited manuscript	N/A
Jeff Albert	reviewed and edited manuscript	N/A
Stephen P. Luby	Contributed to the study design, advice on statistical analysis, critically reviewed and edited manuscript	N/A

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work.

Candidate's

Signature

	15/07/2019
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Main

Supervisor's

Signature

	22/07/2019
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Explaining low rates of sustained use of siphon water filter: evidence from follow-up of a randomised controlled trial in Bangladesh

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Abstract

OBJECTIVE To assess sustained siphon filter usage among a low-income population in Bangladesh and study relevant motivators and barriers.

METHODS After a randomised control trial in Bangladesh during 2009, 191 households received a siphon water filter along with educational messages. Researchers revisited households after 3 and 6 months to assess filter usage and determine relevant motivators and barriers. Regular users were defined as those who reported using the filter most of the time and were observed to be using the filter at follow-up visits. Integrated behavioural model for water, sanitation and hygiene (IBM-WASH) was used to explain factors associated with regular filter use.

RESULTS Regular filter usage was 28% at the 3-month follow-up and 21% at the 6-month follow-up. Regular filter users had better quality water at the 6-month, but not at the 3-month visit. Positive predictors of regular filter usage explained through IBM-WASH at both times were willingness to pay >US\$1 for filters, and positive attitude towards filter use (technology dimension at individual level); reporting boiling drinking water at baseline (psychosocial dimension at habitual level); and Bengali ethnicity (contextual dimension at individual level). Frequently reported barriers to regular filter use were as follows: considering filter use an additional task, filter breakage and time required for water filtering (technology dimension at individual level).

CONCLUSION The technological, psychosocial and contextual dimensions of IBM-WASH contributed to understanding the factors related to sustained use of siphon filter. Given the low regular usage rate and the hardware-related problems reported, the contribution of siphon filters to improving water quality in low-income urban communities in Bangladesh is likely to be minimal.

keywords siphon water filters, usage barriers, integrated behavioural model for water, sanitation and hygiene, Bangladesh

Introduction

Low-cost point-of-use (POU) drinking water treatment technologies such as filters or chlorine can substantially reduce reported diarrhoeal disease in low-income countries – when they are used [1–4]. However, even with continued promotional activities, many users do not sustain use [5–7]. In fact, the usage of these technologies has been so low that the effect of POU water treatment on

improving global public health is now being questioned [8, 9]. To date, few studies have explored the reasons contributing to and reducing sustained use of POU products [10–14]. Attributes of technology such as ease of use, cost compared to boiling water, effectiveness in reducing diarrhoea and persuasive communication messages were related to increase in regularly using solar disinfection of drinking water (SODIS) [10, 11, 14]; durability and ease of use were positively related to

higher usage of a water filter [13]. Taste and smell were barriers to sustained use of chlorine-based products [12]. Identifying these motivators and barriers to sustained use is crucial not only for designing effective future programs for household safe water products but also for understanding the future usage pattern of these products. The benefits of our understandings can be further maximised by explaining these behaviours in a systematic way using theoretical frameworks. One of such theoretical frameworks is the integrated behavioural model for water, sanitation and hygiene (IBM-WASH) [15]. The IBM-WASH framework not only integrates and explains the different behavioural factors related to water, sanitation and hygiene, which are often discussed only partially through other conceptual frameworks, it also explains other important factors such as the technology aspect of a product or contextual factors related to behaviour in resource poor settings more succinctly [16–19].

In Bangladesh, a randomised controlled trial conducted in 2009 introduced four low-cost household water treatment technologies to a low-income urban population along with educational and marketing messages. Siphon filters were used more commonly than the three chlorine-based products [20].

This study revisited households that bought or were provided with a siphon filter at the end of the randomised trial. We aimed to measure the filter's sustained use and studied motivators and barriers to sustained use in the medium term (up to 6 months). We used the IBM-WASH theoretical framework to explain the identified predictors and barriers of sustained use of siphon filter.

Methods

Study context and participants

The 2009 randomised trial enrolled 800 mothers, each with at least one child <5 years of age, from a low-income urban community of the Mirpur area of Dhaka, Bangladesh. Of these participants, we randomly selected 600 to participate in a set of rotating free trials. This 'free-trial group' was followed for 8 months for assessment of preference and uptake of four successively provided POU water treatment technologies: three chemical disinfectants and the siphon filter (described below). Before each of the four free-trial rounds, intervention staff explained in detail about how the local water could be contaminated with germs, and thus how it could make people sick [21]. Details of the education and marketing interventions can be found in our previous publication [20].

Of the 755 caregivers who were still enrolled in the final round of the randomised trial, 744 of their neighbours with at least one child <5 years at home were also recruited to understand the influence of peers in adoption of household water treatment products. All these neighbour households received similar educational messages as was given to the intervention households before being offered purchase of the POU product of their choice.

The study participants were either from Bengali or Bihari ethnic groups. The Biharies, who speak both Urdu and the local language, Bengali, are descendants of families migrated from Bihar and north Indian states and remained in Bangladesh when it became an independent country in 1971 [22].

The siphon filters offered were different from the variety of other water filters available in the local market of Dhaka. Therefore, when the free-trial group started using the filter, intervention staff provided both demonstrations and written instructions on its use and maintenance. For the control households and the neighbours, neither of whom had a free trial, intervention staff provided this information prior to measuring willingness to pay.

In the final survey round of the randomised trial, researchers measured willingness to pay (WTP) for each of the four water treatment products using a Becker-DeGroot-Marschak (BDM) procedure [23]. In the BDM procedure, respondents were told that the name of a randomly chosen product and its price was contained in a sealed envelope and was not known to the enumerator. For the filters, the envelope prices ranged from a high of \$5 (a bit below the retail cost, which would be about \$7) to zero (that is, receiving the filter for free).

Enumerators then asked respondents if they would buy the filter at any of several prices (e.g. \$1, \$2, and so forth). The enumerator then opened the envelope. If the respondent had agreed to pay a price that was equal to or above the envelope price, they were allowed to buy the filter at the envelope price. Because a respondent's stated willingness to pay affected only whether they could buy the filter, but *not its actual price* (as that price was predetermined by whatever price was in the envelope), this procedure gives incentives for respondents to report their true willingness to pay (For details on the assumptions underlying incentive compatibility, and evidence as to the imperfect but approximate realism of those assumptions, see reference [24]).

Two weeks after the end of the randomised trial, the researchers revisited the households that were willing to buy the filter, but were unable to buy it either because the filter was not the randomly selected auctioned product assigned to them in the BDM procedure or because their WTP was below the envelope price. Based on their

previously reported willingness to pay information, researchers gave these participants the opportunity to buy the product at their stated price rather than the envelope price. Thus, some participants received the siphon filter free of cost (if the envelope had zero as its price) and others paid up to US \$5.

Follow-up surveys to assess sustained filter use

In March 2010, 3 months after receiving the filter and then again in June 2010, 6 months after receiving the filter, follow-up surveys were conducted among households which received siphon filters. In August 2010, field workers collected qualitative data through group discussions and in-depth interviews to understand the motivators and barriers of sustained filter usage. During the follow-up period, there were no additional promotion activities to encourage filter use. A flow diagram on study activities is shown in Figure 1.

The siphon filter

The CrystalPur siphon filter is a low-cost (expected retail US\$7) POU water treatment product (Figure 2) [20]. In a laboratory environment, this silver-impregnated filter removes $\log_{10}$ 4.4–5.5 of *Escherichia coli* bacteria. The filter has a flow rate of approximately 3–5 l/h [25, 26].

The filter requires two water vessels. Users place the ceramic candle filter inside the upper vessel and fill it with water. Filtered water then flows to a lower vessel (Figure 3) [27]. We did not provide these water vessels with the filter, so users had to provide their own vessels. When the bulb is pressed, water starts to flow. The cloth pre-filter catches large particles before they reach the ceramic element, and this cloth filter can be washed by hand [28].

When debris builds up within the ceramic filter element, the flow rate decreases. The instructions explained how both backwashing and scrubbing can clean the ceramic element and restore the flow rate. The enumerators also explained this process.

To prevent recontamination of the filtered water, the intervention staff also recommended that users collect treated water in clean pots with clean hands and, at the end of each day, that they empty any extra water from the lower container into the upper container to avoid long-term storage.

Data collection

Quantitative surveys. For each of the 755 participants in the randomised trial group, interviewers collected

information about drinking water treatment practices and preference for water treatment products before participants began any free trials. Interviewers collected similar information on their 744 neighbours prior to measuring their willingness to pay for the filter.

Interviewers administered structured questionnaires via face-to-face interviews with all study participants to collect information on reported water treatment practices and barriers for filtering their water during both follow-up surveys. During the 3-month follow-up, the interviewers asked respondents who self-reported at least occasionally using the filter 12 items about attitudes towards filter usage and the perceived health benefits of filtering water (Table 1). Responses to questions on attitudes were collected using 5-point Likert items that ranged from 'strongly agree' to 'strongly disagree'.

During both surveys, the interviewers visually inspected each filter and recorded whether the filter was currently being used. Specifically, they recorded water moving through the filter or the upper pot being wet and lower pot having water or vice versa.

To assess bacterial contamination of stored drinking water, interviewers tested water samples from each home both at 3 and at 6 months with an H_2S test [29, 30]. The H_2S test is based on the fact that enteric bacteria reduce sulphur to hydrogen sulphide, which forms a black iron sulphide precipitate in the presence of ferrous iron. However, some bacteria that reduce sulphur are not organisms found in the gastrointestinal tract, and it is possible for non-biological processes to also reduce sulphur to hydrogen sulphide. In addition, the H_2S test does not quantify the number of bacteria or genus and species [29].

Qualitative study. We used a convenience sampling method to select 11 informants for in-depth interviews and 15 informants for two group discussions from the 38 households that were using the filter regularly in the 6-month follow-up survey. Among these 38 households, 17 were irregular/non-users of filters at the time of the 3-month follow-up survey. The participants were a mix of both Bengali and Bihari ethnic groups. Four field researchers with experience in qualitative data collection interviewed the participants on motivators and barriers of sustained use of the CrystalPur siphon filter.

The group discussions and the in-depth interviews were conducted in the local Bengali language following an interview guideline. Each interview lasted 45–90 min and data were captured with a digital audio recorder. In group discussions, the qualitative research team performed a ranking exercise with participants focusing on the motivators and barriers of regular filter use that

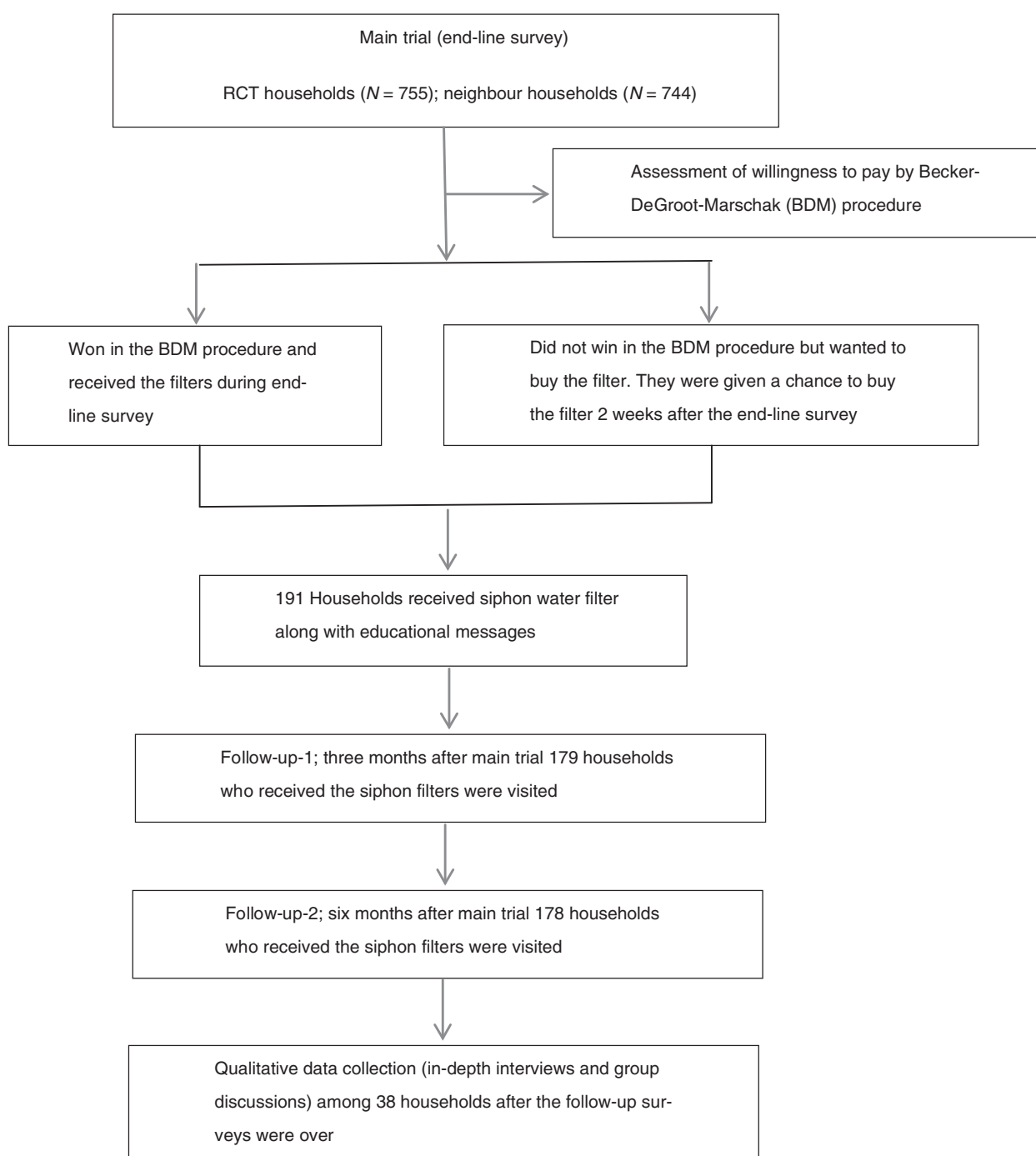


Figure 1 Flow diagram of study activities.

participants reported during the in-depth interviews. In the ranking exercise, the participants identified and prioritised the reasons for both using and not using the filter regularly.

Data analysis

Quantitative data analysis. Data were analysed using STATA statistical software (version 10). Respondents

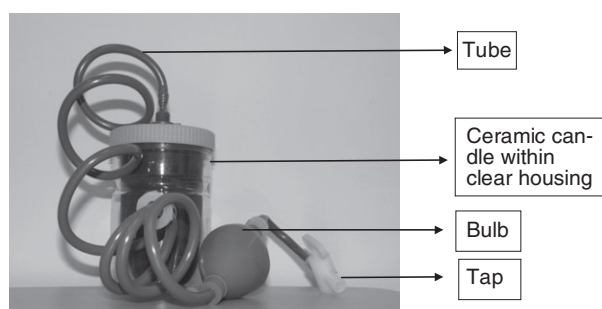


Figure 2 The CrystalPur siphon filter.

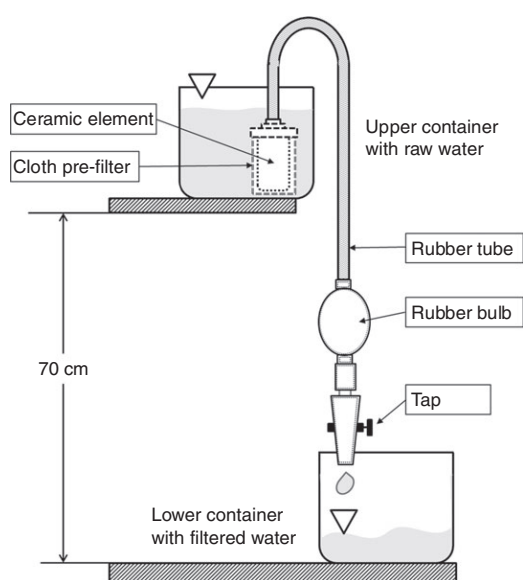


Figure 3 The CrystalPur siphon filter set-up (source: Tanzaniqua, 2008).

were classified as regular users if they self-reported that they used the filter most of the time after collecting water, and if the interviewers observed the filter in use at the time of interview. People were classified as non-users if they reported never using the filter in the 3 months prior to the date of interview. People who met neither the criteria for regular users nor the criteria for non-users were classified as irregular users.

We compared the proportion of households with contaminated drinking water at home between the filter users (both regular and irregular) and non-users. We calculated means and standard deviations of the responses to each of the 12 Likert-scale items that assessed the respondents' perceived value, convenience and other strengths and weaknesses of the filter at individual level during the

3-month follow-up. We defined score direction of an item as positive or negative depending on whether the item assessed the positive or negative aspects of filter use. We used factor analysis to construct a continuous variable from these 12 Likert-scale items and named it as 'attitude towards using the filter' [31]. We used Kaiser–Meyer–Olkin measure to check sampling adequacy for performing factor analysis. For the factor analysis, we used principal factor solution approach on the correlation matrix for the individual items (i.e. standardised item scores). We then performed varimax rotation. Based on the scree plot, we identified factors that jointly explained 85% of total variation. We calculated Cronbach's alpha to assess the internal consistency of the attitude scale towards using the filter [31]. We analysed data using both univariate and multiple logistic regression analysis to identify the variables predicting regular filter usage. On exploratory analysis, explanatory variables with a P -value of ≤ 0.1 from the univariate analyses were included in the multiple logistic models. We estimated the effect of predictors on 'regular filter usage' by calculating odds ratios (ORs), 95% confidence intervals (CIs) and corresponding P -values. We considered the 'willingness to pay' variable both in categorical and in continuous (data presented in Appendix 1) scales in separate regression models to check robustness of the analysis.

Qualitative data analysis. The qualitative team made summaries of each interview after transcribing the audio recordings into English. They then manually analysed the data by compiling it under themes, such as the barriers and motivators related to filter use. They then examined the similarities, differences and connections between each theme.

After analysing the data, we applied the IBM-WASH framework to the factors that we identified as predictors and barriers of siphon filter usage.

Ethics clearance

We obtained informed consent from an adult study participant from each household and maintained the confidentiality of the data throughout the study period and during analysis. The study protocol was reviewed and approved by the Ethical Review Committee of icddr,b.

Results

Adoption and sustained use of filters

Among the 1499 respondents in the RCT who participated in the BDM procedure, 71% ($n = 1059$) reported a

Table 1 Descriptive results for individual questionnaire items on attitude by filter user groups during the 3-month follow-up survey, Dhaka, Bangladesh*

Multi-item measurement of attitude towards using the filter	Score direction	Regular users			Irregular users			P-value of difference in means
		Mean	SD†	n	Mean	SD†	n	
Using the water filter makes me feel 'I am a person who takes good care of her children'	Positive	4.98	0.14	50	4.66	0.81	96	0.01
Using the water filter makes me feel 'I am a modern person who does not drink untreated water'	Positive	4.96	0.20	50	4.55	0.87	96	<0.01
Using the water filter makes me feel 'I am treating water like a rich person'	Positive	4.10	1.47	50	3.78	1.51	96	0.22
Using the water filter makes me feel 'I am setting a good example for my community so that they also follow me in treating their drinking water'	Positive	4.40	1.11	50	4.27	1.07	96	0.49
Using the water filter makes me feel 'I am improving my health'	Positive	4.94	0.24	50	4.57	0.79	96	<0.01
Using the filter to treat water is an effective way of preventing diarrhoea	Positive	4.96	0.20	50	4.71	0.86	96	0.04
I am proud that I own a water filter that I use to treat my drinking water	Positive	4.78	0.46	50	4.48	0.73	96	0.01
I am satisfied with using the filter	Positive	4.82	0.39	50	4.52	0.68	96	<0.01
Using the filter is easy	Positive	4.92	0.27	50	4.12	1.12	96	<0.01
I am happy that I purchased or received the filter	Positive	4.78	0.42	50	4.50	0.65	96	<0.01
Using the filter to clean drinking water makes the water taste bad	Negative	4.80	0.81	50	4.79	0.75	96	0.95
Using the filter to clean drinking water makes the water smell bad	Negative	4.78	0.82	50	4.73	0.84	96	0.72

*Higher numbers indicate more positive attitudes towards using the filters.

†SD (Standard Deviation).

positive willingness to pay (US\$ >0) for the siphon filter. Of those reporting positive willingness to pay, only 13% ($n = 191$) received the filter. As willingness to pay was not related to the filter transaction price, some households paid for the filter and others received it free of charge. Of the 191 households, we interviewed 179 (94%) for the 3-month follow-up and 178 (93%) for the 6-month follow-up.

The majority of the households (88%) receiving siphon filters had access to piped drinking water supply (Table 2), although water was only available intermittently. The proportion of households that purchased or received the filter free of charge was similar for those who had or did not have direct experience of using this particular filter in the randomised trial (Table 2).

At the 3-month follow-up visit, 146 of 179 respondents (82%) reported ever using the filter and 28% ($n = 50$) had used it regularly during the 3 months they had owned it. Regular usage decreased to 21% ($n = 38$) at the 6-month follow-up visit, thus a decline of 7% points in 3 months. However, 45% ($n = 17$) of the regular users at the 6-month follow-up were identified as irregular or non-users during 3-month follow-up.

During the 3-month follow-up, fewer regular users had contaminated drinking water at home, as determined by the H₂S test performed among the regular, irregular and non-users, but the differences were not statistically significant (uncontaminated water: 26% *vs.* 22% and 26% *vs.* 18%; Table 3). However, the regular filter users had significantly better quality water at home at the 6-month follow-up visit than both the irregular and non-users (uncontaminated water: 50% *vs.* 16% and 50% *vs.* 26%; Table 3).

Applying IBM-WASH theoretical framework to the identified factors affecting siphon filter usage

All the predictors and barriers fitted well into the technology, psychosocial and contextual dimensions of the IBM-WASH framework either at individual or at habitual level.

Technology dimension at individual level: willingness to pay

Reporting willingness to pay more than US\$ 1 for the filters predicted regular filter usage at the follow-ups (at

Table 2 Socio-demographic characteristics of participants who did or did not purchase/receive the CrystalPur filters, Dhaka, Bangladesh*

Socio-demographic characteristics	Purchased or received the filters N = 191 (%)	Did not receive or purchase the filters N = 1308 (%)	P-value of difference in means/proportions
Age (mean, SD)	28 (7.5)	28 (7.9)	0.76
Female	97	97	1.00
Bengali ethnicity	70	58	<0.01
Respondent's education			
No formal education	38	42	0.29
Below primary	38	39	0.79
Some secondary & above	24	19	0.10
Income per household (monthly)†			
<4000 taka	35	32	0.41
4001 to 10 000 taka	50	54	0.30
>10 000 taka	15	13	0.45
Source of water supply			
Piped water	88	82	0.04
Deep tubewell	8	16	<0.01
Other	4	3	0.5
Shared water source	86	91	0.03
Had past experience of using the filter	43	37	0.11
WTP >US\$ 1	49	35	<0.001
WTP (Mean US\$)	1.5	1.0	<0.001
Has a positive WTP	100	66	<0.001
Envelope price (Mean US\$)	0.4	0.7	0.001
(among those with positive WTP)			
Self-report boil drinking water (at baseline, prior to receiving filter or starting any free trial)	37	32	<0.001

WTP, willingness to pay.

*Sample = participants in the randomised trial (both the sample who received the free trials and their neighbours).

†US\$ 1 = 69 taka (2009 conversion rate).

Table 3 Water quality of participants using or not using the filters after 3 months and 6 months of receiving it, Dhaka, Bangladesh, 2010

Follow-up time point	Regular usage rate	H ₂ S test negative (no detectable contamination)			P-value of difference in water quality among regular and irregular users	P-value of difference in water quality among regular and non-users
		Regular user	Irregular users	Self-reported non-user*		
3-month follow-up (N = 179)	28% (50/179)	26% (13/50)	22% (21/96)	18% (6/33)	0.59	0.40
6-month follow-up (N = 178)	21% (38/178)	50% (19/38)	16% (8/51)	26% (23/89)	0.001	0.01

*People who reported not using the filter within the last 3 months from the date of interview.

3-month follow-up: OR: 2.6; 95% CI: 1.2, 5.8; at 6-month follow-up: OR: 2.9; 95% CI: 1.0, 5.3; Table 4). Recall of the prices paid for the filter was always less than or equal to reported willingness to pay. We also considered the willingness to pay on a continuous scale in the regression model which showed that higher

willingness to pay was associated with regular filter usage at both time points (data presented in Appendix 1).

27% (*n* = 48) of the respondents received the filter free of charge as a result of zero envelope price in the auction. There were no statistically significant differences in regular filter use between people who received it free of

Table 4 Factors associated with regular *vs.* irregular usage 3 and 6 months after receiving the filter*

Predictors	3-month follow-up		6-month follow-up	
	Univariate logistic regression OR (95% CI)	Multiple logistic regression OR (95% CI)	Univariate logistic regression OR (95% CI)	Multiple logistic regression OR (95% CI)
Willingness to pay >US\$ 1	2.7 (1.4, 5.3)	2.6 (1.2, 5.8)	2.9 (1.4, 6.3)	2.2 (1.0, 5.3)
Attitude towards using the filter (at 3-month follow-up)†	3.2 (1.6, 6.5)	4.3 (1.9, 9.8)	1.9 (1.0, 3.8)	2.1 (1.0, 4.7)
Boil drinking water (self-report at baseline)	2.4 (1.2, 4.9)	2.4 (1.1, 5.2)	2.3 (1.1, 4.9)	2.0 (1.0, 4.7)
Ethnicity (Bihari)	0.5 (0.2, 0.8)	0.6 (0.2, 1.3)	0.1 (0.02, 0.4)	0.1 (0.03, 0.6)

*Sample = Respondents with regular or irregular filter usage at 3 and 6 month surveys.

†Considering the exposure variable 'attitude at 3-month follow-up (3 months after receiving filter)' in the logistic regression model of 6-month follow-up (6 months after receiving filter).

Multivariable regression was also run comparing regular filter users with irregular plus non-users (excluding 'attitude' variable as not measured on non-users). Similarly, significant results for willingness to pay >US\$ 1, boiling and ethnicity were found at both time points.

charge and those who purchased it (at 3-month follow-up: OR: 1.6; 95% CI: 0.7, 3.3; at 6-month follow-up: OR: 0.7; 95% CI: 0.3, 1.6).

Technology dimension at individual and habitual level: attitude towards using the filter

Having a positive attitude towards using the filter during the 3-month follow-up strongly predicted filter use during that follow-up (OR: 4.5; 95% CI: 1.7, 12.2), although the association was weaker at 6-month follow-up (OR: 2.7; 95% CI: 0.9, 7.9) (Table 4).

The Cronbach's alpha of the variables that were used to construct the 'attitude towards using the filter' variable was 0.8, revealing a high degree of internal consistency of the attitude scale [32].

The qualitative data collected from the regular filter users further supported the relationship between having positive attitude towards the filter and regular usage. The most frequent reason (86%) respondents gave for filter use was the health benefits. Respondents mentioned that their children became ill with diarrhoea, dysentery, jaundice and vomiting less often than when they did not use a water filter.

Another frequently mentioned (28%) reason for regular use of the filter was the poor quality of the local water supply: when available, it usually came out of the tap looking murky and brownish. The filter improved the clarity of their drinking water, which made respondents more confident that it was safe.

Participants also liked the taste and smell of filtered water (43%). Some of the respondents had experience with chlorine-based water treatment products either as

part of the randomised trial or through previous exposure to chlorine-based products distributed by other non-government organisations. They reported that water treated with those products had an unpleasant smell.

Some respondents (50%) mentioned that their children preferred the taste of filtered water over the source water, which motivated them to continue to use it. Some respondents (21%) preferred filtering water over boiling drinking water because filtering felt easier than boiling. As one of the mothers explained, *Boiling is tough work ... it required time. First we had to take the pot full of water to the burner and had to boil it for long then had to wait for getting the cold water ... for these reasons sometimes we don't boil drinking water or we drink source water directly while boiled water is not available ... Filtering water is easier than boiling ...*

Most low-income Dhaka residents have unmetered gas connections, so boiling involves only a time cost, but no financial input. For those without unmetered gas, boiling is expensive. As another informant said: *We do not have a gas connection ... Wooden fuel costs 5–7 taka [\$0.10] per kilogram ... Now we do not have to pay for boiling drinking water as we have a filter ...*

Psychosocial dimension at habitual level: existing water treatment habit

The 37% of respondents ($n = 67$) who reported boiling drinking water at baseline were more likely to use the filter regularly during both the 3-month and the 6-month follow-up surveys (at 3-month follow-up: OR: 2.4; 95% CI: 1.1, 5.2; at 6-month follow-up: OR: 2.0; 95% CI: 1.0, 4.7; Table 4).

Contextual dimension at individual level: ethnicity

A higher share of Bengali participants purchased or received the filter than Bihari participants (15% *vs.* 10%; $P < 0.01$). The higher rate of acquiring the filter was due to a greater propensity to report a positive WTP (63% *vs.* 37%) and higher mean WTP (US\$ 1.8 *vs.* US\$ 1.0; $P = 0.001$).

Being Bihari (not Bengali) also predicted lower filter use (at 3-month follow-up: OR: 0.6; 95% CI: 0.2, 0.8; at 6-month follow-up: OR: 0.1; 95% CI: 0.03, 0.6; Table 4). Other demographic factors such as education and household assets were not predictors of regular filter use and therefore were not included in the regression model.

Barriers to regular filter use (technology dimension of IBM-WASH)

Respondents' open-ended responses about why they were not using the filter during both quantitative follow-up surveys were predominantly that using the filter is an additional task and that they experienced hardware problems (Table 5). A higher share of non-boilers at baseline identified using the filter as an additional task compared to the boilers (at 3-month follow-up: 59% *vs.* 41%, $P = 0.2$; at 6-month follow-up: 79% *vs.* 21%, $P < 0.001$).

Table 5 Reasons reported by the irregular and the non-users for not using the filter regularly (in response to open-ended questions asked during the follow-up surveys)

Reported barriers	3-month follow-up $n = 129$ (%)	6-month follow-up $n = 141$ (%)
Additional task	17 (13)	28 (20)
Drink boiled water	21 (16)	20 (14)
Filter was broken	13 (10)	20 (14)
Had to wait too long to have safe water	14 (11)	17 (12)
Do not have a place/container to set the filter	13 (10)	15 (11)
Did not feel it is necessary to use	9 (7)	17 (12)
Filter was clogged	6 (5)	4 (3)
Did not like the taste/small of filter-treated water	5 (4)	2 (1)
Did not know/forgot the instructions to use	5 (4)	2 (1)
Too complicated to use	2 (2)	0 (0)
Other responses*	17 (13)	12 (9)

*Other reported barriers include: mothers had to be alert all the time so the children do not break it; the filter needs extra space; doctor advised to boil water instead of using the filter.

Exploration of qualitative data collected from the regular filter users suggests that the most often reported barrier to regular use of the filter was the time required to filter the water. This barrier particularly affected large families that needed a larger volume of drinking water. As one of our 42-year-old informants who was a handicrafts worker said: *We are 10–12 persons in our family. The amount of filtered water was not adequate; the flow rate of water was also slow. Along with filtered water we had to drink source water directly . . . In this situation, what we could do other than drinking source water directly?*

Many respondents who lived in small rooms with no large common area also reported that lack of space to set the filter was a barrier. Some of those who were non-boilers at baseline felt that using the filter was an added task to their daily chores.

Discussion

While correctly utilised POU products can improve water quality, health benefits require sustained, consistent and widespread usage. The randomised trial found that the CrystalPur siphon filter was the most popular POU water treatment product, but the maximum self-reported rate of use of this product was still only 29% during the trial [20]. After receiving the CrystalPur siphon filters at the end of the randomised trial (either at a cost or for free), approximately a quarter of households were using it regularly during the 3-month follow-up visit, but regular use dropped to approximately one-fifth by the 6-month follow-up visit. Other studies have similarly reported that sustained use of POU water treatment intervention declines with time. In Bolivia, there was an approximately 20% decline in use of water filtration device after 9 months of implementation [33]. An assessment of a household-scale water filtration device provided at no cost to residents in rural Cambodia showed a decline in sustained usage at a rate of 2% per month after the implementation was over [34]. We found regular filter usage declined by 7% from months 3 to 6, and the usage rate after 3 months among our study participants was much lower than in the Bolivian and Cambodian studies.

We have explained the identified barriers and motivators related to regular filter usage through IBM-WASH framework. The technology dimension of the framework explained the commonly reported barriers to regularly using the filter. In this study, hardware problems were one of the most frequently reported barriers to regular filter use during both follow-up surveys. About 3% of the filters broke every month, a barrier to regular usage noted in several other studies [33, 34]. Another important

barrier was the burden of treating the water, reported as 'an additional task'. During qualitative in-depth interviews, some respondents elaborated that using the filter increased their workload and took up precious time. In low-income settings, women spend a substantial amount of time on household tasks, including collecting water for innumerable household uses, often from shared water sources which require queuing for long periods [35]. Another commonly reported barrier in the surveys included long wait times for obtaining the filtered water, which is consistent with findings from other studies [34].

However, some of the factors related to the other technology dimensions of IBM-WASH framework, such as the perceived cost/value of the filter and having a positive attitude towards the attributes of the filter, were strong motivators for people for regularly using the product.

Willingness to pay for a product represents the respondent's perceived cost/value for a product, which is an important component of technology dimension of IBM-WASH framework. In our study, higher WTP for the filters measured using the BDM procedure was a predictor of using the filter regularly [36]. It is possible that charging positive prices in the auction that was designed following the BDM procedure selected those who did not value the product [37]. As the auction mechanism was incentive compatible and presuming that the participants understood the rules properly, their reported WTP rather than the actual price they paid should reveal their true valuation for the product, and we did indeed find that continuation of filter use occurred regardless of the final transaction price. Higher WTP for the filter (even if some ultimately received it for free) could be associated with greater use if individuals perceive that the technology is of higher quality [38]. While WTP informs about consumer valuations for the filter, respondents' usage behaviour in line with their WTP also provides information about price responsiveness of demand and could be informative for choosing a pricing mechanism that would ensure maximal uptake of the 'hardware' to maximise associated health benefits.

The technology dimension of IBM-WASH model at individual level also predicted regular filter usage in terms of respondents' positive attitudes towards using the filter. Our selection of items to construct 'attitude' were related to perceived value and strengths and weakness of the siphon filter. Attitudes sometimes precede behaviour [39], sometimes follow behaviour [40], and sometimes have a reciprocal relationship with behaviours [41–46]. We found that regular filter users had higher positive attitudes towards using the filter during the 3-month follow-up than irregular users. We also found that higher positive attitudes during the 3-month follow-up weakly

predicted regular filter usage at the 6-month follow-up. The positive correlation is consistent with a study in Zimbabwe that found favourable attitudes predicted sustained water treatment using solar water disinfection [47].

The appropriateness of selected items to measure attitude through quantitative data was confirmed through our qualitative exploration. Our regular user informants focused on the health benefits of using the siphon filter because they perceived their children suffered less often from various gastro-intestinal illnesses. They expressed satisfaction in taking good care of their children. They also liked the taste and smell of filter-treated water. The only benefit that the regular users mentioned during qualitative data collection that we did not include in the quantitative data collection tool on measuring attitude was 'relief from the hassle of treating water through boiling'.

Psychosocial dimension of IBM-WASH framework at habitual level was represented by reporting of boiling water at baseline, which was another important predictor for regular filter use. In other contexts, an increased awareness and involvement with water issues predicts early adoption and regular use of a water treatment technology [48]. Before receiving the filter over a quarter of the participants reported, they boiled their water [20]. Greater use could also be related to greater interest in improving household water quality, which is supported by the presence water boilers at baseline. Our qualitative data suggest that participants who boiled their water previously found the filter a reduction in effort. In contrast, previous non-boilers perceived using the filter as an additional and time-consuming task.

The important relationship of contextual dimension of IBM-WASH framework with usage of an intervention was explained through the relationship of 'ethnicity' with filter usage. Bengali respondents used the filter more regularly than Bihari respondents. The underlying reasons for this correlation are unclear but could be due to cultural differences, as the Bihari ethnic group resembled their Bengali neighbours on education, income and the other baseline characteristics we measured. This result is consistent with lower use of the POU products by Bihari during free trials in the previous study [20].

The proportion of households that purchased or received the filter was similar among people who did or did not have past experience of using this particular filter in the randomised trial. This result is consistent with the findings from the randomised trial where we found no evidence of increased interest to purchase POU products among households that had the free trials compared to their neighbours [23]. In this context, creating a

sustainable market for the CrystalPur siphon filter is unlikely to be feasible. If experience does not encourage people to buy a product, there is less possibility that the product will be widely used. This conclusion is reinforced by the finding of high rate of non-use among people who were willing to buy this product.

People who were regular filter users at the time of visit had better quality water at home than the people who were not using the filter regularly, although the results were statistically significant only for the 6-month follow-up. As has been reported in other studies, filtered water is prone to recontamination without safe storage. Thus, proper handling and storage before consumption needs to be considered [27]. It is possible that those who remained regular filter users developed good handling technique given that a much higher proportion of water among users from this period had a negative H₂S test.

Our study has a number of limitations. First, the design of the CrystalPur is different from filters commonly available in the market, and therefore, the measure of sustainability may not apply to other filters. Second, we collected qualitative information on barriers of using the filter only from the regular users, whereas in the quantitative survey, we focused on irregular users and non-users for identifying barriers. Therefore, the reported barriers revealed through the qualitative data may not be relevant for those who were irregular or non-users, the group for whom information would be most useful for shaping interventions to promote sustained use. However, during the survey, we found some of the irregular and non-users of filter in the 3-month follow-up became regular filter users in the 6-month follow-up. Therefore, some of the regular users providing qualitative data were previously irregular or non-users, and the qualitative data were therefore not strictly confined to regular filter users.

In summary, among our study participants who would have benefitted from this particular POU water treatment technology, few were willing to purchase it at a price near the retail price during the randomised trial [20]. Of the people who had received it for free or purchased it, only a minority had positive attitudes towards using the filter and continued regular use. Considering the hardware-related problems reported by study participants and the low level of market demand for the filter, the contribution of the CrystalPur filter to improving water quality in low-income urban communities in Bangladesh is likely to be minimal, despite its efficacy in improving water quality. This study adds to the considerable evidence that only a small minority of low-income households practice efficacious household water treatment [5–7, 49]. Unless future products result in higher demand and increased uptake among the population at highest risk for adverse

health outcomes, POU water treatment device such as siphon water filter is likely to contribute little to reducing the global burden of disease caused by poor water quality.

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Appendix I

Factors associated with regular *vs.* irregular usage 3 and 6 months after receiving the filter*

Predictors	3-month follow-up		6-month follow-up	
	Univariate logistic regression OR (95% CI)	Multiple logistic regression OR (95% CI)	Univariate logistic regression OR (95% CI)	Multiple logistic regression OR (95% CI)
Willingness to pay (taka)†	1.004 (1.001, 1.008)	1.005 (1.001, 1.010)	1.004 (1.001, 1.008)	1.003 (1.0, 1.007)
Attitude towards using the filter (at 3-month follow-up)‡	3.2 (1.6, 6.5)	4.3 (1.9, 9.8)	1.9 (1.0, 3.8)	2.1 (1.0, 4.7)
Boil drinking water (self-report at baseline)	2.4 (1.2, 4.9)	2.8 (1.3, 6.2)	2.3 (1.1, 4.9)	2.1 (0.9, 4.8)
Ethnicity (Bihari)	0.5 (0.2, 0.8)	0.6 (0.2, 1.6)	0.1 (0.02, 0.4)	0.1 (0.03, 0.6)

*Sample = Respondents with regular or irregular filter usage at 3 and 6 month surveys.

†1 USD = 68.4 Bangladesh taka (year 2009 money conversion rate).

‡Considering the exposure variable ‘attitude at 3-month follow-up (3 months after receiving filter)’ in the logistic regression model of 6-month follow-up (6 months after receiving filter).

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Chapter 5: Impact of adding hand-washing and water disinfection promotion to oral cholera vaccination on diarrhoea-associated hospitalization

In chapters 5-7, I have presented the findings from the randomised controlled trial, ‘Introduction of cholera vaccine in Bangladesh’ (ICVB). I have included the published papers relevant to the chapters at the end of each chapter.

Chapter 5 focuses on examining effects of an intervention to promote handwashing with soap and also drinking water disinfection in addition to oral cholera vaccination, on diarrhoea-associated hospitalization in the ICVB study. Chapter 6 compared whether data collected using two different survey methodologies, carried out by different data collection teams to elicit reported diarrhoea, impacted on the interpretation of intervention effects on reported diarrhea among children aged ≤ 5 years in the ICVB study. I also compared the reported diarrhoea data with objectively measured diarrhoea-associated hospitalisation rates for children ≤ 5 years in the same study. Finally, in chapter 7, I reported on an assessment of the impact of hand-washing promotion on reported respiratory illness from the ICVB study.

5.1 Chapter overview

Hand washing and point-of-use water treatment interventions have been effective in preventing diarrhoea in small-scale efficacy studies. It is still unclear whether these approaches are effective when implemented on a larger scale. It is also unclear whether combining cholera vaccination with behaviour-change interventions incrementally

increases health benefits. In this chapter, I have presented results from a cluster-randomised controlled trial that we conducted in 2011 among ~60,000 low-income households of metropolitan Dhaka, Bangladesh with an aim to examine effects of a large scale intervention to promote hand-washing with soap and drinking water disinfection in addition to oral cholera vaccination on an observable outcome namely diarrhoea-associated hospitalization. I found that neither cholera vaccination alone nor cholera vaccination combined with behaviour-change intervention efforts promoting hand washing and water treatment measurably reduced diarrhoea-associated hospitalisation in this highly mobile population, during a time when cholera accounted for a small fraction of diarrhoea episodes. One of the most important reasons for the lack of impact of the behavioural intervention in this study may have been because of the low uptake. Therefore, developing better behavioural interventions that increase water treatment and hand-washing remain important in areas where marginal improvement is possible. Based on my study findings I conclude that, while the low rate of cholera and high rate of population migration accounts for the limited impact of oral cholera vaccination, the failure of the drinking water and hand-washing interventions underscores the need for investment in research to improve the effectiveness of community wide interventions that separates human faeces from the environment, food and water supply of low income country residents.

The findings from this study have been published in the **International Journal of Epidemiology**.

5.2 Declaration for thesis chapter 5

Monash University

Najnin N, Leder K, Qadri F, Forbes A, Unicomb L, Winch PJ, et al. Impact of adding hand-washing and water disinfection promotion to oral cholera vaccination on diarrhoea-associated hospitalization in Dhaka, Bangladesh: evidence from a cluster randomized control trial.

International Journal of Epidemiology. 2017;46(6):2056-66.

Declaration by candidate

In the case of Chapter 5, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Literature review, statistical analysis and interpretation of results, development and writing the manuscript.	80%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Karin Leder	interpreted results and provided critical comments	N/A
Firdausi Qadri	designed the study, served as principal investigators, interpreted results; critically revised the paper	N/A

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Andrew Forbes	analysed and interpreted data; reviewed the manuscript, drafted or critically revised the paper	N/A
Leanne Unicomb	oversaw data collection, supervised behavioural intervention implementation; critically revised the paper	N/A
Peter J. Winch	designed behaviour interventions, provided input on data collection instruments; critically revised the paper	N/A
Pavani K. Ram	designed behaviour interventions, provided input on data collection instruments; critically revised the paper	N/A
Elli Leontsini	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Fosiul A. Nazame	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Shaila Arman	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Farzana Begum	supervised implementation of behavioural interventions; reviewed the manuscript, critically revised the paper	N/A
Shwapon K. Biswas	supervised data collection; reviewed the manuscript, drafted or critically revised the paper	N/A
John D. Clemens	interpreted results and provided critical comments	N/A

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Mohammad Ali	interpreted results and provided critical comments	N/A
Alejandro Cravioto	interpreted results and provided critical comments	N/A
Stephen P. Luby	designed the study, served as principal investigators, interpreted results; reviewed the manuscript, drafted or critically revised the paper and approved the final version for submission	N/A

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work.

Candidate's

Signature

	15/07/2019
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Main

Supervisor's

Signature

	22/07/2019
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Miscellaneous

Impact of adding hand-washing and water disinfection promotion to oral cholera vaccination on diarrhoea-associated hospitalization in Dhaka, Bangladesh: evidence from a cluster randomized control trial

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Abstract

Background: Information on the impact of hygiene interventions on severe outcomes is limited. As a pre-specified secondary outcome of a cluster-randomized controlled trial among >400 000 low-income residents in Dhaka, Bangladesh, we examined the impact of cholera vaccination plus a behaviour change intervention on diarrhoea-associated hospitalization.

Methods: Ninety neighbourhood clusters were randomly allocated into three areas: cholera-vaccine-only; vaccine-plus-behaviour-change (promotion of hand-washing with soap plus drinking water chlorination); and control. Study follow-up continued for 2 years after intervention began. We calculated cluster-adjusted diarrhoea-associated hospitalization rates using data we collected from nearby hospitals, and 6-monthly census data of all trial households.

Results: A total of 429 995 people contributed 500 700 person-years of data (average follow-up 1.13 years). Vaccine coverage was 58% at the start of analysis but continued to drop due to population migration. In the vaccine-plus-behaviour-change area, water plus soap was present at 45% of hand-washing stations; 4% of households had detectable

chlorine in stored drinking water. Hospitalization rates were similar across the study areas [events/1000 person-years, 95% confidence interval (CI), cholera-vaccine-only: 9.4 (95% CI: 8.3–10.6); vaccine-plus-behaviour-change: 9.6 (95% CI: 8.3–11.1); control: 9.7 (95% CI: 8.3–11.6)]. Cholera cases accounted for 7% of total number of diarrhoea-associated hospitalizations.

Conclusions: Neither cholera vaccination alone nor cholera vaccination combined with behaviour-change intervention efforts measurably reduced diarrhoea-associated hospitalization in this highly mobile population, during a time when cholera accounted for a small fraction of diarrhoea episodes. Affordable community-level interventions that prevent infection from multiple pathogens by reliably separating faeces from the environment, food and water, with minimal behavioural demands on impoverished communities, remain an important area for research.

Key words: Vaccine, hand-washing, water treatment, diarrhoea, hospitalization

Key Messages

- Neither cholera vaccination alone nor cholera vaccination combined with hand-washing and water treatment promotion measurably reduced diarrhoea-associated hospitalization.
- The possible reasons for lack of impact of cholera vaccine alone on all-cause diarrhoea hospitalization were: cholera incidence was too low during the study period; and high migration rate diluted cholera vaccination coverage of the intervention areas during the period of the analysis.
- The reason for the lack of impact of the behavioural intervention on diarrhoea-associated hospitalization may have been because of the low uptake.
- Affordable community-level interventions that prevent infection from multiple pathogens by reliably separating faeces from the environment, food and water in impoverished communities remain an important area for research.

Introduction

Diarrhoeal diseases continue to be a major cause of morbidity and mortality in low-income countries, including Bangladesh.^{1–4} In Bangladesh, parents of approximately 36% of the children < 5 years of age, who suffer from diarrhoea, seek care from a hospital or health care centre.⁵

Water, sanitation and hygiene interventions can effectively interrupt transmission of gastrointestinal pathogens to reduce diarrhoea.⁶ The optimum long-term solution in low-income countries would be to build and maintain a water and sanitary infrastructure that consistently separates faecal waste from water and food supplies but, for complex reasons including limited supply, poor governance and low water tariffs leading to lack of funding, achieving this goal in the short term is not feasible.⁷ Therefore, interim approaches for immediate implementation to reduce disease burden would be useful.

One option for preventing diarrhoea is vaccination for specific gastrointestinal pathogens. In cholera-endemic areas, cholera vaccine has been demonstrated to reduce morbidity and mortality from cholera disease including all-cause

diarrhoea-associated hospitalization when the burden of cholera was high.^{8–12} Two other rigorously evaluated low-cost approaches to prevent diarrhoeal disease include treatment of water at point of use and promoting hand-washing with soap.^{13,14} In rural Bangladesh, only 1% of people wash their hands with soap before eating or feeding children and only 14% wash their hands with soap after defecation.¹⁵ Boiling is the usual method for water treatment in urban areas especially where gas supply is available, but in a study conducted in urban Bangladesh only 37% boiled their water.¹⁶

Efficacy studies focusing on promoting water treatment at point of use and hand-washing with soap have targeted up to 4000 households in various countries where diarrhoea is a leading cause of death.^{13,14} However, whether these approaches are effective when implemented on a larger scale is unclear.^{17,18} Additionally, the efficacy of such interventions has been assessed mainly through potentially biased self-reported diarrhoea episodes rather than using an observable measurement to determine reduction in hospitalization rates for diarrhoea.¹⁹ It is also unclear

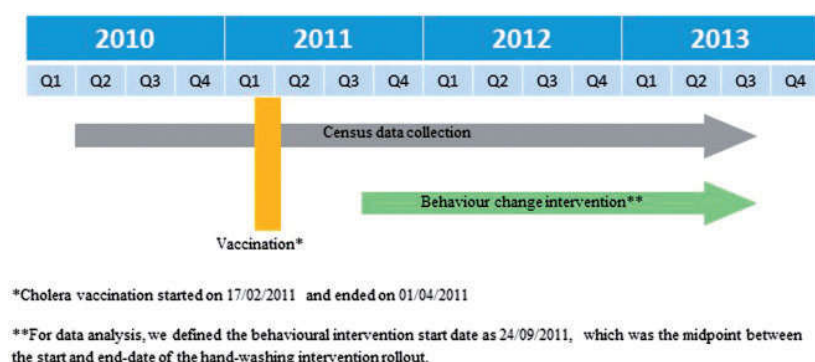


Figure 1. Study timeline.

whether combining vaccination with behaviour-change interventions incrementally increases health benefits.

In 2011, we conducted a cluster-randomized controlled trial that continued over 2 years among ~60 000 low-income households of metropolitan Dhaka, Bangladesh.⁹ This current paper reports a pre-specified secondary outcome, namely to examine effects of an intervention to promote hand-washing with soap and also drinking water disinfection in addition to oral cholera vaccination, on diarrhoea-associated hospitalization. We hypothesized that participants in the cholera vaccine-only intervention area would have lower hospitalization rates compared with the control. We also hypothesized that the combination of cholera vaccine plus hand-washing and point of use water treatment would further lower hospitalization rates for diarrhoea, compared with the vaccine-only intervention or control area.

Methods

Trial design, context and participant selection

We conducted a cluster-randomized controlled trial in diarrhoea-prone communities of urban Dhaka. Details of the study methods have been published previously (ClinicalTrials.gov Registration number: NCT01339845).⁹ The study areas were divided into 90 geographical clusters, each surrounded by a 30-m buffer zone to limit contamination of the interventions across clusters. Twelve governmental and non-governmental hospitals/clinics with inpatient facilities in and around the study area, and which were accessible to study participants, were included in the study. For the purpose of this study, data were collected from these hospitals/clinics to identify diarrhoea-associated hospitalization of the study participants.

Randomization

Ninety clusters were randomly assigned into three groups: (i) cholera vaccine alone (denoted as 'vaccine-only');

(ii) combined cholera vaccine and behaviour-change intervention (denoted as 'vaccine-plus-behaviour-change'); and (iii) control group which continued standard habits and practices. Blinding of the study investigators and participants was not possible.

Intervention

Vaccine

The WHO pre-qualified the vaccine Shanchol™ (ShanthaBiotechnics) as safe and effective against cholera,^{20,21} and it was approved for research purposes in this study. Details of vaccine transportation, storage and administration have been reported.⁹ Two vaccine doses were administered at least 14 days apart at no cost to non-pregnant participants aged ≥ 1 year. Vaccination was done between 17 February 2011 and 1 April 2011 (Figure 1).

Hand-washing and water treatment behavioural intervention

The hand-washing and water treatment intervention included distribution of enabling hardware and interpersonal counselling aided by support print materials. The behaviour change strategy was guided by the Integrated Behavioural Model for Water Sanitation and Hygiene (IBM-WASH) theoretical framework.^{22,23} Where households were organized into compounds with several households sharing a common water source, kitchen, and toilets, hardware enabling hand-washing and water treatment was provided at the compound level. The interpersonal counselling targeted people at both compound and household levels.

Dushtha Shasthya Kendra (DSK), a non-governmental organization, delivered the behavioural intervention and hardware. Within 3 months of cholera vaccination, community health promoters visited each compound and rolled out the hand-washing intervention, with the point of use water treatment intervention rolled out 3 months later.

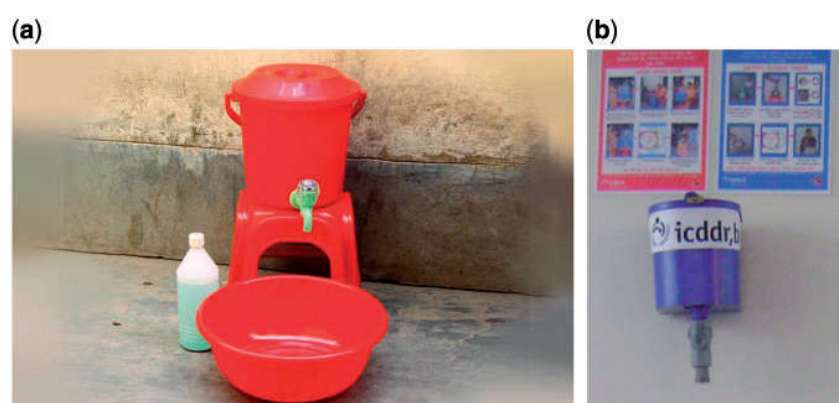


Figure 2. Hand-washing station [includes bucket with tap, bowl, and soapy water (a) and point of use water treatment hardware including chlorine dispenser and instruction sheets (b)].

Hand-washing hardware, provided free of charge, consisted of a bucket with a tap, a bowl where rinse water could accumulate, and a soapy water bottle (Figure 2a). Soapy water was prepared by mixing a commercially available powdered detergent with 1.5 l of water in a plastic bottle with a hole punched in the cap.²⁴ Promoters encouraged all households to either purchase inexpensive detergent sachets (~US\$0.03) to make soapy water, or purchase bars of soap (~US\$ 0.35). They encouraged all household members to wash hands regularly, especially after defaecation and before preparing food, and carefully explained all salient benefits. The latter were based on literature review and site-specific formative research, guided by the IBM-WASH theoretical framework.^{22,23} The water treatment hardware consisted of a chlorine dispenser containing liquid sodium hypochlorite (Figure 2b).²⁵ Study participants were encouraged to add chlorine to their own water vessels, which were marked to match the dispensed chlorine dosage with the size of the vessel. Benefits were again explained.

Promoters visited each compound at least three times during each of the first 2 months after placement of each hardware type. After full implementation, the frequency of visits was reduced to twice per month. During visits, along with promoting behavioural interventions, hardware-related problems (breakage/leakage) were addressed.

Study timeline

For data analysis, we defined the intervention outcome-monitoring start date as 24 September 2011 (Figure 1). We terminated follow-up for all individuals on 31 August 2013 or, if they had died or permanently out-migrated, their final date of assessment; during this monitoring period, study participants in the vaccine-plus-behaviour-change area (including in-migrants) continuously received the behaviour-change interventions.

Measurements

The pre-specified outcome of interest was the rates of hospital admission for diarrhoea of any clinical severity. We also conducted an exploratory analysis of the impact of the interventions on severe diarrhoea hospitalization. Severe diarrhoea was defined by the presence of at least two of the following signs and symptoms: sunken eyes, dry tongue, thirst, irritability, less active than usual, skin pinch going back slowly, low volume radial pulse along with inability to drink, or absence of radial pulse. The number of diarrhoea-associated hospitalizations (defined as ≥ 3 loose/liquid stools within 24 h²⁶) was collected through hospital surveillance. The number of person-years observed was estimated based on information collected through 6-monthly census updates, during which data collectors visited each house in the study areas to obtain information on births, deaths and migrations of individuals.⁹

Each month, a separate survey was conducted among a different set of 200 randomly selected study participants in the vaccine-plus-behaviour-change area, and 100 participants in each of the vaccine-only and control areas, to determine uptake of the hand-washing and water treatment interventions. Unannounced home visits assessed intervention uptake by examining for the presence of soap/soapy water and water in the most convenient place for hand-washing. Presence of residual chlorine in stored drinking water was tested using colorimetre (HACH LANGE GmbH, USA).

Statistical methods

Primary analysis

Using 6-monthly census data, we compared baseline demographic characteristics of study participants across the three intervention areas, and identified individuals who in- or out-migrated into the study area after outcome-monitoring commencement. Since the behavioural interventions were geographically based, people could not take

the intervention-enabling hardware with them following migration out of the vaccine-plus-behaviour-change area. Conversely, people migrating into the vaccine-plus-behaviour-change area gained access to interventions. Our analysis accumulated person-years for each individual in a time-dependent manner according to their time at risk in each trial area. Specifically, when a person moved from one trial area to a different trial area, or migrated for the first time into the overall study area, we waited 14 days before beginning to allocate their person-time to the in-migrated trial area so that the effect of their previous exposures could be reduced and their new exposure established. Once a person migrated out of the overall study area altogether, we stopped accumulating his/her person-time. We allowed multiple hospitalizations per individual by continuing accumulation of person-years after hospitalization.

We calculated the diarrhoea-associated hospitalization incidence by counting the number of admissions from each study area during the outcome-monitoring period, and summed the person-time that study participants contributed to each trial area. We adjusted hospitalization incidence rates for the cluster-randomized trial design, and the potential multiple hospitalizations per individual using robust standard errors applied at the cluster level. To calculate the hazard ratio for diarrhoea-associated hospitalization of any severity, we compared incidence of hospitalization for diarrhoea in the vaccine-plus-behaviour-change area with the control and to the vaccine-only areas using Cox proportional hazards regression with cluster-robust standard errors. Results were adjusted for age, sex, education and pre-intervention individual-level hospitalizations.

We divided the 2-year outcome-monitoring period into quartiles (term 1 to term 4) to examine the consistency of the intervention effect on incidence of hospitalization over time, using intervention*quartile interaction terms in the Cox proportional hazards regression models. We assessed effect modification of the intervention by age in a similar manner with interaction terms.

Supplementary analyses

These included:

- i. an analysis restricted to individuals who resided in the study area at the outcome-monitoring start date and remained in their original intervention area for the entire study duration; this analysis excluded new in-migrations after the outcome-monitoring start date;
- ii. an analysis allocating all person-time to the trial area of each individual at the outcome-monitoring start date, regardless of later migrations to other areas, and excluding in-migration after the outcome-monitoring start date.

Details regarding sample size calculations for the primary study outcome have been published elsewhere.⁹

Ethics

Informed consent from an adult study participant was obtained from each household. The study protocol was reviewed by Human Subject Committee at icddr,b, and the International Vaccine Institute.

Results

Participant characteristics and migration

During the 6–12 months before the outcome-monitoring started, 314 748 people lived in the study area (Table 1). Demographic characteristics were similar across the three areas except educational status, self-reported drinking water treatment practices, and presence of sanitary latrines which were slightly higher in the vaccine-plus-behaviour-change area (Table 1).

We identified 429 995 people who were in the study area at some time point during the outcome-monitoring period and contributed to 500 700 person-years of data; of them, 177 299 people left the study area before outcome-monitoring ended (Figure 3). The median duration of residence in the same house was 12 months. During intervention period, ~4% people ($n = 17\,951$) changed areas, but despite migration, the three areas remained balanced by demographic characteristics (data not shown).

Intervention uptake

Two-dose vaccine coverage during mass immunization was ~65%,⁹ but dropped to ~58% 6 months later, at the start of our analysis, due to population migration. Data from 24-monthly surveys collected from a subset of 7542 households showed that soap/soapy water and water was present at 45% (1729/3886) households of the primary hand-washing stations of the vaccine-plus-behaviour-change area, 22% (438/1965) of the vaccine-only and 28% (556/1991) of the control area. Residual chlorine, indicating uptake of the chlorine dispenser, was present in the stored drinking water of 4% (160/3886) of households in the vaccine-plus-behaviour-change area and none in the other two areas.

Presence of indicators for both hand-washing and point of use water treatment interventions were ~4% higher among people who stayed in the study area for at least 1 year after the intervention started, compared with those who migrated in or out or both.

Diarrhoea-associated hospitalization rates

During the outcome-monitoring period, the overall diarrhoea hospitalization rate for the primary analysis was 9.6/1000 person-years (95% CI: 8.8–10.4). The hospitalization rate

Table 1. Demographic characteristics across the intervention areas before outcome-monitoring started^{a,b}

Demographics	Vaccine-only area (<i>n</i> = 109700) %	Vaccine-plus-behaviour-change area (<i>n</i> = 107134) %	Control area (<i>n</i> = 97914) %
Age (mean, SD)	23.3 (15.6)	23.4 (15.5)	23.4 (15.7)
≤5 years	13.1	13.2	13.3
>5–15 years	19.6	19.2	19.9
>15–50 years	61.9	62.2	61.1
>50 years	5.5	5.5	5.7
Sex (male)	48.2	48.7	48.7
Educational status			
No formal education (includes children < 5 years)	43.8	41.4	43.9
Below primary	17.4	17.5	17.6
Primary and some secondary	30.8	31.7	30.0
Above secondary	8.0	9.4	8.5
Number of people in a family (median, interquartile range)	5 (2)	5 (2)	5 (2)
Number of months living in this house (median, interquartile range)	12 (57)	12 (57)	12 (56)
Characteristics of households	Vaccine area (<i>n</i> = 27341) %	Vaccine-plus-behaviour-change area (<i>n</i> = 26794) %	Control area (<i>n</i> = 24393) %
Source of drinking water (WASA supply water) ^c	99.9	99.7	99.9
Treat drinking water (yes)	52.6	58.7	54.6
Boil water	51.5	56.4	53.1
Filter water	0.7	1.2	0.9
Chemical treatment	0.4	1.1	0.6
Distance from source of drinking water to the kitchen in centimeters (median, interquartile range)	457 (457)	457 (457)	457 (457)
Shared kitchen (yes)	89.6	93.0	87.6
Shared toilet (yes)	96.7	96.0	95.8
Type of toilet (direct observation)			
Sanitary latrine with or without flush	70.5	81.3	78.5
Non-sanitary	28.5	17.9	21.3
Use open space	1.0	0.8	0.2
Waste disposal (fixed place)	81.8	84.7	79.3
House construction material			
Roof			
Corrugated iron	87.1	84.5	83.2
Brick/concrete	12.8	15.4	16.7
Bamboo/wood/other	0.1	0.1	0.1
Floor			
Brick/concrete	90.3	90.4	91.5
Bamboo/wood/other	9.7	9.6	8.5
Wall			
Corrugated iron	28.2	23.9	26.0
Brick/concrete	68.4	73.9	70.1
Bamboo/wood/other	3.4	2.2	3.9
Number of rooms in the house (mean, SD)	1.1 (0.4)	1.2 (0.5)	1.2 (0.5)
Monthly rent paid (median, interquartile range) (US\$) ^d	25.8 (12.9)	25.8 (12.9)	25.8 (12.2)
Monthly household expenditure (median, interquartile range) (US\$)	103.0 (51.3)	105.6 (52.2)	104.3 (49.6)
Monthly average savings (median, interquartile range) (US\$)	0 (3.8)	0 (2.6)	0 (3.1)

WASA, Water and Sewerage Authority; BDT, Bangladeshi Taka.

^aUnique person identification (ID); some categories do not sum to 100% because of rounding.^bPre-intervention period data were used in this table to: (i) avoid migration issues that occurred during intervention period and possibly could have changed the demographics across the intervention/control areas; and (ii) to assess pre-intervention period drinking water treatment and hygiene status.^cOther sources of drinking water include well, bottled water, water vendor and pond/canal/river.^d1 USD = 77.7 BDT (average exchange rate during 2012).

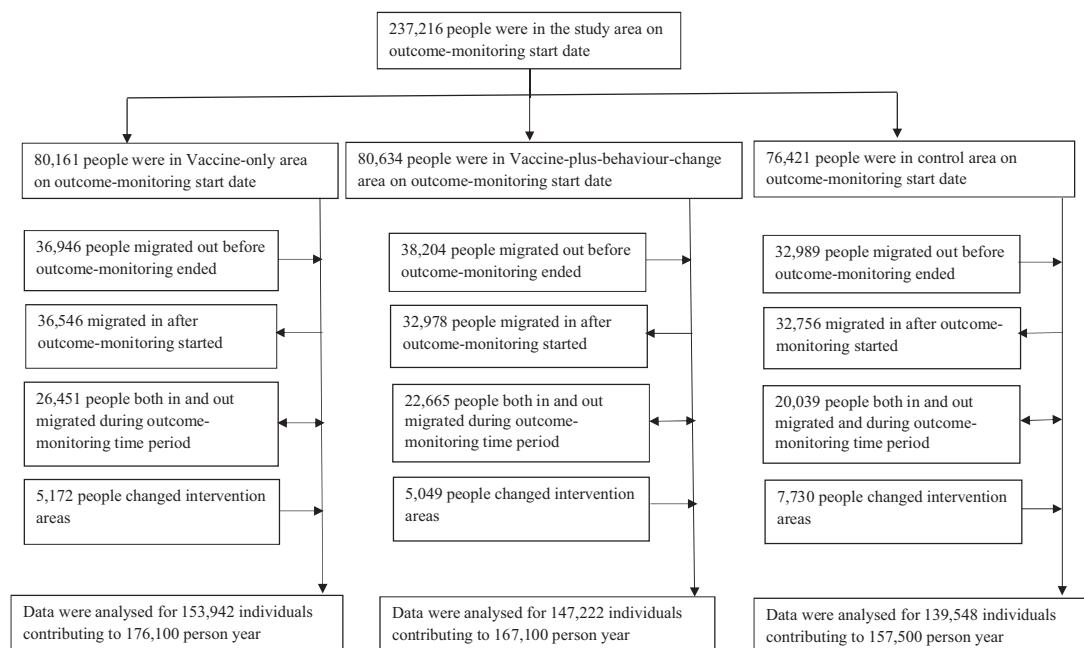


Figure 3. Participant flow during the study outcome-monitoring time period.

Table 2. Hospitalization rates and person-years during outcome-monitoring period by treatment areas (cluster-adjusted)^a

Study areas	Number of people	Number of person-years (1000)	Number of hospitalizations	Hospitalizations/1000 person-years (95% CI)	Hazard ratio (95% CI)	P-value*
Control	145821	164.0	1600	9.7 (8.3–11.6)	1.0	–
Vaccine-only	149839	169.6	1586	9.4 (8.3–10.6)	0.96 (0.78–1.17)	0.69
Vaccine-plus-behaviour-change	147222	167.1	1596	9.6 (8.3–11.1)	0.98 (0.79–1.22)	0.85

^aPrimary analysis

*P-value for comparison with control.

was comparatively similar across the areas (vaccine-only 9.4/1000 person-years; vaccine-plus-behaviour-change 9.6/1000 person-years; control 9.7/1000 person-years) (Table 2). The results remained similar after considering people migrating from vaccine-only/vaccine-plus-behaviour-change areas to control areas as remaining vaccinated (Supplementary Table 1, available as Supplementary data at *IJE* online). The hospitalization rate was also relatively similar across the different areas over terms 1 to 4 (interaction between areas and terms: $P=0.67$) (Table 3). No interaction was present between areas and age (data not shown). During the period, 47% ($n=2270$) of diarrhoea-associated hospitalizations were due to severe diarrhoea. Although the severe-diarrhoea-associated hospitalization rates were slightly lower in the vaccine-plus-behaviour-change area, the 95% CIs overlapped each other [severe diarrhoea hospitalization rate: vaccine-only 4.7/1000 person-years (95% CI: 4.1–5.6); vaccine-plus-behaviour-change 4.1/1000 person-years (95% CI: 3.4–5.0); control 4.7/1000 person-years (95% CI: 3.9–5.8)].

Hospitalization rates were higher among children aged ≤ 5 years compared with the other age groups (Figure 4). The P -value for three-way interaction between intervention/control areas, intervention period and age was 0.12, indicating no rate differences by age over time beyond that expected by chance. The hospitalization rates among study participants ≥ 1 year of age (excluding children < 1 year from the time of vaccination and onwards) were similar across the study areas during the outcome-monitoring period (Supplementary Table 2, available as Supplementary data at *IJE* online).

The hospitalization rate among the subgroup of people who remained in the same location for the entire intervention period was slightly lower in the vaccine-plus-behaviour-change area compared with other areas, but the 95% CIs overlapped each other—hospitalization rate: vaccine-only 9.4/1000 person-years (95% CI: 8.3–10.7); vaccine-plus-behaviour-change 9.0/1000 person-years (95% CI: 7.6–10.6); control 9.7/1000 person-years (95%

Table 3. Diarrhoea-associated hospitalization rates^a and hazard ratios^b before and during outcome-monitoring period by intervention and control areas (primary analysis)

Study areas	Hospitalizations/1000 person-years Before outcome-monitoring start date		Outcome-monitoring period							
	6–12 months before outcome- monitoring started 24/09/2010 to 23/03/2011	0–6 months before outcome-monitoring started ^c 24/03/2011 to 23/09/2011	Term 1 24/09/2011 to 23/03/2012	Term 2 24/03/2012 to 23/09/2012	Term 3 24/09/2012 to 23/03/2013	Term 4 24/03/2012 to 31/08/2013				
			Hospitalizations/ 1000 person- years	Hazard ratio 95% CI	Hospitalizations/ 1000 person- years	Hazard ratio 95% CI	Hospitalizations/ 1000 person- years	Hazard ratio 95% CI	Hospitalizations/ 1000 person- years	Hazard ratio 95% CI
All study areas combined	2.4	12.7	9.6	-	10.2	-	7.6	-	11.0	-
Control	1.2	13.7	9.8	1.0	10.3	1.0	7.9	1.0	11.2	1.0
Vaccine-only	3.2	12.5	8.8	0.90 (0.7–1.2)	10.1	0.98 (0.8–1.2)	7.8	0.99 (0.7–1.4)	10.9	0.97 (0.7–1.4)
Vaccine-plus- behaviour- change	2.8	12.1	10.2	1.04 (0.8–1.4)	10.4	1.01 (0.8–1.2)	7.1	0.90 (0.6–1.3)	10.7	0.95 (0.7–1.3)

^aResults are cluster-adjusted.^bResults are only cluster-adjusted. Results that are adjusted for age, sex, education, toilet type, pre-intervention period hospitalizations and cluster were almost similar to the unadjusted results (data not shown).^cCholera vaccine was delivered during this period.

CI: 8.3–11.5). The absolute and relative rates of hospitalization using the supplementary analysis (ii) were only negligibly different from the primary analysis ([Supplementary Table 3](#), available as [Supplementary data](#) at *IJE* online).

Discussion

This study reports an observable measure of the impact of combined hand-washing and point of use water treatment intervention plus cholera vaccination on hospitalization for diarrhoeal disease, examined through a large-scale, community-based intervention trial. Despite using an effective cholera vaccine and culturally adapted behaviour-change interventions, we found no significant impact of combined vaccine-plus-behaviour-change intervention on rates of hospitalization with diarrhoea or hospitalization with severe diarrhoea.

In an earlier study, cholera vaccine reduced all-cause severely dehydrating diarrhoea-associated hospitalization.⁸ In the current study, in an earlier analysis vaccination reduced the incidence of diarrhoea attributable to *V. cholerae*,⁹ yet we did not observe any significant impact of cholera vaccine alone on all-cause diarrhoea hospitalization, presumably because the cholera incidence was too low during the study period to make a detectable contribution to overall hospitalization rates for all-cause diarrhoea. Indeed, the culture-confirmed cholera cases accounted for ~7% of total number of cases of diarrhoea-related hospitalization, well below the years immediately preceding the study.⁹ In countries like Bangladesh where cholera is endemic, the magnitude of cholera incidence can vary from year to year.²⁷ Additionally, the high migration rate diluted cholera vaccination coverage of the intervention areas, thus reducing the impact of vaccine on diarrhoea-associated hospitalization.

The vaccine-plus-behaviour-change area received intervention hardware and instructions to wash their hands and treat their drinking water, in addition to receiving cholera vaccine. The corresponding behaviour-change strategy was tested in a pilot study to estimate acceptability before roll-out in the main trial.²² Chlorinating water and hand-washing promotion have been effective in reducing self-reported diarrhoeal diseases in small-scale efficacy studies.^{13,14} However, we observed no statistically significant overall or age-specific impact on hospitalization outcomes.

One reason for the lack of impact of the behavioural intervention may have been because of the low uptake. We ideally would have examined diarrhoea hospitalization rates among those who had good intervention uptake versus those who did not, but we could not link the intervention uptake data that was collected from only a small

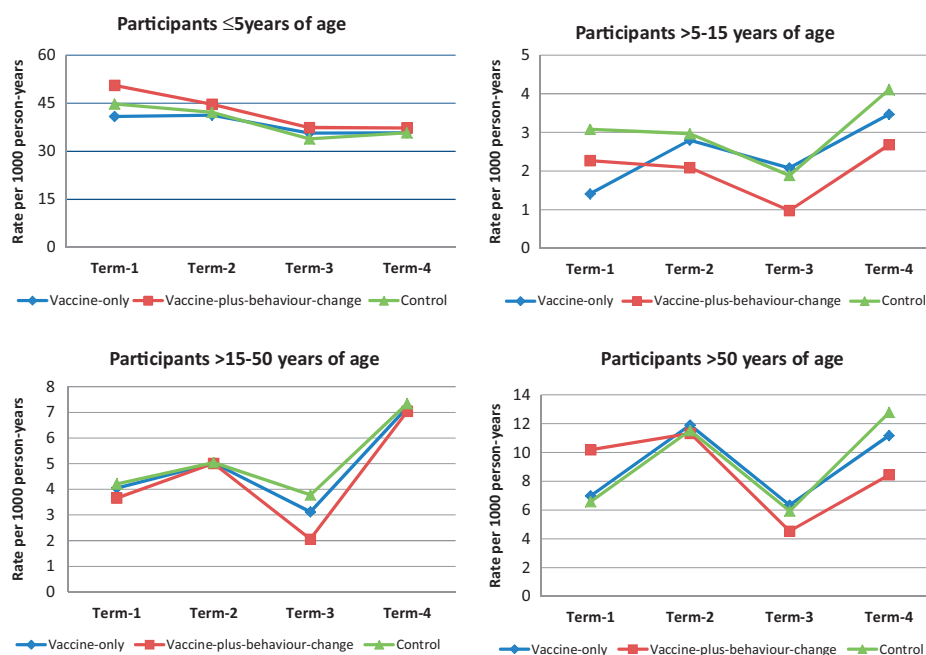


Figure 4. Hospitalization rates for different age groups across the intervention areas* during outcome-monitoring period**.

*The *P*-value of interaction between areas, time and age was 0.12. **Term 1: 24 September 2011 to 23 March 2012; term 2: 24 March 2012 to 23 September 2012; term 3: 24 September 2012 to 23 March 2013; term 4: 24 March 2013 to 31 August 2013.

sub-sample of the study population to the hospitalization data. Identifying and reporting details of the reasons for poor uptake of these previously tested interventions will be assessed and reported separately, but may be related to difficulty of delivering the behaviour change intervention with high quality on a large scale.^{17,18}

Our indicator of hand-washing behaviour uptake was the presence of soap and water at the primary hand-washing station. Among the vaccine-plus-behaviour-change population, the hand-washing indicator was only 17% points (45% vs 28%) higher than in the control area. Even though this is a commonly used indicator to assess hand-washing uptake,^{15,28} it does not ensure that people actually wash their hands or use soap. Based on the presence of residual chlorine in drinking water, only 4% people used the chlorine dispenser. This was disappointing but not entirely unexpected, as the pilot study had also shown low uptake and hardware-related problems which were unresolved when the vaccine became available and main trial commenced. Low uptake of chlorine-based water treatment products has been reported in similar contexts.^{17,29} For example, a study conducted in urban Dhaka in 2009, promoting chlorine-based products detected residual chlorine in only ~8% of households.²⁹ The taste and smell of chlorine-treated water is a commonly reported barrier.³⁰ Moreover, a large number of the study participants migrated out of the study area before completion of

the 2-year follow-up, thereby limiting the consistency of participants' exposure to the intervention. However our analysis, restricted to people who stayed in the study area for the entire study period, also showed no reduction in diarrhoea hospitalization, despite a slightly higher uptake of interventions compared with those who migrated. The hospitalization rate was comparatively lower during the 6–12 months preceding the intervention period. The reason for this is unknown, but it could be due to variations in diarrhoea rate at the community level over time or to delays before the surveillance was fully capturing all cases.

In conclusion, we observed limited public health impact, by the combination of oral cholera vaccine and behavioural interventions to improve drinking water quality and hand-washing behaviour, on the rate of hospitalized diarrhoea in the setting under study. Developing better behavioural interventions that increase water treatment and hand-washing remain important in areas where marginal improvement is possible. Whereas the low rate of cholera and high rate of population migration account for the limited impact of oral cholera vaccination, the failure of the drinking water and hand-washing intervention underscores the need for investment in research to improve the pace and effectiveness of community-wide interventions that separate human faeces from the environment, food and water supply of low-income country residents.

Supplementary Data

Supplementary data are available at *IJE* online.

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Conflict of interest: None declared.

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Supplementary-Table-1: Hospitalisation rates and person years during outcome-monitoring period by treatment areas (cluster-adjusted)*

Study areas	No. of people	No. of person years (1000)	No. of hospitalization	Hospitalizations/ 1000 person-years (95% CI)	Hazard ratio (95% CI)	P-value**
Control	139,584	157.5	1531	9.7 (8.3, 11.5)	1.0	-
Vaccine-only	153,942	176.1	1655	9.4 (8.3, 10.6)	0.97 (0.79, 1.17)	0.74
Vaccine-plus-behaviour-change	147,222	167.1	1596	9.6 (8.3, 11.1)	0.98 (0.79, 1.22)	0.88

**analysis considering people migrating from vaccine-only/vaccine-plus-behaviour-change areas to control area remained vaccinated and were considered in the vaccine-only area during the analysis*

***P-value for comparison with Control area*

Supplementary-Table-2: Hospitalisation rates among study participants ≥ 1 year of age during outcome-monitoring period by treatment areas (cluster-adjusted)*

Study areas	Hospitalizations/ 1000 person-years (95% CI)	Hazard ratio (95% CI)	P-value**
Control	5.5 (4.5, 6.7)	1.0	-
Vaccine-only	5.1 (4.3, 6.1)	0.94 (0.73, 1.21)	0.63
Vaccine-plus-behaviour-change	4.8 (3.9, 5.9)	0.88 (0.67, 1.15)	0.35

** Analysis restricted among people who were ≥ 1 year of age at the time of vaccination and onwards*

***P-value for comparison with Control area*

Supplementary-Table-3: Overall hospitalisation rates and person years by study area using supplementary analysis (ii)* (cluster adjusted)

Study area	No. of people	No. of person years (1000)	No. of hospitalization	Hospitalizations/ 1000 person-years (95% CI)	Hazard ratio (95% CI)	P-value
Control	82,538	107.3	933	8.7 (7.4, 10.3)	1.0	-
Vaccine-only	87,794	112.5	897	8.0 (7.0, 9.1)	0.92 (0.75, 1.13)	0.42
Vaccine-plus-behaviour-change	89,124	111.5	930	8.3 (7.1, 9.8)	0.96 (0.78, 1.20)	0.71

**Allocating all person time to the trial area of each individual at the intervention start date, regardless of later migrations to other areas, and excluding in-migration after the intervention start date*

Chapter 6: Inconsistency in diarrhoea measurements when assessing intervention impact in a non-blinded cluster randomised controlled trial

6.1 Chapter overview

Interventions that improve quality of drinking water, sanitation and hygiene behaviour can potentially break the transmission cycle to reduce diarrhoea. Reported diarrhoea is one of the commonly used indicators to assess effectiveness of these behavioural interventions.

However, a number of concerns have been raised regarding reliability of reported diarrhoea, including courtesy bias (151, 152), poor recall (153-158) and surveillance fatigue (159-161).

Additionally there is concern about the reliability of measuring subjective health outcomes in non-blinded trials due to observer bias. To overcome this, it is now recommended that in studies where blinding is not possible, there should be at least one objectively assessed outcome even if the primary outcome is subjective. To my knowledge no large scale behavioural trial so far have assessed the reported diarrhoea data through two different representative surveys from the same study population during the same study period and compared them with an objectively measured outcome to assess consistency of reported diarrhoea data. In this chapter I discussed results from a cluster randomised trial that was conducted on ~60,000 households to compare reported diarrhoea data collected through two different survey methods. The ‘census’ data were collected from each household every six months for updating household demographic information. The ‘monthly-survey’ data were collected every month from a subset of randomly selected study households for monitoring

uptake of behavior-change interventions. I also compared reported diarrhoea with observed diarrhoea-associated hospitalisation for children aged ≤ 5 years to understand consistency of reported data in assessing impact of intervention on health. In this study, the impact of interventions was detected through reported diarrhoea data in one of the surveys but not in the other. Even though not perfect but the best possible objective health outcome that was available in this study was “observed diarrhoea-associated hospitalization”. There was no impact of intervention present on observed diarrhoea associated hospitalisation. Although the reasons for the different observed treatment effect in the survey data was unclear, this chapter highlights the importance of assessing objective outcomes from non-blinded trials.

The findings of this chapter have been published in the **American Journal of Tropical Medicine and Hygiene**.

6.2 Declaration for thesis chapter 6

Monash University

Najnin N, Leder K, Forbes A, Unicom L, Qadri F, Ram PK, et al. Inconsistency in Diarrhea Measurements when Assessing Intervention Impact in a Non-Blinded Cluster-Randomized Controlled Trial. *Am J Trop Med Hyg.* 2019;101(1):51-8.

Declaration by candidate

In the case of Chapter 6, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Designing data collection instruments; contributed in designing behavioural interventions; literature review, statistical analysis and interpretation of results, development and writing the manuscript.	80%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Karin Leder	interpreted results and provided critical comments; reviewed the manuscript, drafted or critically revised the paper	N/A
Andrew Forbes	analysed and interpreted data; reviewed the manuscript, drafted or critically revised the paper	N/A

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Leanne Unicomb	oversaw data collection, supervised behavioural intervention implementation; critically revised the paper	N/A
Pavani K. Ram	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Peter J. Winch	designed behaviour interventions, provided input on data collection instruments; critically revised the paper	N/A
Shwapon K. Biswas	supervised data collection; reviewed the manuscript, drafted or critically revised the paper	N/A
Firdausi Qadri	designed the study, served as principal investigators, interpreted results; reviewed the manuscript	N/A
Alejandro Cravioto	interpreted results and provided critical comments	N/A
Stephen P. Luby	designed the study, served as principal investigators, interpreted results; reviewed the manuscript, drafted or critically revised the paper and approved the final version for submission	N/A

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work.

**Candidate's
Signature**

	15/07/2019
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**Main
Supervisor's
Signature**

	22/07/2019
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Inconsistency in Diarrhea Measurements when Assessing Intervention Impact in a Non-Blinded Cluster-Randomized Controlled Trial

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Abstract. To explore the consistency in impact evaluation based on reported diarrhea, we compared diarrhea data collected through two different surveys and with observed diarrhea-associated hospitalization for children aged ≤ 5 years from a non-blinded cluster-randomized trial conducted over 2 years in urban Dhaka. We have previously reported that the interventions did not reduce diarrhea-associated hospitalization for children aged ≤ 5 years in this trial. We randomly allocated 90 geographic clusters comprising $> 60,000$ low-income households into three groups: cholera vaccine only, vaccine plus behavior change (cholera vaccine and handwashing plus drinking water chlorination promotion), and control. We calculated reported diarrhea prevalence within the last 2 days using data collected from two different survey methods. The “census” data were collected from each household every 6 months for updating household demographic information. The “monthly survey” data were collected every month from a subset of randomly selected study households for monitoring the uptake of behavior change interventions. We used binomial regression with a logarithmic link accounting for clustering to compare diarrhea prevalence across intervention and control groups separately for both census and monthly survey data. No intervention impact was detected in the census (vaccine only versus control: 2.32% versus 2.53%; $P = 0.49$; vaccine plus behavior change versus control: 2.44% versus 2.53%; $P = 0.78$) or in the vaccine only versus control in the monthly survey (3.39% versus 3.80%; $P = 0.69$). However, diarrhea prevalence was lower in the vaccine-plus-behavior-change group than control in the monthly survey (2.08% versus 3.80%; $P = 0.02$). Although the reasons for different observed treatment effects in the census and monthly survey data in this study are unclear, these findings emphasize the importance of assessing objective outcomes along with reported outcomes from non-blinded trials.

INTRODUCTION

Diarrhea is among the top five leading causes of total years of life lost globally.¹ It is still a major cause of child mortality and morbidity in low-income countries.^{2–5} Most of the pathogens that cause diarrhea are transmitted via the fecal–oral route.^{6,7} Interventions that improve the quality of drinking water, sanitation, and hygiene (WASH) behavior can potentially interrupt transmission and reduce diarrhea.^{8–11} One of the commonly used indicators to assess effectiveness of these environmental interventions is reported diarrhea.^{10–12} For example, a systematic review of 45 cluster-randomized controlled trials for assessing effectiveness of improving water quality for diarrhea reduction shows that the primary outcome in all of these studies was reported diarrhea.¹² Data collectors usually collect this information by regularly visiting study households and asking an adult participant to recall diarrhea episodes experienced by household members within recent days or weeks.¹³ Measuring diarrhea objectively such as by observing diarrhea-associated hospital admissions or by complementing disease reporting with microbiological testing of stool for specific microorganisms is prone to less subjective reporting bias, and hence is a preferred way of measuring diarrhea compared with reported outcomes.¹⁴ However, these approaches require larger study sizes to capture these less common outcomes and are more complex and costly, and so

are deployed less commonly.^{15–19} Concerns raised regarding reliability of reported diarrhea include courtesy bias,^{20,21} imperfect and biased recall,^{22–27} and surveillance fatigue.^{28–30} In addition, there is concern about the reliability of measuring subjective health outcomes in non-blinded trials due to observer bias.³¹ A systematic review of 21 randomized clinical trials with blinded and non-blinded assessment of the same binary outcome showed that the non-blinded assessors of subjective binary outcomes generated substantially biased effect estimates.³² Because of these concerns, in some non-blinded trials, a reduction of diarrhea by even 50% may not necessarily be due to a true intervention effect.³³ To overcome this, it is now recommended that in studies where blinding is not possible, there should be at least one objectively assessed outcome even if the primary outcome is subjective.¹⁴ Alternatively, validation studies for estimating the degree of bias should be incorporated to improve data interpretation.³⁴

In 2011, we conducted a cluster-randomized trial over 2 years among $> 60,000$ low-income households in urban Dhaka, Bangladesh, to evaluate the impact of oral cholera vaccine along with handwashing and water treatment interventions in reducing diarrhea, including cholera.^{35,36} In this study, non-blinded assessors collected reported diarrhea data using similar construction of questions for children aged ≤ 5 years using two separate surveys, each of which was conducted on the same study population throughout the study period; data on diarrhea-associated hospitalization were also collected for children aged ≤ 5 years. We have previously reported that neither cholera vaccination alone nor cholera vaccination combined with behavior change intervention efforts measurably reduced observed diarrhea-associated hospitalization among children aged ≤ 5 years.³⁶

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In this current study, we aimed to compare whether data collected using two different survey methodologies, carried out by different data collection teams to elicit reported diarrhea, impacted on the interpretation of intervention effects on measured reported diarrhea among children aged ≤ 5 years. We also compared the reported diarrhea data with objectively measured diarrhea-associated hospitalization rates for children aged ≤ 5 years in the same study. We hypothesized that in this non-blinded trial, the interpretation of impact evaluation based on reported diarrhea data collected through two different surveys for children aged ≤ 5 years will be similar.

MATERIALS AND METHODS

Trial design, study setting, and participants. We analyzed data from a cluster-randomized control trial conducted in densely populated ($\sim 17,000$ people living/km²) low-income communities of the Mirpur area of urban Dhaka between 2011 and 2013. In these communities, households are commonly organized into compounds (usual number of households in a compound: ~ 20 – 25 ; range: 2 – 100), with individual families often renting a small room and several households sharing a common water source, kitchen, and toilet. Details regarding the trial design, participant selection, and interventions have been described previously.^{35,36} Briefly, we applied criteria including low per-capita income, sharing water source, poor sanitation, and poor living conditions to select high-risk, diarrhea-prone study areas, which were then divided into 90 geographic clusters. Each cluster was surrounded by a 30-m buffer zone to limit contamination of the interventions across clusters. A statistician external to the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), randomly assigned the geographic clusters into three study groups: 1) cholera vaccine alone group (denoted as “vaccine-only” group hereafter); 2) combined cholera vaccine and behavior change communication intervention group (denoted as “vaccine-plus-behavior-change” group hereafter); and 3) control group (continued standard habits and practices).

Study interventions and blinding. The study interventions were as follows: 1) cholera vaccine: two doses of killed whole-cell, oral cholera vaccine, ShanChol™ (Shantha Biotechnics-Sanofi, India), were administered 14 days apart to participants who were non-pregnant and children aged > 1 year; and 2) promotion of handwashing with soap and drinking water chlorination, both implemented at the compound level near the shared water source. Behavior change interventions to improve hand-washing and point-of-use water treatment included enabling both hardware and behavior change communication messages. Hand-washing hardware consisted of a 30-L water tank with a tap, a bowl where rinse water could accumulate, and soap/soapy water.³⁷ Point-of-use water treatment hardware consisted of a chlorine dispenser containing liquid sodium hypochlorite. The behavior change strategy was developed following the Integrated Behavioral Model for WASH theoretical framework.³⁸ Dushtha Shasthya Kendra (DSK), a nongovernmental organization with considerable experience working on WASH issues in Mirpur, delivered the behavioral interventions.

Blinding was not possible in this study because of the nature of the interventions.

Data collection. Two different teams of icddr,b employees having similar employment status and educational qualifications worked independently of each other to collect reported

diarrhea data concurrently among children aged ≤ 5 years from the same study population over the 2-year study period. Two different surveys were used:

a. **Census:** A team of approximately 30 data collectors collected census data every 6 months from each house in the study area. The primary aim of census was to collect information on births, deaths, and in- and out-migration of individuals in the study area. During each visit, data collectors also asked respondents about each family member, including children aged ≤ 5 years, to ascertain whether anyone had had “diarrhea within last 48 hours.” Interviewers explained that ≥ 3 loose stools within 24 hours would be considered to constitute diarrhea.

The census data collection team members were recruited and trained by the icddr,b researchers who were responsible for overseeing cholera vaccine-related activities in the field. Most of the data collectors in this team had experience working on vaccine trials. The training continued for 4 weeks for this group. On average, each data collector visited ~ 30 households each day, usually requiring ~ 15 minutes for completion of data collection from each household.

b. **Monthly survey:** 400 households were randomly selected each month from the most updated census database. This random selection was carried out at the household level and not at the cluster level. Each month a team of approximately 11 data collectors collected data from a different set of 200 randomly selected study households in the vaccine-plus-behavior-change group, and 100 households in each of the vaccine-only and control groups. The sample size calculation was carried out for the primary aim of the original study and not for this sub-study. The monthly assessment of 400 households was designed to be low enough to be logistically manageable, but to provide representative real-time trend data on intervention uptake. This selection process was predefined in the study protocol.

The main goal of monthly surveys was monitoring of uptake of behavioral interventions. This involved asking questions about hand-washing and drinking water treatment behaviors, observing hand-washing practices among study participants, spot-checking for the presence of soap and water at hand-washing stations and for liquid chlorine in chlorine dispensers, and spot-checking for the presence of residual chlorine in stored drinking water using Hach colorimeter (HACH LANGE GmbH, Germany) if the households reported treating water with chlorine. Data collectors also asked the respondents about each of the family members, including children aged ≤ 5 years, to determine if they had “diarrhea within last 2 days.” Interviewers also explained that ≥ 3 loose stools within 24 hours would be considered to constitute diarrhea. Data collectors were instructed to collect information on diarrhea at the beginning of the interview to reduce bias, as asking about diarrhea and intervention products occurred at the same visit. The study households were typically arranged as compounds, and because data collectors visited randomly selected households from these compounds every month, they visited some of the compounds several times during the 2-year study period. The time interval between the visits in these compounds varied from a few days to a few months.

The monthly data collectors were recruited and trained by icddr,b researchers who were responsible for quantitative

assessment of uptake of the behavioral interventions. These researchers were also involved in designing and implementing the behavioral interventions. Most data collectors had previous experience in collecting behavioral intervention-related data. This team received training for 2 weeks before data collection started. In a typical day, they were able to interview ~4 householders, usually requiring ~45–90 minutes for completion of each interview.

- c. A separate team of data collectors collected information on diarrhea-associated hospitalization for children aged ≤ 5 years from 12 governmental and nongovernmental study hospitals/clinics with inpatient facilities in and around the study area. Details of this study have been reported previously.^{35,36}

Qualitative data collection on the training and field experience of census and monthly survey data collection teams. We conducted two group discussions among seven census data collectors and six monthly survey data collectors in the local Bengali language. Our aim was to understand the similarities and differences in their training and data collection procedures, focus of data collection, and data collection experiences in the field that could have affected the reported diarrhea data collected by them. The group discussions lasted for ~45–60 minutes, and data were captured with a digital audio recorder. We also interviewed data collection supervisors from each team separately for cross-checking the information provided by the data collectors.

Study timeline. For all data analyses, we considered the study period from October 2011 to July 2013. During this time, both cholera vaccine and behavior change interventions had already been implemented.

Data analysis of diarrhea reporting. Because of the case definition that we used in both surveys, diarrheal illness of any severity, including cholera cases, might have been included in the analysis. We calculated and compared reported diarrhea prevalence for children aged ≤ 5 years across intervention and control groups separately for both census and monthly survey data. To compare the overall and intervention group-specific reported diarrhea prevalence in census and in monthly surveys, we used binomial regression with a logarithmic link to calculate differences in prevalence with robust standard errors to account for clustering.

Data analysis of diarrhea-associated hospitalization. Details about data analysis related to diarrhea-associated hospitalization for children aged ≤ 5 years have been published elsewhere.³⁶ In short, from the census data, we identified people who migrated in or out of the study area during the study period. We calculated the incidence of diarrhea-associated hospitalization for children aged ≤ 5 years during the study period by counting the number of admissions in each group, and by summing the person-time that study participants contributed for each trial group. We adjusted the hospitalization incidence for the cluster-randomized design of the trial using robust “sandwich” variance estimators.

Qualitative data analysis. We summarized each interview after transcribing the audio recordings into English. We then manually analyzed the data by compiling under themes, such as training experience for collecting data, focus of data collection, field experience in collecting data including frequency of visits in compounds, and involvement of data collectors

with study participants in dealing with problems related to behavior change intervention materials. We then examined the similarities, differences, and connections between each theme.

Ethical consideration. An adult study participant from each household provided informed written consent. Confidentiality was maintained by keeping data anonymous throughout the study period and during analysis. The Institutional Review Board of the International Vaccine Institute, and the Research Review Committee and the Ethical Review Committee of icddr,b, Dhaka, Bangladesh, reviewed and approved the study protocol. The study was registered at ClinicalTrials.gov (Registration number: NCT01339845).

RESULTS

Data from 22 monthly surveys and four census surveys were analyzed.

Demographic and household characteristics of enrolled study participants were similar across the groups, except for the presence of sanitary latrines (latrine with piped sewer system/septic tank, pit latrine with slab plus water seal, pit latrine with slab and no water seal but with lid, ventilated improved pit latrine, dual pit latrine, or composting toilet), which was slightly lower in the vaccine-only group (Table 1). The age-stratified distribution of study participants was similar across the groups in both census and monthly surveys (Supplemental Tables 2 and 3).

Reported diarrhea prevalence. The control group had the highest diarrhea prevalence in both census and monthly surveys during the study period. Diarrhea prevalence was lower in the vaccine-plus-behavior-change group than the control group in the monthly survey (2.08% versus 3.80%; $P = 0.02$) but not in census data (2.44% versus 2.53%; $P = 0.78$) (Table 2). Diarrhea prevalence was slightly lower in the vaccine-only group than in the control group in both census and monthly surveys, but the difference was not statistically significant (Table 2).

Diarrhea prevalence in each quarter over the 2-year study period was mostly higher in the monthly survey than census in the vaccine-only and control groups, but not in the vaccine-plus-behavior-change group (Figure 1). However, the 95% CIs of the census and monthly survey diarrhea prevalence in each quarter across all groups mostly overlapped each other (Figure 1), indicating that the diarrhea prevalence in the census was not very different from the prevalence in the monthly surveys during the study period.

Hospitalization rate for children aged ≤ 5 years. Results on objectively measured diarrhea-associated hospitalization rate for children aged ≤ 5 years have been published elsewhere.³⁶ Briefly, we observed no impact of interventions on the diarrhea-associated hospitalization rate (hospitalization rate in groups: vaccine only: 39.3/1,000 person-years; vaccine plus behavior change: 43.3/1,000 person-years; control: 39.4/1,000 person-years) (Supplemental Table 1).

Qualitative feedback on data collectors' training and field experience. In the group discussions, both census and monthly survey data collectors mentioned that the trainers first discussed the research objectives with them and then discussed each of the items from the questionnaires until the data collectors were clear about all aspects. The data collectors then practiced mock interviews with each other and piloted

TABLE 1
Characteristics of individuals and households across the intervention groups during the study period (October 2011–July 2013)*

Characteristics of individuals	Vaccine-only group (n = 142,879) (%)	Vaccine-plus-behavior-change group (n = 140,202) (%)	Control group (n = 137,451) (%)
Age, mean (SD) (years)	22.8 (15.4)	22.8 (15.3)	22.8 (15.5)
≤ 5	14.7	14.7	14.8
> 5–15	18.3	17.8	18.5
> 15–50	62.1	62.6	61.5
> 50	4.9	4.9	5.2
Gender (male)	48.3	48.7	48.6
Educational status			
No formal education (includes children aged < 5 years)	44.3	40.7	42.9
Below primary	17.0	17.0	17.0
Primary and some secondary	30.6	32.4	30.9
Above secondary	8.1	9.9	9.3
No. of people in a family (median, interquartile range)	5 (4–6)	5 (3–6)	5 (4–6)
No. of months living in this house (median, interquartile range)	5 (2–36)	6 (2–36)	6 (3–36)
Characteristics of households	Vaccine group (n = 42,217) (%)	Vaccine-plus-behavior-change group (n = 42,215) (%)	Control group (n = 39,738) (%)
Source of drinking water (municipal piped water supply)†	99.9	99.8	99.9
Treat drinking water (yes)	53.2	64.2	56.2
Boil water	52.0	58.7	54.8
Filter water	0.8	1.2	0.9
Chemical treatment	0.4	4.3	0.4
Shared kitchen (yes)	91.6	95.0	91.2
Shared toilet (yes)	97.2	96.6	96.6
Type of toilet (direct observation)			
Sanitary latrine with or without flush‡	72.8	85.3	84.0
Non-sanitary	27.2	14.8	16.0
Waste disposal (fixed place)	84.1	88.3	83.4
House construction material			
Roof			
Corrugated iron	85.0	81.7	79.7
Brick/concrete	14.8	18.7	20.2
Bamboo/wood/other	0.2	0.1	0.1
Floor			
Brick/concrete	92.0	92.7	92.9
Bamboo/wood/other	8.0	7.3	7.1
Wall			
Corrugated iron	28.6	21.9	24.8
Brick/concrete	69.2	76.6	72.5
Bamboo/wood/other	2.3	1.4	2.6
No. of rooms in the house, mean (SD)	1.1 (0.4)	1.1 (0.4)	1.1 (0.4)

* Unique person/household identification number; some categories do not sum to 100% because of rounding.

† Other sources of drinking water include well, bottled water, water vendor, and pond/canal/river.

‡ Latrine with piped sewer system, septic tank, pit latrine with slab plus water seal, pit latrine with slab and no water seal but with lid, ventilated improved pit latrine, dual pit latrine, or composting toilet.

the questionnaires in the field. If they had feedback about any item in the questionnaire, the trainers addressed this by discussing or revising it. Finally, when they were clear and confident about the data collection instrument, they began data collection for the study. Both census and monthly survey data collectors received extensive training about how to identify the correct households in the study area using the geographic information system. In addition, the census team was also trained on identifying and updating household information if there was any in- or out-migration in the study area. If a new data collector joined the team, that person was given similar training by the same trainers, and then he/she was attached with another data collector in the field for several days until the person was confident enough to collect data on his/her own.

Data collectors from both teams always introduced themselves as icddr,b employees to the study participants. The census data collectors, who visited each of the study households only once every 6 months, mentioned that before each

census round as the area where they would conduct the survey would change for each of the data collectors. According to the field supervisor, this was practiced to avoid repeated mistakes (if there were any) made by the same data collector in the same area throughout the study period. It was unlikely that the same census data collector visited the same household or the compound twice in a year.

By contrast, for the convenience of some of the monthly data collectors, some of the areas for data collection were fixed. Although they visited a household only once during the whole study period, sometimes they had to go back to the same compound to interview a different household several times. As one of the data collectors mentioned, “We never visited the same household twice throughout the study period but sometimes we had to visit different households within the same compound several times. Depending on random selection of households sometimes we had to visit the same compound twice in a week for interviewing different households.”

TABLE 2

Reported diarrhea prevalence within last 2 days of interview among children aged ≤ 5 years across intervention and control groups from census and monthly survey data (October 2011–July 2013)

Groups	Diarrhea prevalence from census, % (n/N) (95% CI)	Intervention vs. control groups in census,* % of difference in prevalence; 95% CI; P-value	Diarrhea prevalence from monthly surveys, % (n/N) (95% CI)	Intervention vs. control groups in monthly surveys,* % of difference in prevalence; 95% CI; P-value
All study groups combined	2.43 (6,081/250,514) (2.19, 2.69)	–	2.87 (171/5,949) (2.26, 3.65)	–
Vaccine-only group	2.32 (1,981/85,484) (1.91, 2.81)	Prevalence 0.2% lower in vaccine-only group than control; –0.0080, 0.0039; 0.49	3.39 (53/1,564) (2.06, 5.53)	Prevalence is 0.4% lower in vaccine-only group than control; –0.0244, 0.0162; 0.69
Vaccine-plus-behavior-change group	2.44 (2,028/83,075) (2.03, 2.94)	Prevalence 0.1% lower in vaccine-plus-behavior-change group compared to control; –0.0068, 0.0051; 0.78	2.08 (59/2,832) (1.39, 3.12)	Prevalence is 1.7% lower in vaccine-only group than control; –0.0320, –0.0023; 0.02
Control group	2.53 (2,072/81,955) (2.12, 3.01)	–	3.80 (59/1,553) (2.67, 5.37)	–

* Results are adjusted for cluster-randomized design.

Data collectors from both teams asked study participants about diarrhea within the last 48 hours (census) or 2 days (monthly surveys) in a similar way. Both teams explained to the study participants how they should count the 48 hours or 2-day period from the time of interview and mentioned that ≥ 3 loose stools within 24 hours would be considered as diarrhea.

According to both census and monthly survey data collectors, the study participants were aware that the intervention products were distributed in the community by icddr,b through the DSK. Several data collectors from the census team mentioned that study participants from the control or vaccine-only group sometimes asked them why they were not given the behavior change intervention products. Study

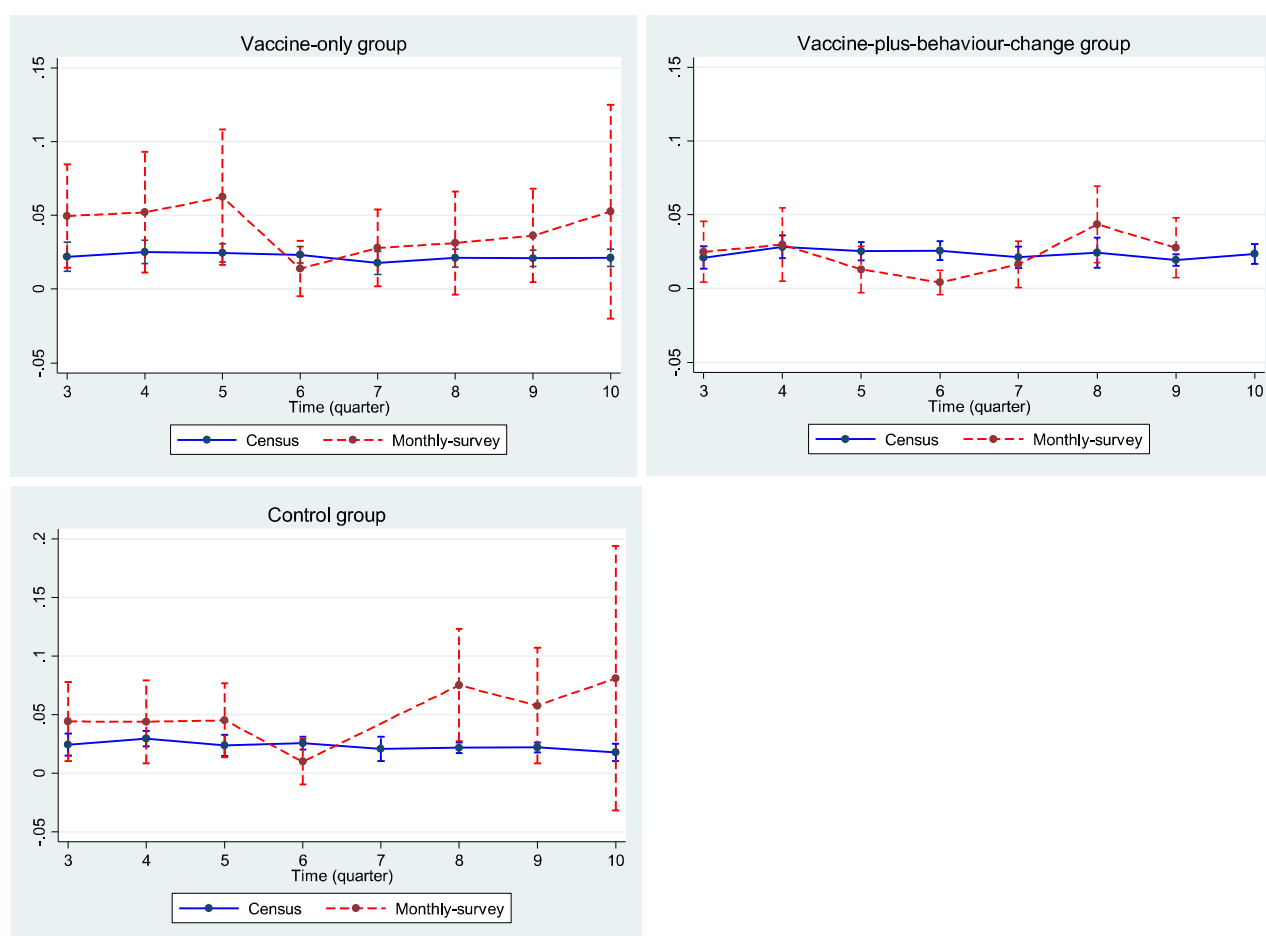


FIGURE 1. Comparison of reported diarrhea prevalence between census and monthly surveys (along with 95% CI) for children aged ≤ 5 years across intervention and control groups during the study period. This figure appears in color at www.ajtmh.org.

participants from the vaccine-plus-behavior-change group sometimes would request that census data collectors convey messages to the DSK personnel about product-related problems (breakage/leakage) or requirements (running out of liquid chlorine). In response, the data collectors would tell them to directly talk to the DSK personnel, but that if they came across any DSK personnel during data collection, they would convey the message. The monthly survey team similarly received both complaints and compliments about behavior change intervention products. Study participants expected monthly data collectors to fix hardware-related problems, or convey messages to DSK personnel to come and fix the problem. The monthly data collectors conveyed these messages to two of the icddr,b field staff who worked directly with the DSK managing hardware-related problems in the field.

DISCUSSION

In this study, we observed an impact of the behavior change intervention on reported diarrhea for children aged ≤ 5 years in the monthly survey but not in the census group. Similar to diarrhea prevalence data collected through census surveys, there was no impact of the intervention on objectively assessed diarrhea-associated hospitalization. This may suggest that the reported diarrhea prevalence data collected through the census may be more reliable than the data collected through the monthly surveys. However, this interpretation assumes that there is correlation between diarrhea hospitalizations and less severe, community-based self-reported diarrhea. This assumption may or may not be correct, given the seasonal patterns of different pathogens that may produce diarrhea of different severity at the community level.³⁹

The reasons for observing the impact of the intervention in the monthly surveys are unclear but could be due to bias rather than an actual intervention effect. The presence of observer bias in non-blinded studies has been frequently reported. Hróbjartsson and others³¹ conducted a systematic review of randomized clinical trials with both blinded and non-blinded assessment of same subjective measurement scale outcomes with an aim to assess the presence of observer bias and reported that the non-blinded assessors exaggerated the pooled effect size by 68%. In our study, the monthly survey team was directly supervised by researchers involved in developing and implementing the behavioral interventions, and the focus of this team was assessing the uptake of behavioral interventions. Given the non-blinded nature of this study, these assessors may have been predisposed to expect lower diarrhea prevalence in the intervention group, and consciously or unconsciously may not have recorded information on diarrhea.⁴⁰ By contrast, the census data collectors may have been comparatively more neutral in collecting diarrhea data considering the vaccine implementation team of researchers supervised them and their focus of data collection was updating household demographic information rather than assessing the uptake of behavior change interventions. However, group discussions with the monthly survey data collectors did not reveal any information on perceived pressure to indicate the presence of observer bias; so if this bias was operating, it may have been unconscious.

Other possible explanations for the difference in the census and monthly survey data include minor differences in methodology, framing of the questions to collect information

on diarrhea, and sampling variability. For the monthly surveys, data collectors did not visit households more than once within the study period, but may have visited the same compound several times even within a week. As our interventions were mostly implemented at the compound level, it is possible that repeated visits to the same compound within a short time interval combined with the considerable amount of time spent assessing behavioral intervention uptake may have alerted some participants to the fact that reduced diarrhea was a “desirable outcome” of the intervention. This could have influenced reporting of diarrhea because of social desirability bias,^{41,42} Hawthorne effect,^{43,44} or courtesy bias.²⁰

In census and monthly surveys, a similar recall period and diarrhea case definition were used, although the framing of the recall period was slightly different (diarrhea within the last 2 days in monthly surveys and within 48 hours in the census). However, it is unlikely that this created any difference in diarrhea prevalence measurement because both data collector teams similarly explained how they counted “2 days” or “48 hours” period at the time of interview. In both surveys, we specified diarrhea as being defined as ≥ 3 loose stools within 24 hours, which is similar to what has been suggested by the WHO⁴⁵ and has been adopted in many other studies.^{46–49} As two different teams collected data from different study participants at different time points, sampling variability could be another possible reason for differences in the intervention impact on reported diarrhea.

Collecting information on reported diarrhea is an easy and inexpensive way of assessing the impact of behavioral interventions, but this presumes that such data are sufficiently valid to support inference. Our study findings add further evidence of the subjectivity of self-reported diarrhea in non-blinded trials that can affect assessment of the intervention impact.³³ Keeping the data collection interview period brief and avoiding assessing health outcome and intervention uptake at the same time could minimize the risk of bias. These study findings highlight the importance of measuring objective outcomes when assessing non-blinded trials and comparing these with subjective outcome measures.

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Supplementary table 1: Diarrhea-associated hospitalization rates and hazard ratios during study period by intervention groups among children ≤5years*

Group	No. of people	No. of person years (1000)	No. of hospitalization	Hospitalization rate (individual group)/ 1000 person-years (95% CI)	Hazard ratio (95% CI)	P-value
Control	20,034	22.7	847	39.4 (33.1, 47.2)	1.0	-
Vaccine-only	21,846	25.0	928	39.3 (34.5, 44.8)	1.0 (0.81, 1.23)	0.98
Vaccine-plus-behavior-change group	20,817	23.6	969	43.3 (36.7, 51.5)	1.1 (0.86, 1.40)	0.44

*Results adjusted for cluster randomized design

Supplementary table 2: Age stratified distribution of participants in the census survey*

Age	Vaccine-only N=142,879 %	Vaccine plus behavior change N=140,202 %	Control N=137,451 %
≤1 year	7.0	7.2	7.2
>1 to ≤2 years	1.9	1.9	1.9
>2 to ≤3 years	2.0	1.9	2.0
>3 to ≤4 years	1.9	1.9	1.9
>4 to ≤5 years	1.9	1.8	1.8
>5 years	85.3	85.3	85.2

* Some categories do not sum to 100% because of rounding

Supplementary table 3: Age stratified distribution of participants in the monthly-survey*

Age	Vaccine-only N=13,914 %	Vaccine plus behavior change N=27,059 %	Control N=14,236 %
≤1 year	3.5	3.7	3.3
>1 to ≤2 years	2.0	1.6	2.1
>2 to ≤3 years	1.9	1.8	1.9
>3 to ≤4 years	2.2	1.9	2.1
>4 to ≤5 years	1.7	1.6	1.7
>5 years	88.6	89.4	89.0

* Some categories do not sum to 100% because of rounding

Chapter 7: An assessment of the impact of a large-scale hand washing interventions on reported respiratory illness

7.1 Chapter overview

The impact of large-scale community-based hygiene promotion interventions on respiratory illness is poorly understood. This chapter reports about an assessment of impact of hand-washing promotion on reported respiratory illness from a cluster-randomised controlled trial conducted in Bangladesh. Details about the interventions and how these were delivered in the study community have been reported in chapter 3 of this thesis and also in the published paper that I have included in chapter 7.3. In short, hand washing intervention hardware included a bucket with a tap, a soapy water bottle and a bowl to collect rinse water after washing hands. Soapy water was prepared by mixing a commercially available sachet of powdered detergent (~US\$ 0.03) with 1.5L of water in a plastic bottle with a hole punched in the cap. The hand washing station hardware was provided free of charge to intervention compounds. In this study I found that the intervention group had more hand-washing stations with soap and water present than controls (45% vs. 25%; $p < 0.001$). However, even with uptake of hand-washing intervention among 45% of households in the intervention group, I found no impact of the intervention on reported respiratory illness. However, those who actually had a hand-washing station with soap and water had less illness. Based on the study findings I concluded that improving the effectiveness of hand-washing promotion in achieving sustained behavior change could result in health benefits.

This paper has been published in the **American Journal of Tropical Medicine and Hygiene**.

7.2 Declaration for thesis chapter 7

Monash University

Najnin N, Leder K, Forbes A, Unicomb L, Winch PJ, Ram PK, et al. Impact of a Large-Scale Handwashing Intervention on Reported Respiratory Illness: Findings from a Cluster-Randomized Controlled Trial. Am J Trop Med Hyg. 2019;100(3):742-9

Declaration by candidate

In the case of Chapter 7, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Literature review, statistical analysis and interpretation of results, development and writing the manuscript.	80%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Karin Leder	interpreted results and provided critical comments	N/A
Andrew Forbes	analysed and interpreted data; reviewed the manuscript, drafted or critically revised the paper	N/A
Leanne Unicomb	oversaw data collection, supervised behavioural intervention implementation; critically revised the paper	N/A
Peter J Winch	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Pavani K. Ram	designed behaviour interventions, provided input on data collection instruments; critically revised the paper	N/A
Fosiul A. Nizame	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Shaila Arman	designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript	N/A
Farzana Begum	supervised implementation of behavioural interventions; reviewed the manuscript, critically revised the paper	N/A
Shwapon Biswas	supervised data collection; reviewed the manuscript, drafted or critically revised the paper	N/A
Aljandro Cravioto	interpreted results and provided critical comments	N/A
Stephen P. Luby	designed the study, served as principal investigators, interpreted results; reviewed the manuscript, drafted or critically revised the paper and approved the final version for submission	N/A

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work.

Candidate's

Signature

15/07/2019

Main

Supervisor's

Signature

22/07/2019

Impact of a Large-Scale Handwashing Intervention on Reported Respiratory Illness: Findings from a Cluster-Randomized Controlled Trial

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Abstract. We assessed the impact of handwashing promotion on reported respiratory illness as a secondary outcome from among > 60,000 low-income households enrolled in a cluster-randomized trial conducted in Bangladesh. Ninety geographic clusters were randomly allocated into three groups: cholera-vaccine-only; vaccine-plus-behavior-change (handwashing promotion and drinking water chlorination); and control. Data on respiratory illness (fever plus either cough or nasal congestion or breathing difficulty within previous 2 days) and intervention uptake (presence of soap and water at handwashing station) were collected through monthly surveys conducted among a different subset of randomly selected households during the intervention period. We determined respiratory illness prevalence across groups and used log-binomial regression to examine the association between respiratory illness and presence of soap and water in the handwashing station. Results were adjusted for age, gender, wealth, and cluster-randomized design. The vaccine-plus-behavior-change group had more handwashing stations with soap and water present than controls (45% versus 25%; $P < 0.001$). Reported respiratory illness prevalence was similar across groups (vaccine-plus-behavior-change versus control: 2.8% versus 2.9%; 95% confidence interval [CI]: $-0.008, 0.006$; $P = 0.6$; cholera-vaccine-only versus control: 3.0% versus 2.9%; 95% CI: $-0.006, 0.009$; $P = 0.4$). Irrespective of intervention assignment, respiratory illness was lower among people who had soap and water present in the handwashing station than among those who did not (risk ratio_{adjusted}: 0.82; 95% CI: 0.69–0.98). With modest uptake of the handwashing intervention, we found no impact of this large-scale intervention on respiratory illness. However, those who actually had a handwashing station with soap and water had less illness. This suggests improving the effectiveness of handwashing promotion in achieving sustained behavior change could result in health benefits.

INTRODUCTION

Acute respiratory infections continue to be a major cause of mortality in low-income countries.^{1,2} Many respiratory infections are transmitted via infected droplets, but some viruses including the respiratory syncytial virus infecting the respiratory tract can also be spread from one person to another by hand contact.^{3,4} The focus of many hand hygiene interventions has been to reduce diarrhea, but data from a systematic review and a meta-analysis show that hygiene behavior change, including handwashing with soap has also been effective in reducing respiratory illness.^{5,6} The commonly used indicator to assess health impact of handwashing interventions in most of these studies is self-reported or caregiver-reported respiratory illness and, therefore, study findings may be subjected to reporting bias. Few studies have objectively measured the impact of handwashing on respiratory illness.^{7,8} For example, Cowling et al. objectively measured transmission of respiratory infection by using reverse-transcription polymerase chain reaction of nasal and throat swabs and reported that hand hygiene interventions prevented household transmission of influenza virus.⁸ Despite benefits for both diarrhea and respiratory infection prevention, hand hygiene practices (washing hands with soap) are suboptimal. A systematic review of 42 studies estimated that 19% of the world population washes hands with

soap after contact with excreta.⁹ Structured observations of residents of rural Bangladesh found that only 1% of people washed their hands with soap before eating and before feeding a child and only 14% washed their hands with soap after defecation.¹⁰ Most previous efficacy studies reporting the impact of intense implementation of hygiene behavior change on respiratory illness have been small, involving up to 6,000 people.^{5,6} Upscaling known effective interventions is essential for improving global health¹¹; however, the impact of implementing hygiene promotion programs on respiratory illness on a large scale is still unclear.^{12,13}

Accurately assessing handwashing behaviors is problematic. Self-reported handwashing consistently overestimates observed behavior.^{10,14,15} Direct observation of handwashing by trained staff is both highly resource intensive and also biased, as the presence of an observer alters the handwashing behavior.^{16,17} Assessment of handwashing behavior through a low-cost proxy measure such as presence of soap and water in a designated handwashing station is a practical alternative and has been associated with lower rates of respiratory illness in some settings, but not in others.^{18–21}

We conducted a cluster-randomized controlled trial in 2011–2013 among > 60,000 low-income households of metropolitan Dhaka, Bangladesh. The primary aim of the study was to evaluate the impact and feasibility of a mass cholera vaccination program in reducing diarrhea due to *Vibrio cholerae* in a high-incidence urban area. We have reported already that vaccination reduced the incidence of diarrhea attributable to *V. cholerae* in this community.²² This present article reports a prespecified secondary outcome of the trial to examine effects of an at-scale intervention under real-world conditions to

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promote handwashing with soap on reported respiratory illness. We hypothesized that scaling up a community-based handwashing intervention could reduce respiratory illness. We also examined whether the presence of soap and water at primary handwashing stations was associated with a reduction in respiratory illness, irrespective of intervention assignment of participants.

METHODS

Trial design and participant selection. We conducted a cluster-randomized controlled trial in low-income communities of the Mirpur area of urban Dhaka. Details of the study methods including participant selection procedures have been published elsewhere.²² In short, the criteria that we used to select high-risk, cholera-prone study areas were low per capita income, poor sanitation, unsafe water use, sharing of water source, and poor living conditions. The study area was divided into 90 geographic clusters, with 30 m buffer zones around each cluster created to prevent contamination of the intervention across clusters. The selection criteria enabled having homogenous study participants across the clusters.

Interventions. *Handwashing and water treatment promotion.* Handwashing and point-of-use water treatment promotion interventions both included hardware and behavior-change-communication activities and messages that were developed based on the integrated behavioral model for water sanitation and hygiene theoretical framework.^{23,24} Details about the interventions and how these were delivered in the study community have been reported elsewhere.²⁵ In short, handwashing intervention hardware included a bucket with a tap, soapy water bottle,²⁶ and a bowl to collect rinse water after washing hands (Figure 1).²⁵ Soapy water was prepared by mixing a commercially available sachet of powdered detergent (~US\$ 0.03) with 1.5 L of water in a plastic bottle with a hole punched in the cap. The handwashing station hardware was provided free of charge to intervention compounds, but participating compounds had to supply either their own bar soap (~US\$ 0.35) or detergent sachets to make the soapy water. The behavior-change intervention also included point-of-use water treatment. The water treatment intervention hardware consisted of a dispenser containing liquid sodium hypochlorite.²⁵

Study participants used their own water vessels for treating water.

A nongovernmental organization, Dushtha Shasthya Kendra (DSK), delivered the behavioral intervention through community health promoters. In the study area, several households often shared a common water source, kitchen, and toilets; therefore, we mostly provided the handwashing and water treatment intervention hardware at the compound level, although the behavior-change-communication messages were delivered both at compound and household levels. Within 3 months of cholera vaccination, the community health promoters visited each compound, discussed the trial, delivered the handwashing intervention, and specifically encouraged household members to wash their hands after defecation, after cleaning child's anus, and before preparing food. The point-of-use intervention was rolled out 3 months later. During the initial 2 months after placement of each type of hardware, the promoters were instructed to visit each compound at least three times. After this period, the frequency of compound visits was reduced to twice monthly. The promoters also managed any problems related to intervention hardware.

Vaccine. The cholera vaccine that was used in the study was ShanChol™ (Shantha Biotechnics-Sanofi, India), which is a killed whole cell, oral vaccine approved by the WHO as safe and effective against cholera.^{27,28} Details of vaccine transportation, storage, and administration to the study population have been previously reported.²²

The study interventions that are not the focus of this article include point-of-use water treatment intervention and cholera vaccine. Details about these interventions including uptake have been described elsewhere.^{22,25}

Randomization and allocation concealment. Ninety clusters were randomly allocated into three groups: 1) a cholera-vaccine-alone group (denoted as “vaccine-only” group hereafter), 2) a combined cholera-vaccine and behavior-change-communication intervention group (denoted as “vaccine-plus-behavior-change” group), and 3) a control group who continued regular habits and practices.²²

Allocation concealment was not possible in this study because of the nature of interventions.

Measurements. The outcome of interest for this analysis was the prevalence of reported respiratory illness. During each

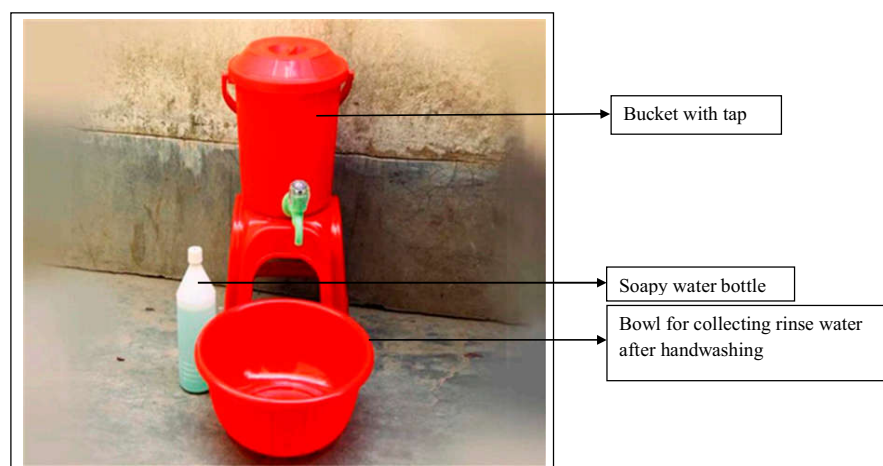


FIGURE 1. Handwashing station (includes bucket with tap, bowl, and soapy water bottle). This figure appears in color at www.ajtmh.org.

month of the 2-year intervention period, data collectors visited a different set of 200 randomly selected study participants in the vaccine-plus-behavior-change group, and 100 participants in both the vaccine-only and control groups. They visited each of these households to collect information on respiratory illness, diarrhea, jaundice, and injuries within the 2 days before interview for each household member. These data collectors and the community health promoters from the DSK who delivered the behavior-change intervention products to the study participants worked independently of each other.

We classified people as having respiratory illness if they reported having fever plus either cough or nasal congestion or fever plus breathing difficulty.¹² These unannounced home visits also assessed intervention uptake by observing the presence of soap/soapy water and water in the most convenient place for handwashing.

In an exploratory analysis, we compared the prevalence of respiratory illness among people who had soap/soapy water and water present in the primary handwashing station with those who did not, irrespective of intervention assignment.

During the study period through a separate six-monthly census survey, data collectors obtained information on births, deaths, and migrations of individuals from each house in the study area.²²

Study timeline. For data analysis, we defined the behavioral intervention start date as September 24, 2011 (midpoint between the start and end dates of the handwashing intervention rollout). The behavior-change intervention and respiratory illness follow-up ceased on August 31, 2013 (Figure 2).

Statistical methods. We did not expect any direct association between cholera vaccine and respiratory illness. Therefore, respiratory illness prevalence in the vaccine-only group was expected to be similar to that in the control group. However, to preserve design-based scientific inference leveraging the randomized assignment of interventions (as prespecified before the trial), we chose to keep the vaccine-only group and the control group separate and compare them with vaccine-plus-behavior change group for our outcome of interest.

We compared baseline demographic characteristics of study participants across the three groups. The overall prevalence of respiratory illness across the follow-up period was calculated for each group, and we used binomial regression with a logarithmic link to calculate risk ratios (RR) directly and confidence intervals (CI) comparing groups, with robust standard errors to account for clustering.²⁹ To examine the consistency of the intervention effects on the prevalence of reported respiratory illness over time, we divided the 2-year period of the intervention into quartiles (term 1 to term 4) and reported the prevalence for each quartile.

We performed an exploratory analysis to evaluate the relationship between presence of soap and water in the handwashing station and respiratory illness prevalence, regardless of the allocated intervention arm. We calculated respiratory illness prevalence according to the presence or absence of soap/soapy water and water in the primary handwashing station. We estimated RRs adjusting for age, and wealth of study participants, type of fuel used for cooking, and gender of respondents. We constructed a wealth index using principal component analysis.³⁰ In the wealth index, we included household construction materials, education of respondents, and ownership of specific durable goods that are commonly used in Bangladesh and are considered to be discriminatory.³¹ We used the first factor from the principal component analysis, as this has been reported to best capture economic status.³² Based on their wealth score, we divided households into quintiles and adjusted for wealth quintile in the log-binomial regression models. Supplementary analyses adjusted for the first three principal components but results differed negligibly from using the first component only.

Ethics. Both verbal and written informed consent were obtained from each study participant before intervention and data collection started. Signature (or thumbprint, if illiterate) of the participants and parents/guardian of a child was obtained before their enrollment in the study. Informed written consent was again obtained from an adult study participant from each household before data were collected in each survey. The International Centre for Diarrheal Disease Research, Bangladesh ethics and research review committees approved the methods of consent gathering for this study. Data were kept anonymous throughout the study period and during analysis to maintain confidentiality. The study was registered at ClinicalTrials.gov (registration number: NCT01339845).

RESULTS

The census team identified a total of 237,216 people residing in the study area on the behavioral intervention start date. Among them, 80,161 were in the vaccine-only group, 80,634 were in the vaccine-plus-behavior-change group, and 76,421 were in the control group (Figure 3).²⁵ For the monthly assessments, data collectors visited 7,842 households consisting of 52,237 people during the intervention period. Among these households, 1,965 (consisting of 13,148 individuals) were from the vaccine-only, 3,886 (consisting of 25,566 individuals) were from the vaccine-plus-behavior-change, and 1,991 (consisting of 13,523 individuals) were from the control group (Figure 3). Demographic characteristics were similar across all groups apart from educational status of respondents, presence of a sanitary latrine, and monthly income,



FIGURE 2. Study timeline. *For data analysis, we defined the behavioral intervention start date as September 24, 2011, which was the midpoint between the start and end dates of the handwashing intervention rollout. Data collection on respiratory illness and handwashing intervention uptake started from September 2011. **We ceased follow-up of the respiratory illness assessment at this time point.

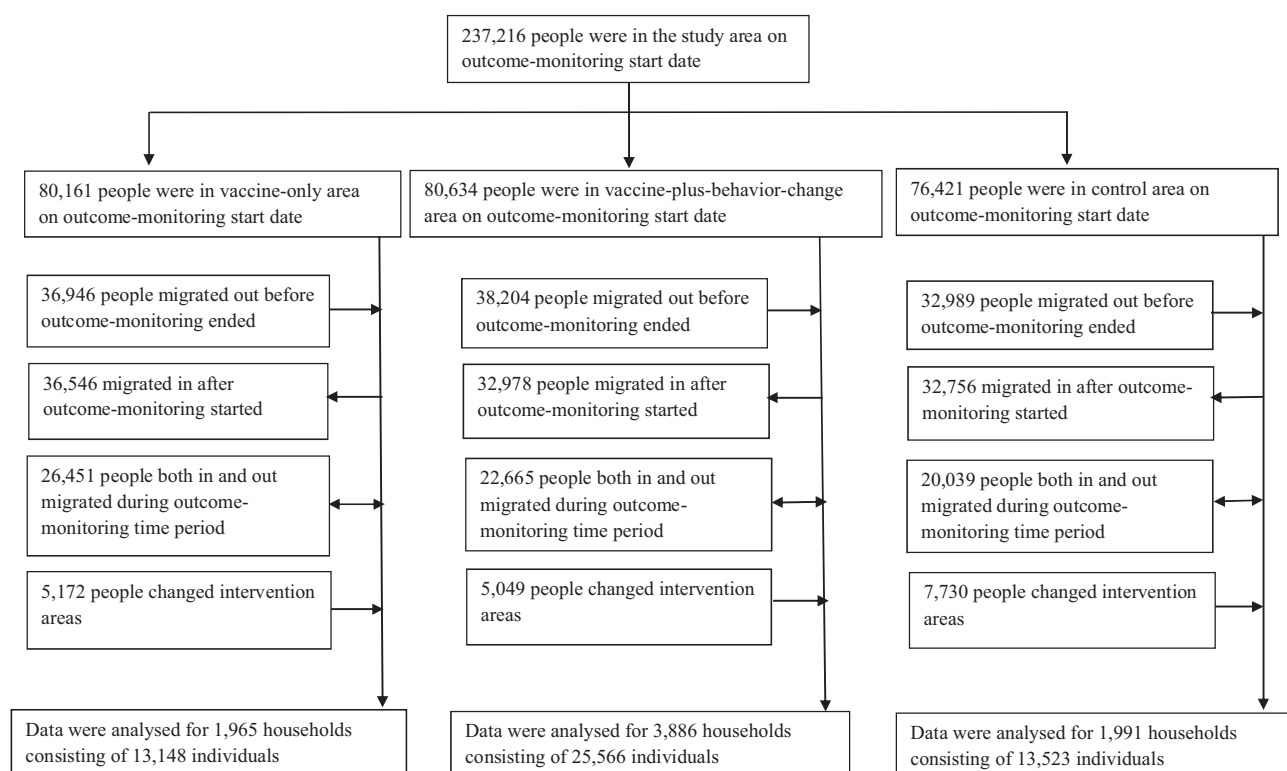


FIGURE 3. Participant flow during study period.

which were slightly higher in the vaccine-plus-behavior-change group (Table 1). The pre-intervention period demographic characteristics were also similar across groups, suggesting homogenous distribution of study participants.²⁵

Intervention uptake. Uptake of behavior-change interventions was modest as previously reported.²⁵ In short, during the intervention period, interviewers identified the presence of soap/soapy water and water (either reserved in a container or available at the tap) at 45% (1,729/3,886) of primary handwashing stations in vaccine-plus-behavior-change group compounds, in 22% (438/1,965) of the vaccine-only group compounds, and in 28% (556/1,991) compounds of the control group.

Prevalence of respiratory illness across intervention groups. The overall reported respiratory illness prevalence (all intervention and age groups combined) within the last 2 days of interview was 2.9% (1,494/52,237 surveyed individuals). Respiratory illness prevalence was similar across the groups (vaccine-plus-behavior change versus control: 2.8% [708/25,566] versus 2.9% [388/13,523], 95% CI: -0.008, 0.006; $P = 0.6$; vaccine-only versus control: 3.0% [398/13,148] versus 2.9%; 95% CI: -0.006, 0.009; $P = 0.4$). On univariate regression analysis (adjusted for the cluster design), the prevalence of respiratory illness in the intervention groups was similar to that in the control group (vaccine-plus-behavior-change versus control: RR: 0.97; 95% CI: 0.76, 1.22; vaccine-only versus control: RR: 1.06; 95% CI: 0.82, 1.35). The results remained unchanged after adjusting these for age and wealth of study participants, and gender of respondent (data not shown). Even though the reported respiratory illness prevalence decreased in all groups over time, there was no difference in illness prevalence across intervention and control groups during the intervention period (Figure 4).

Children ≤ 5 years of age had the highest respiratory illness prevalence compared with children of other age groups. Even though reported respiratory illness among children ≤ 5 years was comparatively lower in the vaccine-plus-behavior-change group compared with other groups (Table 2), the difference was not statistically significant (vaccine-plus-behavior-change group versus control: 6.7% versus 7.4%; 95% CI: -0.03, 0.02; $P = 0.4$ and vaccine-only group versus control group: 7.1% versus 7.4%; 95% CI: -0.03, 0.03; $P = 0.7$).

Presence of soap/soapy water and water in handwashing station and prevalence of respiratory disease. Overall (all groups combined), 35% (2,723/7,842) of the households had either soap or soapy water with water present in the primary handwashing station. People who had soap/soapy water and water present in the handwashing station reported lower respiratory illness prevalence (2.4% versus 3.0%, $P < 0.001$; $RR_{unadjusted} = 0.80$, 95% CI: 0.67, 0.95). The prevalence of having respiratory illness was approximately 18% less among people who had soap/soapy water and water present in handwashing station after adjusting for possible confounders (age and wealth of study participant, type of fuel used for cooking, gender of respondent, and cluster-randomized design of the trial): ($RR_{adjusted} = 0.82$, 95% CI: 0.69, 0.98). The association of the presence of soap/soapy water plus water and respiratory illness did not vary by age.

DISCUSSION

This study presents the impact of a large-scale community-based handwashing intervention trial on respiratory illness. We found no impact of the handwashing intervention on overall or age-specific reported respiratory illnesses. However, people

TABLE 1

Demographic characteristics of individuals and households across the intervention groups during the study intervention period (September 2011–August 2013)*

Characteristics of individuals	Vaccine-only group (n = 13,148) %	Vaccine-plus-behavior-change group (n = 25,566) %	Control group (n = 13,523) %
Age (mean, SD) (years)	24 (15.9)	25 (15.9)	24 (16.0)
≤ 5	11	11	11
> 5 to 15	21	20	22
> 15 to 50	62	63	61
> 50	6	6	6
Characteristics of households	Vaccine-only group (n = 1,965) %	Vaccine-plus-behavior-change group (n = 3,886) %	Control group (n = 1,991) %
Gender of the respondent (female)	82	84	85
Educational status of respondent			
No formal education	37	34	38
Below primary	16	17	16
Primary and some secondary	45	47	45
Above secondary	1	2	1
Source of drinking water (WASA supply water)†	80	82	85
Toilet shared among families	91	90	90
House construction material			
Roof			
Corrugated iron	85	83	83
Brick/concrete	14	17	17
Bamboo/wood/other	1	0.2	0.2
Floor			
Brick/concrete	92	94	94
Bamboo/wood/mud/sand/other	8	6	6
Wall			
Brick/concrete	71	77	71
Bamboo/wood/corrugated iron/other	29	23	29
Type of fuel used for cooking			
Natural gas	72	84	77
Wood/husk/charcoal/kerosene	22	12	17
Other (electric heater)	6	4	5
Monthly income (median, interquartile range) (US\$‡)	141 (97)	155 (90)	141 (90)

* Some categories do not sum to 100% because of rounding.

† Other sources of drinking water include well, tube well, bottled water, water vendor, and pond/canal/river.

‡ 1 USD = 77.6568 Bangladesh taka (average exchange rate during 2012).

who had soap/soapy water plus water present at their handwashing station, irrespective of intervention allocation, had lower prevalence of respiratory illness.

There are two potential explanations for the lack of impact of the handwashing intervention in this large-scale trial. First, it is possible that study participants followed the hand hygiene recommendations but that washing hands with soap does not reduce the burden of respiratory illness in these communities. However, evidence from a systematic review and from a meta-analysis of small-scale efficacy studies suggests that washing hands with soap can effectively reduce respiratory illness in similar contexts.^{5,6} An alternate and more likely explanation is that there was insufficient uptake of the recommended handwashing behavior to interrupt respiratory pathogen transmission. This explanation is supported by the observation that people who actually had soap and water present at their handwashing station, regardless of intervention assignment, had lower respiratory illness prevalence. Our findings suggest that even though handwashing can effectively reduce respiratory illness in this context, in this large-scale trial, the intervention did not improve handwashing behavior sufficiently to measurably impact on respiratory illness.

The indicator of uptake for handwashing behavior in our study, namely, the presence of soap/soapy water plus water in the primary handwashing station, was 17% higher (45% versus 28%) in the vaccine-plus-behavior-change intervention

group compared with the control group. Even though this increase seems low compared with some efficacy studies with more intense promotion of handwashing behavior,^{33,34} the handwashing intervention uptake was not much higher in our study compared with those of other large-scale interventions.^{12,13} For comparison, a project, Sanitation, Hygiene Education, and Water Supply in Bangladesh (SHEWA-B), aimed to improve hygiene, sanitation, and water supply for 20 million people in rural Bangladesh.¹² During the first 2 years of the intervention period, the focus was to improve water sanitation and hygiene behavior through interpersonal communication and group discussions. By the end of this 2 years intervention period, the presence of water, soap, or ash in convenient handwashing location had increased up to 16% from baseline (baseline 47% versus postintervention 63%).³⁵ Similarly, the national handwashing promotion program in Peru, targeting ~28 million people, found no effect of a mass media intervention on handwashing behavior and combined the mass media campaign, although with more intense training and promotional activities at the community level increased the share of households with handwashing facilities by 4.9%.¹³ Neither SHEWA-B nor the Peru national handwashing program resulted in a measurable reduction in childhood diarrhea or respiratory illness.^{12,13} However, both SHEWA-B and the Peru national handwashing program were externally funded programmatic interventions targeting millions of people

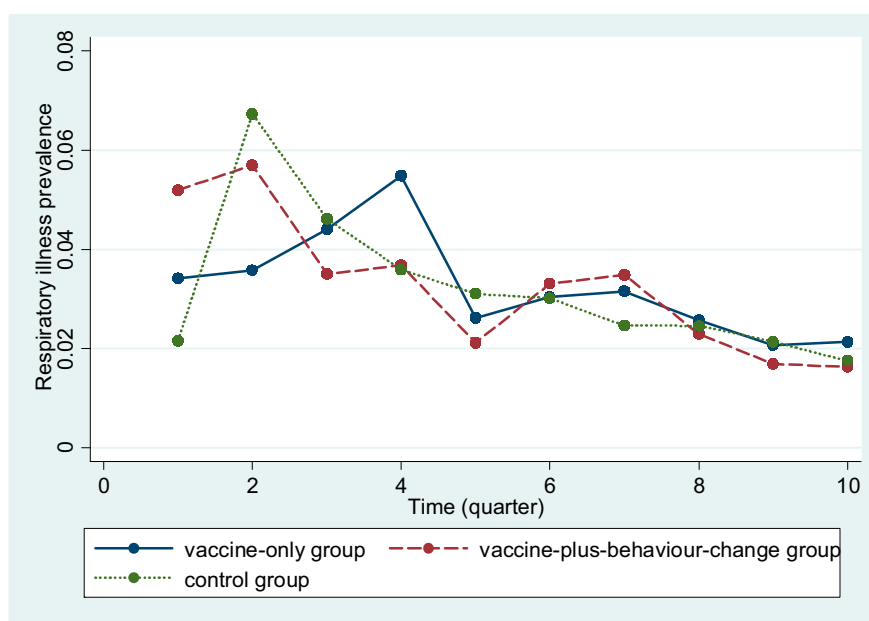


FIGURE 4. Reported respiratory illness prevalence within last 2 days across the groups during the intervention period (September 2011–August 2013). *Intervention time period (presented in quarters) started from quarter 2. This figure appears in color at www.ajtmh.org.

compared with our trial focused in one neighborhood of a large city. The reasons for poor uptake of this pretested intervention will be assessed and reported separately, but maintenance and management difficulties related to provision of shared handwashing facilities in intervention compounds may have contributed.

It is possible that the high-population migration rate in this study reduced the impact of the behavior-change intervention and so prevented an observable impact on respiratory illness risk. We have previously reported that large numbers of study participants moved outside the study area within the 2-year study period, and this might have limited the consistency of participants' exposure to the hygiene behavior intervention.²⁵ Uptake of the intervention was marginally (~4%) higher among people who stayed in the study area for at least 1 year after the intervention started compared with those who migrated in or out.²⁵ However, among people whose respiratory outcome was analyzed, we do not know how many were recent immigrants into the study areas and so could not directly explore the relationship between migration and respiratory illness.

In our study, the households that had soap and water present in the handwashing station irrespective of intervention

assignment experienced less respiratory infection. The presence of soap and water in the handwashing station does not necessarily ensure that participants actually washed their hands or used soap. However, evidence suggests that people are more likely to wash their hands at key times if they have soap and water present in the handwashing station.^{10,36} An association between this surrogate measure of handwashing behavior and interruption in disease transmission has been observed in other studies that showed fewer child respiratory infections among participants with access to water for washing hands in the house.^{18,19} This protective effect of the presence of soap/soapy water and water in handwashing stations on respiratory illness that we observed in this study was for the overall study population rather than for any specific age group. Because these handwashing indicators are common among households with higher socioeconomic status¹⁸ and women in this context have been observed to practice better respiratory hygiene compared with men,³⁷ we adjusted the results for both wealth and gender; the results remained significant. However, it was not possible to adjust for unmeasured confounders, such as intervention families taking more care to maintain a handwashing facility or providing better care for their children. In addition, one of the pathways that handwashing interventions may reduce the risk of respiratory disease is by preventing diarrhea that predisposes to subsequent respiratory infection.^{38,39} Because the intervention did not substantially impact diarrhea-related hospitalization rates by study groups,²⁵ this complementary pathway to reduce respiratory infections was less likely to be active.

Our study has several limitations. The focus of the behavioral messages for washing hands was related mainly to defecation and food preparation events, as the goal of the main study was aimed at reducing diarrhea in the community rather than respiratory diseases. Even though hands have a potential role in transmission of respiratory viruses,^{40,41} focused behavioral interventions targeting reducing transmission of

TABLE 2

Reported respiratory illness prevalence within last 2 days of interview according to age and intervention groups during intervention period (September 2011–August 2013)

Age	All intervention groups combined (N = 52,237) %	Vaccine-only group (n = 13,148) %	Vaccine-plus-behavior-change group (n = 25,566) %	Control group (n = 13,523) %
< 5 years	7.0	7.1	6.7	7.4
> 5 to ≤ 15 years	1.9	2.1	1.7	2.0
> 15 to ≤ 50 years	2.5	2.6	2.5	2.4
> 50 years	2.6	2.8	2.6	2.3
All age groups combined	2.9	3.0	2.8	2.9

respiratory pathogens might be more effective in reducing illness prevalence. In fact, respiratory hygiene is often poorly practiced in low- and middle-income Bangladesh communities.³⁷ A study conducted in Bangladesh reported that in 81% of the observed events, the participants coughed or sneezed into air (i.e., uncovered), and in 11% into their hands. No one washed their hands after coughing or sneezing into their hands.³⁷ Another limitation is that it is possible that the intervention impacted on severe respiratory illness such as pneumonia but not on milder forms of self-reported respiratory symptoms at the community level that we assessed. Because severe respiratory infections represent the greatest public health burden, future evaluations would ideally assess this outcome.

Although the association of having soap and water present in the handwashing station and lower respiratory infection suggests that continued effort to develop low-cost strategies to improve population handwashing practices has the potential to improve child health, the interventions deployed in this trial did not impact respiratory illness. Changing handwashing behavior among large populations remains difficult, and so, such efforts should be rigorously evaluated so that the global community can learn from ongoing efforts and attempt to develop and optimize sound strategies.

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Chapter 8: Risk Factors for Community-Based Reports of Gastrointestinal, Respiratory, and Dermal Symptoms: Findings from a Cohort Study in Australia

8.1 Chapter overview

Few studies have examined epidemiologic associations for symptomatic episodes of gastrointestinal (GI), respiratory, or dermal complaints via a prospective, community-based approach, but no previous study has examined risk factors for all three morbidity outcomes concurrently. In this chapter I have explored epidemiological associations for symptomatic episodes of diarrhoea, respiratory or dermal complaints via a prospective, community-based approach. I have examined risk factors for all three morbidity outcomes concurrently. I found that attendance at childcare or kindergarten was similarly associated with GI and respiratory symptoms. Recreational swimming in public pools was an equally strong risk factor for GI, respiratory, and dermal symptoms. Clustering of symptoms within households was common for GI and respiratory symptoms, although more respiratory clusters were seen. Prospectively assessing risk factors for three symptom complexes together in one cohort during same time period is new and enabled us to compare risk ratios and strengths of associations for different risk factors. These comparative data will be helpful in prioritizing prevention strategies for various health outcomes.

The findings described in this chapter have been published in the **Journal of Epidemiology**.

8.2 Declaration for thesis chapter 8

Monash University

Najnin, N., Forbes, A., Sinclair, M., & Leder, K. (2014). Risk factors for community-based reports of gastrointestinal, respiratory, and dermal symptoms: findings from a cohort study in Australia. *Journal of Epidemiology*, 24(1), 39.

Declaration by candidate

For Chapter 8, the nature and extent of my contribution to the work was the following:

Nature of contribution	Extent of contribution (%)
Literature review, statistical analysis and interpretation of results, and writing the manuscript.	80%

The following co-authors contributed to the work. If co-authors are students at Monash University, the extent of their contribution in percentage terms must be stated:

Name	Nature of contribution	Extent of contribution (%) for student co-authors only
Andrew Forbes	Data analysis, critically reviewed and edited manuscript	N/A
Martha Sinclair	Contributed to the study design and critically reviewed and edited manuscript	N/A
Karin Leder	Contributed to the study design, provided suggestion on analysis and critically reviewed and edited manuscript	N/A

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the candidate's and co-authors' contributions to this work.

Candidate's Signature		15/07/2019
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Main Supervisor's Signature		22/07/2019
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Risk Factors for Community-Based Reports of Gastrointestinal, Respiratory, and Dermal Symptoms: Findings From a Cohort Study in Australia

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ABSTRACT

Background: Although gastrointestinal (GI), respiratory, and dermal symptoms are common, few studies have conducted concurrent and comparative prospective analyses of risk factors for these 3 morbidity outcomes.

Methods: We used data from a community-based randomized controlled trial among 277 South Australian families to analyze GI (diarrhea, vomiting), respiratory (sore throat, runny nose, cough) and dermal (rash, generalized itch, dermal infection) symptoms.

Results: Log-binomial regression analysis revealed similar risks of GI (adjusted risk ratio [RR], 1.65; 95% CI, 1.05–2.58) and respiratory (RR, 1.68; 95% CI, 1.31–2.15) symptoms among childcare/kindergarten attendees. Swimming in public pools/spas in the current or previous week was associated with all 3 symptom complexes, conferring similar risk for each (RR for GI: 1.33; 95% CI, 0.99–1.77; respiratory: 1.20; 95% CI, 1.04–1.38; dermal: 1.41; 95% CI, 1.08–1.85). Pet ownership was not associated with symptoms. Household clustering of GI and respiratory symptoms was common, and clustering of respiratory symptoms correlated with number of individuals per household.

Conclusions: This simultaneous examination of risk factors for 3 health outcomes yielded new comparative data that are useful for developing prevention strategies.

Key words: risk factors; respiratory symptoms; gastrointestinal symptoms; dermal symptoms; swimming; swimming pools; household clustering

INTRODUCTION

Gastrointestinal (GI), respiratory, and dermal diseases are common and cause substantial morbidity and economic loss.^{1–4} Each of these 3 symptom complexes has a number of underlying causes and can be associated with infection or other (noninfectious) problems such as allergy. Some underlying etiologic causes for these symptoms have known risk factors. For example, previously reported risk factors for GI and respiratory infections include young age, attending an educational institution outside the home, and having another household member who is unwell.^{5–11} For respiratory infections, factors such as air pollution and smoking are also important.¹² However, few studies have examined epidemiologic associations for symptomatic episodes of GI, respiratory, or dermal complaints via a prospective, community-based

approach, and no previous study has examined risk factors for all 3 morbidity outcomes concurrently.

We attempted to identify risk factors associated with GI, respiratory, and dermal symptoms at the community level among a prospective cohort. Identifying and assessing these risk factors for all 3 disease symptoms from the same cohort within the same time period enables comparison of the strengths of associations and thus provides a new and useful public health perspective.

METHODS

Study participants and data collection

As part of a double-blinded, randomized, controlled trial conducted in South Australia from June 2007 to August 2008, weekly diaries were given to 300 families (37% of the total

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number of households initially approached) to collect health data during a 12-month period. The details of the participant recruitment process are available elsewhere.¹³ Eligibility criteria for inclusion related to the main study goal, which was to determine whether consumption of untreated rainwater contributed to gastroenteritis. The criteria included: using untreated rainwater from an above-ground tank as the usual drinking water source, having at least 4 eligible household members (including at least 2 children aged 1–15 years), home ownership or stable rental history (≥ 12 months in current home), and having a reasonable command of English. Households were randomly allocated to receive real or sham water treatment devices to treat rainwater for drinking; real devices removed microorganisms from the water, while sham devices did not. Full details on the study and methods used have been reported previously.¹⁴ In brief, the study families completed a health diary each week, which included reporting of symptoms related to GI, respiratory, and dermal complaints. They also provided exposure information regarding recreational swimming activities, pet ownership, and childcare/school attendance, as well as health-seeking behavior.

Definitions

We defined a GI symptom as passing a loose stool or vomiting at least once within a 24-hour period. We considered people to have respiratory symptoms if they had a sore throat, runny nose, or cough. A report of rash, generalized itching, or dermal infection was defined as having dermal symptoms. Rather than collect information for each of these symptom complexes daily, we collected information on the overall presence or absence of each type of clinical event during the course of each week.

A recreational swimming setting was defined as a public pool/spa, a private pool/spa, an ocean/beach, or a river/lake/dam. Participants were asked to record whether they had swum during the week and in which setting. No information was recorded regarding duration of swimming, number of times the participant entered the water, or whether the participant had put his/her head underwater.

A cluster of GI, respiratory, and dermal symptoms was defined as development of GI, respiratory, or dermal symptoms, respectively, in more than 1 household member in the same or consecutive weeks. Each cluster was considered to have ended if 2 weeks elapsed with no symptoms reported by any household member. Participants could appear in more than 1 cluster over the period of observation. Sporadic GI, respiratory, and dermal symptoms were defined as cases that occurred outside of a cluster.

Data management

Completed health diaries were mailed to the study center (Monash University) every 4 weeks. Diaries were scanned, and the accuracy and completeness of data were verified using Cardiff Teleform software (version 10.1, 2006; Vista, CA,

USA) before data entry into a Microsoft Access database. Reporting participants were telephoned for clarification if information was missing or ambiguous.

Data analysis

The number of weeks with valid information was determined for each of the 3 symptom complexes and for information on swimming exposure. Analyses of the effect of swimming in different settings during the current or previous week on incident events in relation to the 3 symptom complexes during the current week were performed using log-binomial regression to estimate risk ratios (RRs),¹⁵ accounting for family clustering using robust standard errors and adjusting for age, sex, season, and swimming in different settings. To estimate incident rather than prevalent events, the analyses were restricted to weeks when each individual did not experience the symptom complex of interest in the prior week. Associations of risk factors with being in a symptom cluster versus a sporadic event or no event were also estimated using log-binomial regression accounting for family clustering. Each independent variable was evaluated for confounding and effect modification. Two-sided *P* values less than 0.05 were considered statistically significant. All calculations were performed using Stata version 11.1.¹⁶

Ethical considerations

During enrollment, written informed consent was obtained from all adult household members and from parents and guardians on behalf of children. This study received approval from the Monash University Standing Committee on Ethics in Research Involving Humans (SCERH; 2006/555EA) and the South Australia Department of Health Human Research Ethics Committee.

RESULTS

The original study comprised 300 households with 1352 residents. We excluded 23 households who failed to return any health diaries (21 households) or had missing demographic information (2 households). Ultimately, our analysis included 277 households comprising 1237 participants. The households who failed to return health diaries and were therefore excluded from the analysis and the households that were included in the analysis had similar demographic characteristics. A comparison of gastroenteritis rates between groups with real or sham water treatment devices showed no significant difference, indicating that drinking untreated rainwater did not contribute appreciably to health outcomes.¹⁴ Therefore, results from both sham and real filter groups were combined, and this cohort was considered generally representative of households with young children.

The mean age of the study participants was 24.1 years (age range: 0.6–78.6 years); 11% ($n = 132$) of the study participants were children aged 5 years or younger. The

numbers of male and female participants in the study were similar (Table 1). Among the total of 1237 study participants, 54% ($n = 674$) were attending an educational institution (child care/kindergarten, primary/secondary school, university) at the time of the study.

Children attending child care/kindergarten were at higher risk of GI (RR, 1.65; 95% CI, 1.05–2.58) and respiratory

symptoms (RR, 1.68; 95% CI, 1.31–2.15) as compared with all others (Table 2). The risk of reporting dermal symptoms showed no such association. The similarity in the strength of the association of childcare/kindergarten attendance with GI and respiratory symptoms suggests that such attendance is an equally strong risk factor for these health outcomes.

Overall, 77% ($n = 957$) of the study participants reported swimming at least once during the study period. There was no difference in swimming status between males and females (51% vs 49%; $P = 0.22$). Among those who reported having swum at least once, many swam in more than 1 setting. Overall, 75% ($n = 722$) swam in a public pool or spa, 62% ($n = 591$) swam in a private pool or spa, 56% ($n = 538$) swam in the ocean, and 22% ($n = 210$) swam in a river, dam, or lake. The largest proportion of swimmers were those aged 5 to 15 years (45%; $n = 433$). Fewer people swam during winter as compared with the other seasons.

Among those who swam at least once, swimming in a public pool/spa during the current and/or previous week was significantly associated with all 3 symptom complexes, as compared with swimming in other settings and not swimming, in univariate regression analysis. These associations remained significant after adjusting for potential confounders (Table 2). The strengths of the associations of public pool/spa exposure with dermal (RR, 1.41; 95% CI, 1.08–1.85), GI (RR, 1.33;

Table 1. Demographic characteristics of study participants, Adelaide, Australia (June 2007–August 2008)

Characteristics	$n = 1237$ (%)
Age	
≤5 years	132 (11)
>5 to ≤15 years	489 (40)
>15 years	616 (50)
Sex	
Male	626 (51)
Female	611 (49)
Educational status	
Currently attending an educational institution	
Attending childcare/preschool	98 (8)
Primary	406 (33)
Secondary	139 (11)
College/university	31 (3)
Education completed^a	
Primary	7 (1)
Secondary/commercial/technical	250 (20)
College/university	273 (22)

^aData missing for 38 (3%) participants.

Table 2. Association of attendance at childcare, school, or other educational institution, pet ownership, and swimming exposure during the previous or current week with GI, respiratory, and dermal symptoms, Adelaide, Australia (June 2007–August 2008^a) ($n = 1237$)

Attending institution outside home	Unadjusted		Adjusted ^b		P value
	Risk ratio	95% CI	Risk ratio	95% CI	
GI					
Attending child care/kindergarten ^c	2.51	2.02, 3.12	1.65	1.05, 2.58	
Having a pet at home ^d	0.98	0.68, 1.41	—	—	
Swimming in any setting	1.24	0.98, 1.56	1.19	0.94, 1.52	0.149
Swimming in public pool/spa ^e	1.5	1.15, 2.04	1.33	0.99, 1.77	0.057
Swimming in private pool/spa ^e	0.75	0.55, 1.03	0.83	0.60, 1.15	0.251
Swimming in ocean and/or river ^e	0.94	0.68, 1.31	0.99	0.70, 1.39	0.948
Respiratory					
Attending child care/kindergarten ^c	2.52	2.09, 3.03	1.68	1.31, 2.15	
Having a pet at home ^d	1.11	0.83, 1.47	—	—	
Swimming in any setting	1.06	0.92, 1.22	1.09	0.97, 1.23	0.153
Swimming in public pool/spa ^e	1.34	1.13, 1.58	1.20	1.04, 1.38	0.014
Swimming in private pool/spa ^e	0.71	0.58, 0.87	0.98	0.80, 1.20	0.842
Swimming in ocean and/or river ^e	0.77	0.62, 0.95	0.92	0.72, 1.18	0.517
Dermal					
Attending child care/kindergarten ^c	2.74	1.71, 4.39	0.96	0.52, 1.77	
Having a pet at home ^d	1.45	0.81, 2.60	—	—	
Swimming in any setting	1.82	1.43, 2.33	1.59	1.26, 2.01	<0.001
Swimming in public pool/spa ^e	2.07	1.50, 2.87	1.41	1.08, 1.85	0.013
Swimming in private pool/spa ^e	1.16	0.74, 1.80	1.16	0.77, 1.74	0.471
Swimming in ocean and/or river ^e	1.08	0.76, 1.52	1.42	0.95, 2.14	0.088

Abbreviation: GI, gastrointestinal.

^aAll analysis accounted for clustering by household.

^bRisk ratios adjusted for age, sex, season, and household clustering.

^cComparator group: Attending primary school or a higher educational institution or not attending any educational institute.

^dDogs, cats, birds, and fish.

^eAdjusted for swimming in other settings; comparator group: swimming in other settings and non-swimmers.

Table 3. Demographics of individuals within and outside a GI symptom cluster, Adelaide, Australia (June 2007–August 2008^a) (*n* = 1235)

Demographic characteristics	People in cluster <i>n</i> = 355 (%)	People with sporadic GI symptoms <i>n</i> = 211 (%)	People with no GI symptoms <i>n</i> = 669 (%)	Risk ratio ^b (95% CI)	<i>P</i> value
Sex					
Male	169 (48)	104 (50)	352 (53)	1.00	
Female	186 (52)	107 (51)	317 (47)	1.13 (0.96, 1.32)	0.131
Age					
<5 years	78 (22)	22 (10)	32 (5)	2.49 (2.01, 3.05)	<0.001
5 to 15 years	131 (37)	87 (41)	270 (40)	1.13 (0.93, 1.37)	0.208
>15 years	146 (41)	102 (48)	367 (55)	1.00	—
Attending educational institution					
Attending child care/kindergarten	60 (17)	15 (7)	23 (3)	2.32 (1.89, 2.86)	<0.001
Attending primary school or higher educational institution	147 (41)	100 (47)	328 (49)	0.97 (0.80, 1.18)	0.76
Not attending any educational institution	148 (42)	96 (46)	318 (48)	1.00	—

Abbreviation: GI, gastrointestinal.

^aCluster was defined as >1 person in a household having GI symptoms during the current or previous week.

^bRisk ratio for being in a cluster vs not being in cluster (people with sporadic and no GI symptoms combined), using binary regression adjusted for clustered family design.

95% CI, 0.99–1.77), and respiratory symptoms (RR, 1.2; 95% CI, 1.04–1.38) were similar. In multivariable analysis, swimming in any setting was associated only with dermal symptoms. We found no significant association of swimming exposure in a private pool/spa or in an ocean/river/lake/dam with any disease symptoms of interest (Table 2). Moreover, if we restricted the multivariable regression analysis to swimming in the previous week only, only swimming in a public pool and respiratory symptoms were significantly associated ($P = 0.022$). Corresponding analysis restricted to swimming and having symptoms during the same week showed that dermal symptoms were associated with swimming in any setting ($P = 0.003$) and swimming in a public pool/spa ($P = 0.029$), and that GI symptoms were associated with swimming in a private pool/spa ($P = 0.018$). We found no association of GI, respiratory, or dermal symptoms with pet (cat/dog/fish/bird) ownership (Table 2).

Of the 45% ($n = 561$) of participants who had GI symptoms during the study period, 63% ($n = 355$) were part of a cluster and 37% ($n = 211$) were sporadic cases. There was a total of 287 GI symptom clusters, distributed among 124 (45%) of households. The mean number of GI clusters per household in those recording at least 1 cluster was 2.3 (median 2, maximum 15), and the mean number of symptomatic weeks among individuals in a GI cluster(s) was greater than that among those who were never part of a cluster (2.5 vs 1.5, $P < 0.001$). We found no correlation between number of members per household and number of study participants in a GI cluster ($P = 0.11$). Those in at least 1 GI cluster were younger (mean 20.3, median 11.4 years) than those not in a GI cluster (mean 25.7, median 16.6 years, $P < 0.001$).

Overall, 80% ($n = 987$) of study participants had respiratory symptoms, among whom 94% ($n = 929$) were part of a cluster and 6% ($n = 84$) were sporadic cases. The 1568 respiratory symptom clusters reported involved 240 households (87%).

People in a respiratory cluster(s) reported more weeks with symptoms than did sporadic cases (mean 4.8 vs 1.8, $P < 0.001$). The mean number of respiratory clusters per household was 6.5 (median 5, maximum 33), and there was a correlation between number of household members and total number of participants involved a cluster ($P < 0.001$). The mean ages for those in (22.9 years) and outside (27.9 years) a cluster were different ($P < 0.001$).

Of the 31% ($n = 273$) of study participants who had dermal symptoms during the study, 39% ($n = 107$) were part of a cluster and 61% ($n = 166$) were sporadic cases. There were 107 dermal symptom clusters affecting 39 (14%) of households. More symptomatic weeks were reported by those in a dermal cluster(s) (mean, 5.8 weeks vs 3.4 for sporadic cases, $P = 0.012$). The maximum number of dermal clusters per household was 28 (mean 4.7, median 2). There was no correlation between number of household members and number of people in a cluster ($P = 0.124$). The mean age for individuals in a cluster (17.3 years) was lower than that for those not in a cluster (24.8 years) ($P < 0.001$).

For all 3 symptom complexes, the identified risk factors for being part of a household cluster were age under 5 years and attendance at a child care/kindergarten (Tables 3, 4 and 5).

DISCUSSION

To our knowledge, this is the first prospective longitudinal cohort study to examine risk factors associated with community reports of GI, respiratory, and dermal symptoms concurrently. Among our study participants, those who attended childcare or kindergarten were more likely to suffer from respiratory symptoms, even after adjustment for age. People swimming in public pools or spas had an increased risk of reporting all 3 symptom complexes, and household clusters of GI and respiratory symptoms were common.

Table 4. Demographics of individuals within and outside a respiratory symptom cluster, Adelaide, Australia (June 2007–August 2008^a) (n = 1235)

Demographic characteristics	People in cluster n = 929 (%)	People with sporadic respiratory symptoms n = 84 (%)	People with no respiratory symptoms n = 220 (%)	Risk ratio ^b (95% CI)	P value
Sex					
Male	465 (50)	39 (46)	121 (55)	1.00	—
Female	464 (50)	45 (54)	101 (46)	1.02 (0.96, 1.10)	0.457
Age					
<5 years	118 (13)	7 (8)	7 (3)	1.24 (1.15, 1.34)	<0.001
5 to 15 years	369 (40)	38 (45)	82 (37)	1.05 (0.99, 1.11)	0.102
>15 years	442 (48)	39 (46)	1433 (60)	1.00	—
Attending educational institution					
Child care/kindergarten	87 (9)	7 (8)	4 (2)	1.21 (1.11, 1.32)	<0.001
Attending primary school or higher educational institution	432 (47)	44 (52)	100 (45)	1.03 (0.97, 1.09)	0.84
Not attending any educational institution	410 (44)	33 (39)	118 (53)	1.00	—

^aCluster was defined as >1 person in a household having respiratory symptoms during the current or previous week.

^bRisk ratios for being in a cluster vs not being in cluster (people with sporadic and no respiratory symptoms combined), using binary regression adjusted for clustered family design.

Table 5. Demographics of the individuals within and outside a dermal symptom cluster, Adelaide, Australia (June 2007–August 2008^a) (n = 1235)

Demographic characteristics	People in cluster n = 107 (%)	People with sporadic dermal symptoms n = 166 (%)	People with no dermal symptoms n = 962 (%)	Risk ratio ^b (95% CI)	P value
Sex					
Male	49 (46)	76 (46)	499 (52)	1.00	—
Female	58 (54)	90 (54)	463 (48)	1.21 (0.83, 1.77)	0.33
Age					
<5 years	24 (22)	34 (21)	74 (8)	3.39 (2.04, 5.62)	<0.001
5 to 15 years	50 (47)	74 (45)	364 (38)	1.91 (1.31, 2.77)	0.001
>15 years	33 (31)	58 (35)	524 (55)	1.00	—
Attending educational institution					
Child care/kindergarten	18 (17)	28 (17)	52 (5)	2.37 (1.68, 4.62)	0.002
Attending primary school or higher educational institution	52 (49)	83 (50)	440 (46)	1.37 (0.93, 2.02)	0.11
Not attending any educational institution	37 (35)	55 (33)	470 (49)	1.00	—

^aCluster was defined as >1 person in a household having dermal symptoms during the current or previous week.

^bRisk ratios for being in a cluster vs not being in cluster (people with sporadic and no dermal symptoms combined) using binary regression, adjusted for clustered family design.

Attending childcare or kindergarten was previously reported as a risk factor for GI and respiratory symptoms.^{5,17–20} Our results support those findings but additionally suggest that childcare/kindergarten attendance increases the risks of these health outcomes by approximately 60%. One likely reason for the vulnerability to illness among young children attending childcare is close contact with other infected children (and/or staff) in a crowded environment, particularly as hygiene measures may be compromised in this setting. We observed no strong association between dermal symptoms and attendance at educational institutions, consistent with the premise that transmission of contagious dermal symptoms is less likely. We also found that keeping any kind of pet at home was not a risk factor for any of the 3 symptoms of interest. This is supported by studies conducted in other settings.^{21–25}

Recreational swimming is another recognized risk factor for GI, respiratory, and dermal symptoms,^{26–28} although no previous study examined whether there is a differential impact in relation to type of swim setting for all 3 symptom complexes. We found that recreational swimming in any body of water was significantly associated only with dermal symptoms. However, swimming in a public pool/spa was an identified risk factor for GI, respiratory, and dermal symptoms (adjusted RRs for all 3 symptom complexes, 1.2–1.4). Outbreaks of gastroenteritis associated with swimming in a public pool or spa are reported frequently,^{29,30} but the relationship between sporadic gastroenteritis and swimming is complex, as it reflects factors such as the background pathogen load in the source water, the likelihood of water contamination due to fecal pathogen excretion by other swimmers,³¹ the impact of any disinfection procedures (eg,

chlorination) on pathogen concentration,³² and the volume of water ingested by the swimmer.

While it is important to treat pool water with disinfectants to kill microorganisms and reduce the chance of disease, these chemical products and/or their by-products might contribute to respiratory and dermal symptoms by inducing an allergic reaction.^{28,33,34} However, swimming in a private pool, which would also involve chemical disinfectants (albeit at potentially lower concentrations), was not significantly associated with symptoms.

The final aspect examined was the frequency of clustered symptoms among household members. Although presence of concurrent symptoms among householders was reported previously,^{8–10,35} many of the relevant studies were performed in the setting of a community outbreak or as a follow-up of a laboratory-confirmed case of an individual pathogen^{36–39} rather than in a prospective community-based study. In the present study, clusters of dermal symptoms affected 31% of households, as compared with 45% and 80% for GI and respiratory symptoms, respectively. For all 3 symptom types, being in at least 1 cluster was associated with a higher mean number of weeks with symptoms, as compared with sporadic cases. The 2 demographic characteristics most strongly associated with being in any type of cluster were age younger than 5 years and attending childcare or kindergarten, which confirms the findings of previous research conducted in a variety of settings.^{6,7,39–42} Respiratory symptoms were most common overall, and clustering of respiratory symptoms was also more common in larger households. These findings may reflect the comparative transmissibility of respiratory, GI, and dermal pathogens.

In contrast to earlier reports of family clustering of GI and respiratory symptoms, which gathered evidence from known outbreaks or laboratory surveillance data, our prospectively collected data are more likely to reflect levels of community-based clustering. However, we were not able to examine the underlying reasons for clustering of symptoms within families, which could be due to common exposure, secondary spread, simultaneous occurrence of unrelated sporadic cases, or (for noninfectious etiologies) familial sensitivity. For example, clustered dermal symptoms do not necessarily reflect pathogen transmission and may be due to atopy within families.

Our study has several limitations. First, we relied on self-reported data over a 1-year time period. It is possible that response fatigue may have meant some people did not report all symptoms, which may have resulted in under-reporting and therefore underestimation of the strength of association for some risk factors. Second, we collected information on the presence or absence of different symptoms using broad symptom-based case definitions. Therefore, the results must be interpreted with caution, as not all symptoms were necessarily serious or infectious. Nevertheless, they are indicative of the frequency and burden of each of the 3

symptom types in the community. Third, our case definition of swimming considered swimming during the current and/or previous week and GI, respiratory, and dermal symptoms during the current week. Consideration of the current week in our case definition means that we measured exposure (swimming) and outcome in the same week; thus, we cannot be entirely certain that exposure preceded outcome. Additionally, we measured weeks, rather than days, with symptoms and therefore cannot precisely define the start and end points of episodes. Finally, our findings may not be generalizable across whole communities. We deliberately enrolled selected English-speaking households in South Australia with at least 2 children aged 1 to 15 years. Therefore, our results reflect the demographics of those included, namely, young families living in urban Adelaide. While the results may thus not be applicable to all other populations, they are nevertheless likely to be relevant for families in urban areas of developed countries.

In summary, in a prospective cohort of 277 Australian families, we confirmed and extended previous reports of risk factors for illness by performing a prospective community-based study that simultaneously examined respiratory, GI, and dermal health complaints. Attendance at childcare or kindergarten was similarly associated with GI and respiratory symptoms. Recreational swimming in public pools was an equally strong risk factor for GI, respiratory, and dermal symptoms. Clustering of symptoms within households was common for GI and respiratory symptoms, although more respiratory clusters were seen. Prospectively assessing risk factors for 3 symptom complexes together in 1 cohort during 1 time period is new and enabled us to compare risk ratios and strengths of associations for different risk factors. These comparative data are helpful in prioritizing prevention strategies for various health outcomes.

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Chapter 9: Discussion and Conclusions

9.1 Chapter overview

In this chapter I aimed to highlight the key findings from the previous chapters (Chapter 4 to 8), and to discuss implication of these findings on future research in preventing diarrhoea and respiratory illness. I also briefly discussed the strengths and the limitations of the research that I undertook for each of the objectives. Finally, this section presents the conclusions of this thesis.

9.2 Discussion (Summary of key findings, potential implications, recommendations for future research and strengths and limitations of each objectives)

To date billions of people still lack access to safe water and sanitation, resulting in deaths, missed education and reduced productivity. To achieve the 2030 Agenda for Sustainable Development (SDG) #6, it is important to ensure availability and sustainable management of drinking water, sanitation and hygiene services for all (140). About 2.1 billion people still need improvement of water quality services (140). The definition of the new global SDG indicator ‘proportion of population using safely managed drinking water services’ includes improved drinking water source that is not only located in premises and available when needed but also compliant with faecal and chemical standard. Hand-washing with soap and water is one of the hygiene measures that is widely recognized as a top priority for reducing transmission of diseases. The low-income countries have the lowest coverage for hand-washing facilities (140). The SDG 6 synthesis report on 2018 reported that almost 60% of countries do not have data available for most of global SDG 6 indicators, suggesting a major knowledge gap.

Systematic reviews and meta-analysis of previous efficacy studies showing positive impact of promoting water treatment at POU and hand-washing with soap on diarrhoea targeted only small number of households in various countries (88, 89). Whether these approaches are effective when implemented on a larger scale is still unclear (128, 129). Upscaling effective interventions to improve drinking water quality, sanitation and hygiene behaviour and sustained use of these interventions especially in resource poor settings are key to achieve the SGD 6. POU water treatment is recognised as the most cost effective approach to provide access to safe water for the global poor who are at higher risk of suffering from waterborne diseases (104). While correctly utilized POU water treatment interventions can improve water quality, public health benefits require more sustained, consistent and widespread usage. Schmidt *et al* reviewed the evidence on acceptability, scalability, adverse effects, and non-health benefits as the main criteria to establish the evidence that is needed before scaling up of POU water treatment interventions (87). They concluded that widespread promotion of POU water treatment intervention is still premature given the available evidence and recommended further studies to assess acceptability of POU water treatment products are needed before these can be recommended to policy makers and implementers (87).

I have discussed the summary of key findings, potential implications, recommendations for future research and strengths and limitations of each objectives below:

Objective 1

In this thesis, to address **objective 1**, I examined sustained use and associated motivators and barriers of a particular POU water treatment product (CrystalPur siphon filter) in a low-income urban community in Bangladesh to understand if this product would be ideal for scaling up in that context. I have briefly mentioned the results in **Chapter 4** and details of this study findings and interpretations can be found in the published paper that I have included in **Chapter 4.3** (165).

Briefly, the study described by Luoto *et al.* provided 600 households in poor communities in Dhaka,

Bangladesh randomly-ordered two-month free trials of four water treatment products: dilute liquid sodium hypochlorite solution (marketed locally as Water Guard), sodium dichloroisocyanurate tablets (branded as Aquatabs), a combined flocculant-disinfectant powdered mixture (the PUR Purifier of Water), and a silver-coated ceramic siphon filter (107). The reason for choosing the CrystalPur siphon filter as an intervention product in this study was that it is an economical (expected retail US\$7) and microbiologically effective POU water treatment product (167). Households reported highest usage of the filter in this trial, suggesting it was one of the most popular water treatment products among the participants. After receiving the CrystalPur siphon filters at the end of this randomised trial (either at a cost or for free, as determined by the BDM auction procedure; discussed in **Chapter 3**), approximately a quarter of households were using it regularly during the three-month follow-up visit, but regular usage decreased to approximately one-fifth during the six-month follow-up visit.

Other studies have similarly reported that sustained use of POU water treatment intervention declines with time. In Bolivia, there was an approximately 20% decline in use of water filtration device after 9 months of implementation (181). An assessment of a household water filtration device provided at no cost to residents in rural Cambodia showed a decline in sustained usage at a rate of 2% per month after the implementation was over (182). We found regular filter usage declined by 7% from months 3 to 6, and the usage rate after 3 months among our study participants was much lower than in the Bolivian and Cambodian studies. Positive predictors of regular filter usage at both times were: reporting boiling drinking water at baseline; willingness to pay >US\$1 for filters at auction; positive attitude towards filter use; and Bengali (not Bihari) ethnicity. Frequently reported barriers to regular filter use were: filter breakage, considering filter use an additional task, and time required for water filtering. Given the low regular usage rate and the hardware-related problems reported by study participants, contribution of the siphon filter to improving water quality in low-income urban communities in Bangladesh or other similar contexts is likely to be minimal. This study adds to the considerable evidence that only a small minority of low-income households practice efficacious

household water treatment (109-111, 183). Unless future products result in higher demand and increased uptake among the population at highest risk for adverse health outcomes, point of use water treatment will contribute little to reducing the global burden of disease caused by poor water quality. This study also confirmed that the CrystalPur water filter would not be a suitable POU water purifying product to be promoted at a larger scale in Bangladesh. I have discussed the specific strengths and limitations of this study in details in the published paper included in **Chapter 4**. In short, one of the strengths of this study is that we explored the reasons contributing to and reducing sustained use of POU water treatment products in this study. To date, only few studies have explored this. We also explored motivators and barriers to sustained use in this study, which is crucial for designing effective future programs for household safe water products. One of the main limitations of this study was generalisability of the result. The design of the CrystalPur water filter is different from water filters commonly available in the market and therefore the measure of sustainability may not apply to other water filters.

Objective 2

Scaling up of WASH interventions remain difficult. Evaluations of several large-scale WASH intervention trials and programs have reported limited health impacts and incomplete intervention uptake (184-188). Additionally, in the small-scale trials the efficacy of such interventions has been assessed mainly through potentially biased self-reported disease episodes rather than using an objective measurement. It is also unclear from literature whether combining vaccination with WASH interventions incrementally increases health benefits. The **second objective** of this thesis was to assess whether large scale implementation (includes >60,000 households) of a POU water treatment (liquid sodium hydrochloride) and hand hygiene intervention (washing hands with soap and water) in combination with cholera vaccination could effectively reduce objectively assessed diarrhoea-associated hospitalisation in a randomised controlled trial, known as the **ICVB trial** in low-income communities of Bangladesh. I have presented the detailed relevant results in **Chapter 5** and in

published paper (189). In short, despite using an effective cholera vaccine and culturally adapted behaviour change interventions, in this study I found no significant impact of combined vaccine-plus-behaviour-change intervention on rates of hospitalisation among participants of all age group or children ≤ 5 years of age with diarrhoea or hospitalisation with severe diarrhoea. One of the possible reasons was, cholera incidence being too low during the study period in the study community to make a detectable contribution to overall hospitalisation rates for all-cause diarrhoea. In fact the culture confirmed cholera cases accounted for $\sim 7\%$ of total number of cases of diarrhoea-related hospitalisation at the time of study (68). The low cholera rate during the study period could be due to people not seeking care from the study hospitals. However, the possibility of this is low because, all the study hospitals including the icddr,b hospitals were within the study catchment areas and the icddr,b hospitals are renowned locally for cholera treatment. Another reason could be vaccinated people migrating to the control group area, or herd immunity from cholera vaccine. Even though a 30 meter buffer zone was created around each cluster in this study to avoid contamination of the intervention, this might not have been enough of a buffer to truly reduce vaccine contamination (e.g., herd protection due to the vaccine). However, during the intervention period only $\sim 4\%$ people changed study areas, suggesting spillover effect is unlikely to have affected intervention impact. Other possible reasons were low uptake of behaviour change interventions and high population migration rate in the study area. Data collected from a subset of households in this study showed that the indicator of uptake of hand washing intervention (presence of soap and water at primary hand-washing station) was present at $\sim 45\%$ of the households and the indicator of uptake of POU water treatment intervention (presence of residual chlorine in stored drinking water) was present at 5% households.

Low uptake of chlorine-based water treatment products has been reported in similar contexts (107, 146). For example, a study conducted in urban Dhaka in 2009 promoting chlorine-based products detected residual chlorine in only $\sim 8\%$ of households (107). The taste and smell of chlorine-treated

water is a commonly reported barrier (108). The reasons for poor uptake of these previously-tested interventions may be related to difficulty of delivering the behaviour change intervention with high quality at a large scale (146, 147). A recent evaluation of one of the largest WASH programs in history the Sanitation Hygiene Education and Water Supply in Bangladesh (SHEWA-B) program, targeting approximately 20.4 million beneficiaries from 2007 to 2012 also reported the difficulty of maintaining program quality while scaling up (190).

The strength of this study is that it reports an objective measure of the impact of combined hand-washing and POU water treatment intervention plus cholera vaccination on hospitalisation for diarrhoeal disease examined through a large scale, community-based intervention trial. To my knowledge, no other large-scale study previously reported this. One of the limitations of this study is that I used a proxy indicator for assessing hand-washing behaviour uptake, which was the presence of soap and water at the primary hand-washing station. Even though this is a commonly used indicator to assess hand-washing uptake (124, 176), it does not guarantee that people actually wash their hands or use soap. Another limitation was high population migration in the study area, which is common in low-income communities of urban Dhaka. Approximately 58% of the study participants migrated out of the study area before completion of the two-year follow-up and thus limited the consistency of participants' exposure to the intervention. However, our analysis restricted to people who stayed in the study area for the entire study period also showed no reduction in diarrhoea hospitalisation, despite a slightly higher uptake of interventions compared to those who migrated. While the low rate of cholera and high rate of population migration accounts for the limited impact of oral cholera vaccination in this study, the failure of the drinking water and hand washing intervention underscores the need for investment in research to improve the effectiveness of community wide interventions that separates human faeces from the environment, food and water supply of low income country residents.

Objective 3

Evidence shows that hygiene behaviour change intervention including hand washing with soap that have been promoted to prevent diarrhoea have also been effective in reducing respiratory illness in a range of settings (84, 122). Using the ICVB study data, to address the **third objective** of this thesis, I also attempted to examine effects of an at-scale intervention under real-world conditions to promote hand-washing with soap on reported respiratory illness. I hypothesized that upscaling a community based hand-washing intervention to reduce diarrhoea could also reduce respiratory illness. The thesis also examined whether the presence of soap and water at primary hand-washing stations was associated with a reduction in respiratory illness, irrespective of intervention assignment of participants. The detailed study findings have been presented in **Chapter 7** in a published paper (191). Briefly, there was no impact of the hand washing intervention on overall or age-specific reported respiratory illnesses though uptake of the hand-washing intervention was modest compared to other large scale hygiene promotion programmes. The uptake indicator for hand-washing behaviour in this study, namely the presence of soap/soapy water plus water in the primary hand-washing station, was 17% higher (45% vs. 28%) in the vaccine-plus-behaviour-change intervention group compared to the control group. Even though this increase seems low compared to some efficacy studies with more intense promotion of hand-washing behavior (192, 193), the hand-washing intervention uptake was not much lower in our study compared with other large-scale interventions (128, 129). For comparison, a project, Sanitation, Hygiene Education and Water Supply in Bangladesh (SHEWA-B) aimed to improve hygiene, sanitation and water supply for 20 million people in rural Bangladesh (128). During the first two year of the intervention period the focus was to improve water sanitation and hygiene behaviour through interpersonal communication and group discussions. By the end of this two years intervention period the presence of water, soap or ash in convenient hand-washing location had increased up to 16% from baseline (145). Similarly the national hand washing promotion program in Peru, targeting ~28 million people, found no effect of a mass media intervention on hand washing behaviour and combined the mass media campaign,

though, with more intense training and promotional activities at the community level increased the share of households with hand washing facilities by 4.9% (129). Neither SHEWA-B nor the Peru national hand washing program resulted in a measurable reduction in childhood diarrhea or respiratory illness (128, 129). However, both SHEWA-B and the Peru national hand washing program were externally funded programmatic interventions targeting millions of people compared with the ICVB trial focused in one suburb of a large city.

In the ICVB trial people who had soap/soapy water plus water present at their hand-washing station (an indicator of hand washing behaviour uptake in this study), irrespective of intervention allocation, had lower prevalence of respiratory illness. Evidence suggests that people are more likely to wash their hands at key times if they have soap and water present in the hand-washing station (124, 176). An association between this surrogate measure of hand-washing behaviour and interruption in disease transmission has been observed in other studies that showed fewer child respiratory infections among participants with access to water for washing hands in the house (134, 135). The findings of this thesis suggest that because hands have a role in transmission of respiratory viruses (194, 195), focused behavioural interventions targeting reducing transmission of respiratory pathogens might be more effective in reducing illness prevalence. Although the association of having soap and water present in the hand-washing station and lower respiratory infection suggests that continued effort to develop low cost strategies to improve population hand washing practices has the potential to improve child health, the interventions deployed in this trial did not impact respiratory illness. Changing handwashing behavior among large populations, remains difficult, and so such efforts should be rigorously evaluated so that the global community can learn from ongoing efforts and attempt to develop and optimize sound strategies.

One of the strengths of this study is that it was conducted on ~240,000 people. Most previous efficacy studies reporting the impact of intense implementation of hygiene behaviour change on

respiratory illness have been on small number of people (up to ~6,000). One of the limitations of this study is that the focus of the behavioural messages for washing hands was related mainly to defecation and food preparation events, as the goal of the main study was aimed at reducing diarrhoea in the community rather than respiratory diseases.

Objective 4

In **Chapter 2.7** of this thesis, I have discussed the difficulty in assessing impact of behavioural intervention on health outcome such as diarrhoea. There is concern about the reliability of measuring reported health outcome due to observer bias in non-blinded trials (162), courtesy bias (151, 152) imperfect and biased recall (153-158) and surveillance fatigue (159-161). **Objective 4** of this thesis was to compare data collected using two different survey methodologies, carried out by different data collection teams to elicit reported diarrhoea impacted on the interpretation of intervention effects on measured reported diarrhoea among children aged ≤ 5 years. In this thesis, I also had the opportunity to compare the reported diarrhoea data with objectively measured diarrhoea-associated hospitalisation rates for children ≤ 5 years in the same study. I have previously reported that the interventions did not reduce diarrhoea-associated hospitalisation for children ≤ 5 years of age in the ICVB trial. In **Chapter 3.2**, I have discussed the study methodology that I used to address this objective. The source of data was the ICVB trial, where non-blinded interviewers collected reported diarrhoea data using similarly constructed questions for children aged ≤ 5 years using two separate surveys (census and monthly-survey), each of which was administered on the same study population throughout the study period. The ‘census’ data were collected from each household every six months for updating household demographic information. The ‘monthly-survey’ data were collected every month from a different subset of randomly selected study households for monitoring uptake of behaviour-change interventions. Data on diarrhoea-associated hospitalisation were also collected for children aged ≤ 5 years. I hypothesised that in this non-blinded trial, the interpretation of impact

evaluation based on reported diarrhoea data collected through two different surveys for children aged ≤ 5 years will be similar. The details on study findings could be found in **Chapter 6** that includes the paper that has been published in the **American Journal of Tropical medicine and Hygiene**.

Briefly, no intervention impact was detected in the census or in the monthly-survey for vaccine-only versus control. However, diarrhoea prevalence was lower in the vaccine-plus-behaviour-change group compared to control measured in the monthly-survey. The reasons for observing impact of the intervention in the monthly-survey is unclear but could be due to bias rather than an intervention effect.

Presence of observer bias in non-blinded studies has been frequently reported. Hróbjartsson and colleagues conducted a systematic review of randomized clinical trials with both blinded and non-blinded assessment of same subjective measurement scale outcomes with an aim to assess presence of observer bias and reported that the non-blinded assessors exaggerated the pooled effect size by 68% (162). In the ICVB trial, the monthly-survey team was directly supervised by researchers involved in developing and implementing the behavioural interventions and the focus of this team was assessing the uptake of behavioural interventions. Given the non-blinded nature of this study, these assessors may have been predisposed to expect lower diarrhoea in the intervention group, and consciously or unconsciously may not have recorded information on diarrhoea (196). By contrast, the census data collectors may have been comparatively more neutral in collecting diarrhoea data considering the vaccine implementation team of researchers supervised them and their focus of data collection was updating household demographic information rather than assessing the uptake of behaviour interventions. However, group discussions with the monthly survey data collectors did not reveal any information on perceived pressure to indicate the presence of observer bias, so, if this bias was operating, it may have been unconscious.

Other possible explanations for the difference in the census and monthly-survey data include minor differences in methodology, framing of the questions to collect information on diarrhoea and sampling variability. For the monthly surveys, data collectors did not visit households more than once within the study period, but may have visited the same compound several times even within a week. As the ICVB trial interventions were mostly implemented at the compound level, it is possible that repeated visits to the same compound within a short time interval combined with the considerable amount of time spent assessing behavioural intervention uptake, may have alerted some participants to the fact that reduced diarrhoea was a ‘desirable outcome’ of the intervention. This could have influenced reporting of diarrhoea because of social desirability bias (197, 198), or courtesy bias (199).

The strength of this study is that to our knowledge no other study previously assessed inconsistency of reported diarrhoea data in assessing intervention impact from the same study by comparing data from two representative surveys and objectively collected data. It is possible that the interventions actually had impact on mild diarrhoeal episodes at the community level, which was reflected in monthly-survey data, but not on moderate to severe diarrhoea that required hospitalisation. This statement could be supported if we could compare the reported diarrhoea data with stool pathogen data collected from the community, which was not done in this study. This is one of the limitations of this study.

The findings of this study add further evidence of the difficulty of interpreting self-reported diarrhoea in non-blinded trials, difficulties that can affect assessment of the intervention impact (87). Avoiding assessing health outcome and intervention uptake at the same time may reduce risk of bias. These study findings highlight the importance of measuring objective outcomes when assessing non-blinded trials and comparing these with subjective outcome measures.

Objective 5

Risk factors of diarrhoea and respiratory illnesses are context specific. Therefore when designing preventive measures, one has to consider context. In **Chapter 2.4** of this thesis, I have discussed the rationale for concurrent examinations of risk factors of diarrhoea, respiratory and dermal diseases from the same cohort within the same study period in a high-income country, namely Australia. Details about the study methodology could be found in **Chapter 3.3** of this thesis and I have included the published paper in **Chapter 8**. Briefly, risks of gastro-intestinal (GI) and respiratory symptoms were similar among childcare/kindergarten attendees in this study. Swimming in public pools/spas in the current or previous week was associated with all three symptom complexes, conferring similar risk for each. Pet ownership was not associated with symptoms. Household clustering of GI and respiratory symptoms was common, and clustering of respiratory symptoms correlated with number of individuals per household.

Attending childcare or kindergarten has been previously reported as a risk factor for GI and respiratory symptoms (56, 200-203). These results support previous findings, but additionally suggest that childcare/kindergarten attendance increases the risks of both health outcomes by approximately 60%. It was also found that keeping any kind of pet at home was not a risk factor for any of the three symptoms of interest. This is supported by studies conducted in other settings (204-208).

Recreational swimming is another recognised risk factor for GI, respiratory and dermal symptoms (209-211), although no previous study has examined whether or not there is a differential impact of the type of swim setting for all three symptom complexes. This study identified that swimming in a public pool/spa was an identified risk factor for GI, respiratory and dermal symptoms, with the adjusted risk ratios for all three symptoms complexes being between 1.2-1.4. Outbreaks of gastroenteritis associated with swimming in a public pool or spa are reported frequently (212, 213),

but the relationship between sporadic gastroenteritis and swimming is complex, reflecting factors such as the background pathogen load in the source water, the likelihood of water contamination due to faecal pathogen excretion by other swimmers (214), the impact of any disinfection procedures (e.g. chlorination) on the pathogen concentration (215), and the volume of water ingested by the swimmer. While it is important to treat pool water with disinfectants to get kill microorganisms and reduce the chance of disease, these chemical products and/or their by-products might contribute to respiratory and dermal symptoms by inducing an allergic reaction (211, 216, 217). However swimming in a private pool, which would also involve chemical disinfectants (but perhaps at a lower concentration) was not found to be significantly associated with symptoms.

This study also examined the frequency of clustered symptoms among household members. Although concurrent symptoms among householders has been reported previously (59-61, 218), many relevant studies have been performed in the setting of either a community outbreak or as follow-up of a laboratory confirmed case of an individual pathogen (219-222) rather than in a prospective community-based study. Clusters of dermal symptoms affected 31% of households, compared to 45% and 80% for GI and respiratory symptoms, respectively. For all three symptom types, being in at least one cluster was associated with a higher mean number of weeks with symptoms than for sporadic cases. The two demographic characteristics found to be most strongly associated with being in any type of cluster were age <5 years and attending childcare or kindergarten, again supporting previous research conducted in a variety of settings (57, 58, 222-225). Respiratory symptoms were most common overall, and clustering of respiratory symptoms was also more common with larger household size. These findings may reflect the comparative transmissibility of respiratory, GI and dermal pathogens.

I have discussed the limitations of this study in the published paper. Briefly, this study relied on self-reported data over a one year time period. Response fatigue may have meant some people did not

report all symptoms, which may have resulted in under-reporting and therefore underestimation of the strength of association of some risk factors. The study deliberately enrolled selected English-speaking households living in urban areas in South Australia with at least two children aged 1-15 years. While the results may therefore not be applicable to all other populations, they are nevertheless likely to be relevant for families in urban areas of high-income countries.

Prospectively examining the risk factors for three different symptom complexes together through one cohort during one time period is novel and has enabled me to compare the risk ratios and strength of association for different risk factors. Comparative data such as this study has provided is helpful in prioritising prevention strategies for various health outcomes.

9.3 Conclusions

Access to WASH services is essential not only for ending diarrhoea and other water related preventable deaths, but also for improving nutrition, social well-being and economic productivity in low- and middle-income countries. Water-related diseases disproportionately affect vulnerable populations that do not have access to basic WASH services. Scaling up of low-cost effective WASH interventions is important in eliminating WASH related inequalities and to meet SDG WASH targets by 2030. However, findings of this thesis show that despite knowing about proven benefits of WASH interventions in improving health, usage of these interventions by the poor often do not sustain due to complex reasons. It also suggests that promoting WASH interventions especially POU water treatment interventions at larger scale remains difficult. Even though uptake of hand-washing intervention was among 45% of households in the intervention group in this thesis, the null effect of WASH interventions on both observed and reported diarrhoea is consistent with the evidence from large body of observational and efficacy studies that I have discussed about in chapter 2 of this

thesis. Findings from my thesis show that the WASH interventions, especially the POU water treatment intervention, implemented primarily at the compound level at scale in low-income communities are unlikely to be effective in reducing diarrhoea.

Considering results of the ICVB trial in my thesis, future research should focus on interventions that are more effective in reducing diarrhoea than the interventions that were implemented in this thesis. Recent interpretation of the WASH interventions effects from the WASH Benefits and SHINE trials indicates that, all published trials on contextually appropriate POU water chlorination and hand washing promotion that had less than fortnightly contact between the hygiene promoters and the study participants, have not found reductions in diarrhoea (96). However, for WASH trials/programs at scale, such as the ICVB trial that I included in this thesis, this level of contact is infeasible. Based on my findings from this thesis, I concur with the statement from *Pickering et al* that, handwashing and point-of-use water chlorination programmes are unlikely to reduce diarrhoea in low- and middle-income countries unless innovative means of achieving very high adherence to interventions are identified that are feasible for programme implementation (96). This thesis also did a prospective concurrent and comparative exploration of risk factors for diarrhoea, respiratory and dermal diseases in Australian context. This simultaneous examination of risk factors for three health outcomes provided comparative results that would be useful for prioritizing prevention strategies in selective contexts.

Findings of this thesis may help future researchers to improve selection and implementation of water treatment and hygiene interventions at the community level and could help to better facilitate allocation of resources in preventing diarrhoea and respiratory illness. Marginalised people will continue to be left behind unless WASH solutions are culturally acceptable, sustainable and convenient. Community level WASH interventions that are affordable and prevent infection from multiple pathogens by reliably separating faeces from the environment, food and water remain

important areas for future research until people living in poverty have achieved the long term goal of accessing contamination free safe water supply and hygiene facilities available to them whenever needed.

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Appendix 1: Other peer reviewed paper

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Abstract. We conducted a randomized, non-inferiority field trial in urban Dhaka, Bangladesh among mothers to compare microbial efficacy of soapy water (30 g powdered detergent in 1.5 L water) with bar soap and water alone. Fieldworkers collected hand rinse samples before and after the following washing regimens: scrubbing with soapy water for 15 and 30 seconds; scrubbing with bar soap for 15 and 30 seconds; and scrubbing with water alone for 15 seconds. Soapy water and bar soap removed thermotolerant coliforms similarly after washing for 15 seconds (mean $\log_{10}$ reduction = 0.7 colony-forming units [CFU], $P < 0.001$ for soapy water; mean $\log_{10}$ reduction = 0.6 CFU, $P = 0.001$ for bar soap). Increasing scrubbing time to 30 seconds did not improve removal ($P > 0.05$). Scrubbing hands with water alone also reduced thermotolerant coliforms (mean $\log_{10}$ reduction = 0.3 CFU, $P = 0.046$) but was less efficacious than scrubbing hands with soapy water. Soapy water is an inexpensive and microbiologically effective cleansing agent to improve handwashing among households with vulnerable children.

INTRODUCTION

Each year, approximately 600,000 children < 5 years old, mostly from low-income countries, die of diarrhea.¹ Handwashing with soap after defecation and handling feces and before preparing and eating food can reduce the risk of diarrhea.^{2–4} In both rural and urban communities of Bangladesh, people rarely wash their hands with soap at recommended times.^{5,6} In a study among rural Bangladeshi caregivers, fewer than 1% used soap and water for handwashing before eating and/or feeding a child, and only 33% of caregivers and 14% of all household members were observed washing both hands with soap after defecation.⁵

Barriers to washing hands with soap in low-income communities include the high cost of soap relative to household income, the concern that soap left out at a common handwashing place could be stolen, and the concern that children could play with or waste the bar soap.^{7–11} A study from 68 sub-districts of Bangladesh suggested that rural residents who live in households with either water or soap at the handwashing place were two times as likely to wash both hands with soap after contact with feces as those residents who did not have soap or water conveniently available.¹² In addition, Bangladeshi urban households from the wealthiest quintile were more likely to have soap consistently at handwashing stations (odds ratio [OR] = 1.9, 95% confidence interval [95% CI] = 1.4–2.4) and wash their hands with soap at critical times (adjusted OR [OR_{adj}] = 1.4, 95% CI = 1.1–1.7).¹³ A number of research studies from Bangladesh have shown that the cost of soap is a barrier to its use.^{7–11} These findings suggest that overcoming economic barriers to maintaining access to soap in the home could increase handwashing frequency.

Soapy water is a mixture of powder detergent in water, previously introduced as a handwashing agent in Kenya and Peru in 2008.^{14,15} Soapy water is currently being piloted in

low-income rural¹⁶ and urban¹⁷ communities in Bangladesh¹⁸ for acceptability and feasibility. To make soapy water, 30 g powdered detergent (Wheel, Unilever, Dhaka, Bangladesh) is mixed in any 1.5 L container, such as a reused water/soda/juice bottle. Preliminary qualitative research suggests that soapy water is popular because of its low cost and ease of preparation.¹⁶ In Bangladesh, a 30 g sachet of powder laundry detergent costs US\$0.03 compared with a common bar of soap (Lux, Unilever, Dhaka, Bangladesh), which costs US\$0.35. The cost of freshly prepared soapy water is US\$0.09 (detergent US\$0.03 + plastic bottle US\$0.06), and the cost of refilling an existing bottle is only US\$0.03. Therefore, the lower cost of soapy water compared with bar soap and the fact that it can be kept in a reused plastic bottle may allow households to ensure the availability of a cleansing agent for handwashing at home. In addition, soapy water may be less likely to be stolen than bar soap because of its low cost.¹⁸

However, there are no data on the microbial efficacy of handwashing with soapy water in field settings. In a low-income urban area in Dhaka, Bangladesh, we conducted a randomized, non-inferiority field trial to compare the efficacy of soapy water with the efficacy of bar soap and water alone for removing thermotolerant coliforms and *Clostridium perfringens* from hands. We also compared the efficacy of soapy water and bar soap using two different hand scrubbing times (15 and 30 seconds).

METHODS

A non-inferiority trial seeks to determine whether a new treatment (soapy water) is not worse than a reference treatment (bar soap) by more than an acceptable amount.¹⁹

Selection and enrolment of respondents. We conducted this study from July to September of 2011 in the Mirpur area of urban Dhaka among mothers with at least one child < 5 years old recruited from an ongoing observational study unrelated to hand hygiene.²⁰ The study area was selected for the handwashing trial, because this area represents the other low-income urban slums of Bangladesh with high levels of environmental contamination. Using the Microsoft Excel random number generator, one of the investigators (N.A.)

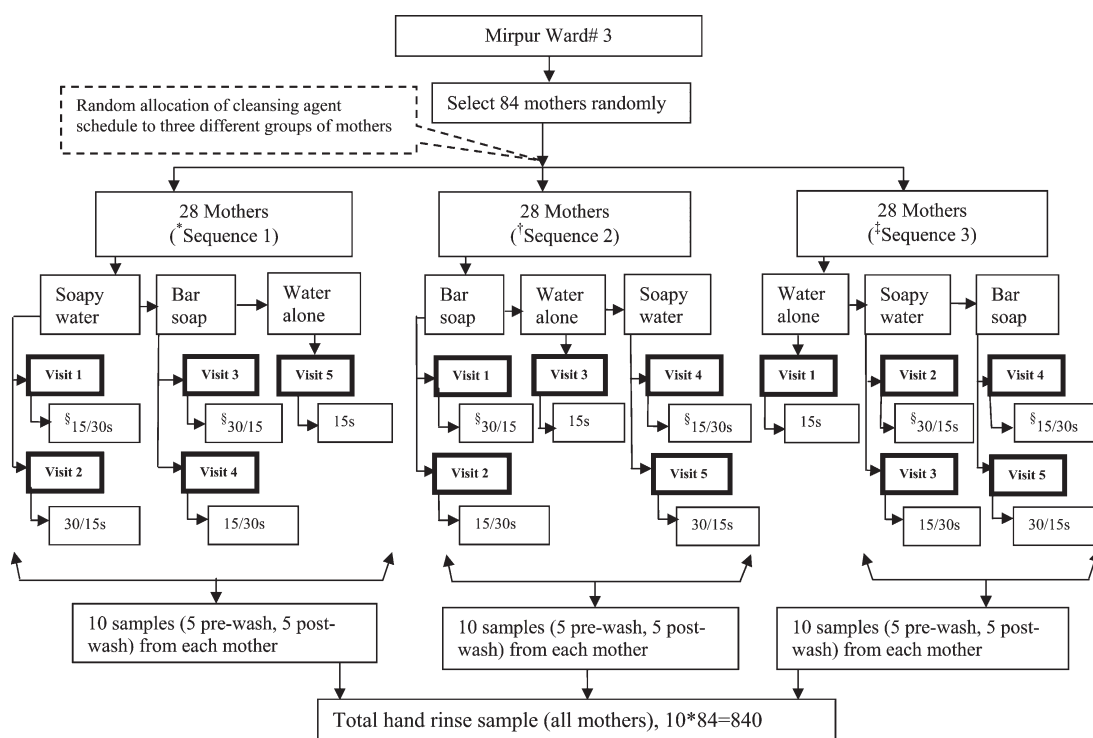
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randomly selected 84 mothers from a participant list of the ongoing observational study. Using the same randomization technique, N.A. assigned 28 mothers each (from 84 selected mothers) to one of three different handwashing sequences using the three different cleansing agents (Figure 1). All selected mothers used three cleansing agents (soapy water [30 g powdered detergent in 1.5 L water], bar soap [Lux], and water alone; one agent per each visit).

Selection of hands and first scrubbing time. The investigator N.A. prepared 420 slips of paper, where hand selection (right versus left) and duration of scrubbing (15 or 30 seconds) were marked. The slips were placed within an envelope and shuffled to assure that no one can identify which envelope contains which hand and rubbing time. The fieldworker collected the required number of paper slips everyday in an envelope and as needed during that day, selected one slip at random to determine the hand with which each mother would start the assigned handwashing sequence; because the level of microbial hand contamination could differ in the left versus right hand,⁸ we deemed it important to avoid bias that might result from systematically selecting either the right or left hand for hand rinse sampling. The fieldworker used the opposite hand of the mother on the subsequent visit to avoid the selection of the same hand. The same hand was not sampled two times, because the pre-wash hand rinse sampling method was similar to washing with water alone, and such pre-treatment would limit our ability to compare the efficacy of washing hands with soap/soapy water versus water alone.²¹ The fieldworker also

used the paper slips to randomly assign a scrubbing time of 15 or 30 seconds for both soapy water and bar soap and used only a 15 second scrubbing time for water alone. We used 15 and 30 seconds scrubbing times to ensure that the recommended scrubbing time was included.²² A 15 second scrubbing time was close to the observed average hand scrubbing time of 12.5 seconds found in a study in urban Kamalapur, Dhaka⁶ and the observed average hand scrubbing time of 14 seconds found in the United Kingdom.²³ Thirty seconds of scrubbing was the maximum scrubbing time observed after receiving the soap intervention in the Kamalapur study.⁶ The fieldworker visited each mother five times to collect a total of 10 hand rinse samples from each mother (Figure 1).

During the first visit with the mother, fieldworkers described the study and after obtaining informed consent, administered a questionnaire on demographic characteristics and principle household water sources. During each of the five visits with the mother, fieldworkers collected information about recent hand hygiene practices, contact with feces from either their own defecation or cleaning a child who had defecated, and use of a cleansing agent for handwashing within the preceding 1 hour. The fieldworkers also observed hand cleanliness for both hands. We assigned hand cleanliness scores to three areas of the hand: fingernails, palms, and fingers. Fingernails included the fingernails, the skin under the fingernails, the skin directly surrounding the fingernails, and the cuticles. The palms included the inner surface of the hands not including the fingers, and the fingers included the base (proximal phalanges),



*Sequence 1: Soapy water, bar soap, water alone

†Sequence 2: Bar soap, water alone, soapy water

‡Sequence 3: Water alone, soapy water, bar soap

§For soapy water and bar soap groups, mothers were randomized to either 15sec or 30sec and then alternated scrubbing time in the subsequent visit.

FIGURE 1. Study design flowchart.

middle portion (middle phalanges), finger pads, and side of the fingers. Using pictorial cue cards, fieldworkers assessed the visible appearance of these three areas of both hands using a three-point scale: clean (observed part of the hand is clean as would appear after someone washes their hands or takes a bath), unclear (no dirt is visible on the hand, but part of the hand appears unclear), and dirty (visible dirt/mud/soil/ash or any other material).²¹

Hand rinse sample collection. After observing hand cleanliness, fieldworkers opened a sealed opaque envelope containing a paper slip indicating the random assignment of either the right or left hand for collecting a pre-wash hand rinse sample and either a 15 or 30 second scrubbing time with soapy water, bar soap, or water alone (Figure 1).

Before the prescribed handwashing, fieldworkers collected a pre-wash hand rinse sample by having the mother insert the selected hand into a sample collection bag (19 × 38 cm; Nasco Whirl-Pak, Fort Atkinson, WI) containing 200 mL sterile Ringer's solution and asking her to rub her fingers against her palm for 15 seconds. Then, fieldworkers massaged the inserted hand from the outside of the bag for an additional 15 seconds to ensure that all parts of the hand were fully immersed in the Ringer's solution. They closed the sample collection bag and immediately placed it into a cold box that was maintained at < 10°C with ice packs.²⁴

After the pre-wash hand rinse sample was collected, fieldworkers showed a standard handwashing technique using a pictorial cue card (Supplemental Figure 1). They then requested that the mother wash both her hands with the hand cleansing agent as determined by the randomization. If the respondent was assigned to wash hands with soapy water, the mother wetted both of her hands with 10 mL water, and fieldworkers poured 20 mL soapy water solution onto the mother's hands. The mother scrubbed both her hands for the assigned duration (15 or 30 seconds), and then, fieldworkers poured 500 mL water over the mother's hands to rinse away the foam of the soapy water. Fieldworkers used a stopwatch to record the time of hand rinsing.²² If the respondent was assigned to wash her hands with bar soap, she wetted her hands with 10 mL water and used a 100 g bar of soap to create foam. Fieldworkers then followed the same scrubbing and rinsing procedure as with soapy water. If the respondent was assigned to wash hands with water alone, fieldworkers poured water over the mother's hands while she scrubbed them for 15 seconds. The water used for hand wetting, scrubbing, and rinsing with soapy water, bar soap, and water alone was from the Dhaka municipal water supply collected from the household into a provided clean container.

After handwashing with the prescribed cleansing agent, fieldworkers collected a hand rinse sample from the hand that was not tested in the pre-wash hand rinse sample using similar techniques.

Municipal water testing. We tested samples from the Dhaka municipal water supply, the main source of water in the study participants' households, to determine the amount of indicator bacteria in the water that would be used for handwashing and other purposes. The field team used convenience sampling to select 10 households from five geographically different areas for source water testing. Fieldworkers collected a 100 mL water sample in a Whirl-Pak bag from the primary water source. If water was not available during the assigned visit from the primary water source, they col-

lected a water sample from the household's stored water. Fieldworkers sealed the water sample bag and immediately placed it into a cold box.

Soapy water solution testing. The fieldworkers used convenience sampling to collect five water samples in five different 1.5 L plastic bottles from five different households (Water Supply and Sewerage Authority [WASA] tap or hand pump) and prepared the soapy water using the same recipe. Fieldworkers collected a 100 mL water sample in a Whirl-Pak bag from each soapy water bottle and immediately placed it into a cold box. The soapy water samples were tested to assess the load of thermotolerant coliforms in the WASA water after mixing the detergent powder.

Laboratory procedures. The International Center for Diarrheal Disease Research, Bangladesh (icddr,b) laboratory received the rinse water samples within 6 hours of collection and conducted a microbiological evaluation of each hand rinse sample using membrane filtration and the drop plate technique to detect thermotolerant coliforms and *C. perfringens*.²¹ Thermotolerant coliforms are commonly used as indicators of fecal contamination in handwashing evaluations.^{25–27} *C. perfringens* is a potential alternative biomarker of fecal contamination that persists in the environment for a longer period than other indicator organisms, such as *Escherichia coli* (a subset of fecal coliforms).²⁸ We chose to use thermotolerant coliforms to allow for comparison with other studies and selected *C. perfringens* to assess its use as a stable indicator of fecal contamination on hands.

For thermotolerant coliforms, 20 mL pre-wash and 50 mL post-wash hand rinse samples were filtered separately through 0.22-μm pore size membrane filters (Millipore Corp., Bedford, MA). Different volumes of hand rinse samples were filtered, because the pre-wash samples were more contaminated. The filter papers were then placed on plates of media prepared with mFC agar (Difco, MD). At the same time, 100 μL each hand rinse sample was taken directly from the sample bag using a micropipette (LabSystem, Australia) and inoculated onto the mFC agar plates using the drop plate technique.^{29–31} The plates were then inoculated at 44°C for 18–24 hours. After incubation, characteristic blue colonies were counted as thermotolerant coliforms expressed as colony forming units (CFU) per hand (200 mL rinse solution). When the number of colonies was too numerous to count on the filter paper, the colonies enumerated by the drop plate technique were used to calculate CFU per hand.

To assess the concentration of *C. perfringens*, 20 mL pre-wash and 50 mL post-wash hand rinse samples were passed through 0.22 μm pore size membrane filters, placed onto plates containing modified *C. perfringens* medium (mCP; Oxoid, England), and incubated in an anaerobic jar at 44°C. After 24 hours, yellow colonies, characteristic of *C. perfringens*, were presumptively counted as *C. perfringens*. The yellow colonies were then exposed to 30% ammonium phosphate; the colonies that turned dark pink were confirmed as *C. perfringens*, and the count was expressed as CFU per hand.

Because the volume filtered differed for the pre- versus post-wash hand rinses, the lower limit of detection by membrane filtration was 10 CFU per hand for the pre-wash hand rinse samples and 4 CFU per hand for the post-wash hand rinse samples. The upper detection limit for all samples by drop plate technique was 100,000 CFU per hand. Levels of hand contamination with thermotolerant coliforms and

C. perfringens were $\log_{10}$ -transformed to compare mean CFU per hand between groups.

From the municipal water and soapy water samples collected, 20 mL water was filtered through a 0.22 μm membrane filter, which was placed onto an mFC agar plate to test for thermotolerant coliforms. Then, the same procedure as for the hand rinse samples was followed.

SAMPLE SIZE CALCULATION AND STATISTICAL ANALYSIS

The concentration of bacteria was calculated as the number of CFU per hand and then converted to $\log_{10}$ counts for analysis. Non-inferiority involves selecting a meaningful difference between two groups that would indicate that they are different, and then calculating the sample size necessary to detect this difference. To achieve 80% power for detection of a non-inferiority difference margin of 0.50 $\log_{10}$ CFU between bar soap and soapy water, we calculated a required sample size of 84 mothers.³² Therefore, we collected 420 paired hand rinse samples (five pre- and five post-treatment pairs for two different scrubbing times of 15 and 30 seconds) and analyzed them separately using the same regression model. After $\log_{10}$ transformation, we used paired *t* tests to evaluate the mean differences between the concentrations of indicator organisms in the pre-wash and post-wash hand rinses for each of the hand cleansing regimens. To estimate the difference between $\log_{10}$ -transformed bacterial counts between pre- and post-wash (15 versus 30 seconds) and also the difference between handwashing agents, we used linear regression, where the dependent variable was the $\log_{10}$ -transformed bacterial counts and independent variables were timing of hand rinse (pre- or post-wash), type of handwashing agent (soapy water or bar soap), and interaction between them. We also calculated the difference between the differences using the same regression model. To account for repeated measures (i.e., multiple hand rinse samples from the same mother), we used robust SEs to estimate 95% CIs. We used STATA 10 (StataCorp LP, College Station, TX) for analysis.

All participants provided written informed consent. The study protocol was reviewed and approved by the Ethics Review Committee of icddr,b.

RESULTS

Household characteristics. We enrolled 84 participants into the study. The characteristics of the randomly assigned groups of mother were comparable (Supplemental Table 1). The mean age of the enrolled mothers was 26 years (SD = 0.5, range = 18–38 years). They completed a mean 3 years of formal education and lived in households with a mean of five members. Among 84 participating households, 82 (98%) households had water supplied by the Dhaka municipality. All 10 source water samples taken were contaminated with thermotolerant coliforms (mean $\log_{10}$ = 3.2 CFU/100 mL, range = 2.3–5.2 $\log_{10}$ CFU/100 mL), but 5 soapy water solution samples were free from thermotolerant coliforms (0 CFU/100 mL).

Reported hand hygiene behavior. Reported hand hygiene behavior within the last 1 hour and the level of visible hand

contamination (dirty, unclear, and clean) before washing were similar across all mothers, regardless of the cleansing agent used. One-third of the mothers reported that at least one hand came into contact with feces after they either defecated or cleaned a child who had defecated; about one-third reported not washing their hands within the last 1 hour. More than 90% of mothers reported washing their hands with soap after defecation and cleaning a child's anus, but only 18% of mothers reported washing hands with soap before eating and/or feeding a child. On observation, 75% of study participant's hands were visibly clean, with the palms of both hands being visibly cleaner than the fingernails (Table 1).

Fieldworkers collected 840 (100%) hand rinse samples (420 pre-wash [210 right and 210 left hands] and 420 post-wash [210 right and 210 left hands] samples). More than 90% of the pre-wash hand rinse samples were contaminated with thermotolerant coliforms, and more than 70% were contaminated with *C. perfringens*; the mean $\log_{10}$ concentration was similar across groups for both organisms (Table 2). Right hands (*N* = 210) were more contaminated with thermotolerant coliforms in the pre-wash samples (mean $\log_{10}$ difference of right hands minus left hands = 0.36 CFU, 95% CI = 0.10–0.61, *P* = 0.0058), but in the post-wash samples, right and left hands (*N* = 210) were equally contaminated (mean $\log_{10}$ difference of right hands minus left hands = –0.08 CFU, 95% CI = –0.29–0.14, *P* = 0.48). The concentrations of *C. perfringens* in both pre-wash and post-wash samples were equal for both right and left hands.

Microbiological effectiveness. Scrubbing hands for 15 seconds with soapy water reduced thermotolerant coliforms to a similar degree as observed with washing with bar soap (mean $\log_{10}$ reduction = 0.7 CFU per hand, 95% CI = 0.44–0.92, *P* < 0.001 for soapy water and mean $\log_{10}$ reduction = 0.6 CFU per hand, 95% CI = 0.24–0.95, *P* = 0.001 for bar soap). There were also significant reductions in the concentrations of *C. perfringens* (mean $\log_{10}$ reduction = 0.8 CFU per hand, 95% CI = 0.65–1.0, *P* < 0.001 for soapy water and mean $\log_{10}$ reduction = 0.8 CFU per hand, 95% CI = 0.64–1.0, *P* < 0.001 for bar soap) after scrubbing hands with soapy water and bar soap for 15 seconds. We calculated that it took an average of 12 seconds (range = 10–15 seconds, SD = 0.07) to remove the foam produced during scrubbing for both the soapy water and bar soap. Washing hands with water alone for 15 seconds also reduced the load of thermotolerant coliforms on hands (mean log reduction = 0.3 CFU per hand, 95% CI = 0.004–0.57, *P* = 0.047) but to a lesser degree than washing with soapy water or bar soap. The reduction of thermotolerant coliforms was significantly higher after scrubbing with soapy water compared with scrubbing with water alone ($\log_{10}$ mean difference of thermotolerant coliforms between soapy water and water alone = –0.4 CFU per hand, 95% CI = –0.76–0.02, *P* = 0.038) but not significantly higher in reducing *C. perfringens* ($\log_{10}$ mean difference of *C. perfringens* between soapy water and water alone = –0.15 CFU per hand, 95% CI = –0.40–0.09, *P* = 0.22). Increasing the scrubbing time from 15 to 30 seconds with either soapy water or bar soap did not significantly increase the microbiological effectiveness of removing fecal indicator organisms (Table 2).

Adjustment for visible hand contamination (visibly clean versus visibly dirty hands) before handwashing did not significantly change the effectiveness of the handwashing agents in removing fecal indicator organisms (Table 3).

DISCUSSION

Soapy water has been developed and promoted as a low-cost alternative to bar soap for handwashing in Kenya,¹⁴ Bangladesh,^{16–18} and Peru.¹⁵ In a study conducted by icddr, b, a family of five members used a 1.5 L mixture of soapy water in 8–10 days on average for handwashing near the

latrine and 14–15 days near the kitchen (Alam FN, personal communication). This time is similar to the mean use time for a bar of soap (13 days).³³ In our study, soapy water performed as well as bar soap at reducing thermotolerant coliforms and *C. perfringens* on hands in a low-income urban community with a highly contaminated water supply. We tested for *C. perfringens*, because it would indicate that soapy

TABLE 1

Reported hand hygiene behavior within the previous 1 hour and appearance of mother's hands immediately before sample collection in Mirpur, Dhaka in 2011

Reported and observed behavior	Soapy water (N = 168)* n (%)	Bar soap (N = 168)* n (%)	Water alone (N = 84) n (%)	Total (N = 420) n (%)
Reported hand(s) contact with feces (self or child's) within last 1 hour	61 (36)	51 (30)	24 (29)	136 (32)
Reported handwashing within 1 hour preceding pre-wash hand rinse sampling	129 (77)	128 (76)	67 (80)	324 (77)
Hand(s) reported washed within the previous 1 hour				
Right hand	5 (4)	9 (7)	1 (1.5)	15 (4)
Left hand	3 (2)	5 (4)	1 (1.5)	9 (2)
Both hands	121 (94)	114 (89)	65 (97)	300 (71)
Handwashing agent used within the last 1 hour (multiple responses allowed)				
After defecation				
Any soap and water (soap, soapy water, or detergent)	27 (96)	19 (83)	13 (100)	59 (92)
Water only	1 (4)	3 (13)	0	4 (6)
Other	0	1 (4)	0	1 (2)
After toileting				
Any soap and water	6 (14)	1 (4)	3 (19)	10 (12)
Water only	37 (86)	24 (96)	13 (81)	74 (88)
After cleaning child's anus				
Any soap and water	36 (86)	35 (92)	17 (100)	88 (91)
Water only	6 (14)	1 (3)	0	7 (7)
Other	0	2 (5)	0	2 (2)
During bathing				
Any soap and water	14 (88)	9 (90)	4 (100)	27 (90)
Water only	2 (12)	1 (10)	0	3 (10)
Before eating and feeding				
Any soap and water	7 (13)	11 (24)	3 (18)	21 (18)
Water only	46 (87)	34 (76)	14 (82)	94 (82)
After household or kitchen works				
Any soap and water	52 (58)	38 (45)	25 (57)	115 (53)
Water only	37 (42)	46 (55)	19 (43)	102 (47)
How many times hand(s) was washed within the previous 1 hour				
No handwashing	39 (23)	40 (24)	17 (20)	96 (23)
One time	36 (21)	51 (30)	31 (37)	118 (28)
Two times	42 (25)	42 (25)	18 (22)	102 (24)
More than two times	51 (31)	35 (21)	18 (21)	104 (25)
Appearance of right hand: fingernails				
Dirty†	16 (10)	5 (3)	8 (10)	29 (7)
Unclean‡	63 (38)	69 (41)	25 (30)	157 (37)
Clean§	89 (53)	94 (56)	51 (61)	234 (56)
Appearance of right hand: palms				
Dirty	4 (2)	1 (0.6)	1 (1)	6 (1)
Unclean	33 (20)	14 (8)	7 (8)	54 (13)
Clean	131 (78)	153 (91)	76 (91)	360 (86)
Appearance of right hand: fingers				
Dirty	5 (3)	1 (0.6)	1 (1)	7 (2)
Unclean	32 (19)	22 (13)	9 (11)	63 (15)
Clean	131 (78)	145 (86)	74 (88)	350 (83)
Appearance of left hand: fingernails				
Dirty	16 (10)	9 (5)	13 (15)	38 (9)
Unclean	78 (46)	72 (43)	27 (32)	177 (42)
Clean	74 (44)	87 (52)	44 (52)	205 (49)
Appearance of left hand: palms				
Dirty	5 (3)	1 (0.6)	2 (2)	8 (2)
Unclean	34 (20)	15 (9)	9 (11)	58 (14)
Clean	129 (77)	152 (90)	73 (87)	354 (84)
Appearance of left hand: fingers				
Dirty	4 (2)	1 (0.6)	2 (2)	7 (2)
Unclean	34 (20)	27 (16)	10 (12)	71 (17)
Clean	130 (77)	140 (83)	72 (86)	342 (81)

* Data collected at two different visits: 15- and 30-second scrubbing times; N = (84 × 2).

† Dirty: Visible dirt/mud/soil/ash or any other material.

‡ Unclean: No dirt is visible on the hand, but part of the hand appears unclean.

§ Clean: Observed part of the hand is clean (as it would appear after someone washes their hands or takes a bath).

TABLE 2
Comparison of mean log concentration of thermotolerant coliforms and *C. perfringens* per hand of water alone, bar soap, and soapy water within group and between groups for both 15 and 30 second scrubbing among mothers in Mirpur, Dhaka in 2011

Scrubbing time and indicator organisms	Mean log CFU per hand (95% CI)											
	Soapy water group			Bar soap group			Water alone group			Difference in differences between groups (<i>P</i> value)		
	Pre-wash (<i>N</i> = 168)	Post-wash (<i>N</i> = 168)	Difference within group	Pre-wash (<i>N</i> = 168)	Post-wash (<i>N</i> = 168)	Difference within group	Pre-wash (<i>N</i> = 84)	Post-wash (<i>N</i> = 84)	Difference within group			
15 seconds of scrubbing												
Thermotolerant <i>coliforms</i>	2.5	1.8	0.7 (0.44–0.92)	2.7	2.1	0.6 (0.24–0.95)	2.3	2.0	0.3 (0.004–0.57)	–0.09 (–0.51–0.34)	–0.4 (–0.76 to –0.02)	–0.3 (–0.76–0.14)
<i>C. perfringens</i>	1.2	0.4	0.8 (0.65–1.0)	1.2	0.4	0.8 (0.64–1.0)	1.2	0.6	0.7 (0.49–0.85)	–0.004 (–0.27–0.26)	–0.15 (–0.40–0.09)	–0.15 (–0.41–0.11)
30 seconds of scrubbing												
Thermotolerant <i>coliforms</i>	2.7	2.0	0.7 (0.46–0.96)	2.7	2.2	0.5 (0.24–0.75)	NA	NA	NA	–0.22 (–0.57–0.14)	NA	NA
<i>C. perfringens</i>	1.0	0.3	0.7 (0.52–0.91)	1.2	0.3	0.9 (0.74–1.1)	NA	NA	NA	0.21 (–0.05–0.46)	NA	NA

NA = not applicable.

TABLE 3
Mean log concentration of thermotolerant coliforms and *C. perfringens* before and after washing both hands with soapy water, bar soap, and water alone based on observations of visibly dirty and visibly clean hands in Mirpur, Dhaka in 2011

Indicator organisms in hand rinse samples	Mean log CFU per hand (95% CI)									
	Soapy water			Bar soap			Water alone			Difference
	Visibly dirty hands* (N = 140)	Visibly clean hands† (N = 196)	Difference	Visibly dirty hands* (N = 168)	Visibly clean hands† (N = 168)	Difference	Visibly dirty hands* (N = 74)	Visibly clean hands† (N = 94)	Difference	
Thermotolerant coliforms										
Pre-wash	2.6	2.5		2.7	2.7		2.4	2.2		
Post-wash	2.0	1.7		2.2	2.1		2.2	1.9		
Differences	–0.6 (–0.87 to –0.37)	–0.8 (–1.1 to –0.54)	0.2 (–0.18–0.55)‡	–0.5 (–0.87 to –0.22)	–0.5 (–0.83 to –0.25)	–0.006 (–0.42–0.4)‡	–0.25 (–0.64–0.14)	–0.3 (–0.76–0.09)	–0.08 (–0.49–0.66)‡	
<i>C. perfringens</i>										
Pre-wash	1.1	1.2		1.2	1.3		1.2	1.3		
Post-wash	0.4	0.4		0.4	0.4		0.7	0.4		
Differences	–0.7 (–0.92 to –0.56)	–0.8 (–1.0 to –0.6)	0.07 (–0.19–0.33)‡	–0.8 (–0.98 to –0.63)	–0.9 (–1.1 to –0.76)	–0.1 (–0.13–0.4)‡	–0.4 (–0.67 to –0.21)	–1.0 (–1.2 to –0.72)	0.5 (0.19–0.87)‡	

* Visible dirt/mud/soil/ash or any other material on any part of both hands and no dirt visible on the hand, but in general, part of the hand appears unclear.

† All parts of both hands were clean as they would appear after someone washes hands or takes a bath.

‡ Difference between mean difference of before and after washing hands and visibly dirty and clean hands.

water also works well on hardier organisms. Handwashing with water alone also worked well in reducing *C. perfringens*, indicating that the removal of these organisms may be mostly a physical process from the friction of rubbing hands together.

In Bangladesh, the average price of a common bar soap (Lux) is US\$0.35, whereas a mixture of soapy water costs US\$0.03. The 1.5 L plastic bottle (e.g., mineral water bottle or soft drink/juice bottle), which costs US\$0.06, could be reused as long as it continues to hold water. Because we estimate that soapy water lasts the same duration as soap (three bar soaps or three soapy water bottles required per month per household), its use would cost only US\$0.15 (three sachets of detergent cost US\$0.09 + one plastic bottle costs US\$0.06) in the first 1 month and US\$0.09 for each subsequent 1 month. This cost provides a savings of US\$0.90 in the first 1 month and US\$0.96 for each subsequent 1 month compared with bar soap. Households may find cost saving an added incentive for adopting soapy water or having multiple bottles of soapy water to use at different sites within the home, which may facilitate handwashing at times of possible pathogen transmission to or from hands.^{11,34}

Our microbial evaluation showed that handwashing with water alone also reduced the level of both thermotolerant coliforms and *C. perfringens* on hands, although the reduction was significantly lower than for handwashing with soapy water ($\log_{10}$ mean difference of thermotolerant coliforms between soapy water and water alone = -0.4 CFU per hand, 95% CI = -0.76 to -0.02 , $P = 0.038$). A recent laboratory-based study in the United Kingdom similarly found that the presence of fecal bacteria was reduced by 23% by handwashing using water alone.²³ A community-based observational study in Bangladesh reported that children who lived in households where food preparers briefly washed their hands with water alone experienced significantly less diarrhea than children living in households where food preparers did not wash their hands at all.⁴ Other evaluations suggest that washing hands with water alone can reduce the amount of bacteria^{8,28,35,36} but not to the same extent as bar soap. Conversely, Hoque and Briend,⁷ from a small community-based handwashing study in Dhaka, suggested that washing hands with soap, mud, or ash significantly removed fecal coliforms from hands, whereas washing with water alone did not. However, their study measured only presence or absence of fecal coliforms. Our study enrolled nearly five times as many participants and was designed to have sufficient power to detect differences in microbial concentrations after washing hands with soapy water, bar soap, and water alone.

Mothers in our study washed their hands with contaminated water ($\log_{10}$ mean of thermotolerant coliforms/100 mL water = 3.2 CFU, range = 2.3–5.2). We did not evaluate handwashing with contaminated water against handwashing with uncontaminated water, but a community-based study in Pakistan found that difference in the level of hand contamination did not differ significantly for households provided bacteria-free chlorinated water for handwashing versus households that used heavily contaminated municipal water for handwashing.³⁵ These findings contrast with a study in Uttarkhan, Bangladesh that suggested the hands of women who washed their hands with highly contaminated pond water (geometric mean of the count of fecal coliforms = 17,330/100 mL) were significantly more contaminated compared with the hands of women who washed their hands with

less contaminated tube well water (geometric mean of the count of fecal coliforms = 32/100 mL).²⁵ Perhaps handwashing with either soapy water or bar soap in our study would have resulted in additional reduction of hand contamination if the hands were washed using uncontaminated water.^{35,37} Although we only tested a small sample of municipal water, our data suggest that even using moderately contaminated water for handwashing can still reduce fecal contamination from hands. More generally, our study supports that handwashing should be encouraged even when available water is bacterially contaminated.

Effective handwashing to reduce bacteria from hands depends on several factors: duration of handwashing, type and volume of cleansing agent, and quality of water.^{21,25,34} A US laboratory-based study, focusing on duration and type of cleansing agent, found that antimicrobial soap reduced *Shigella flexneri* significantly more at 30 seconds than 15 seconds, but plain soap did not.²¹ A US hospital-based study found that washing hands with plain soap and water for 15 seconds reduced bacterial counts on the skin by 0.6–1.1 $\log_{10}$, whereas washing hands with plain soap and water for 30 seconds reduced counts by 1.8–2.8 $\log_{10}$.³⁸ These differences in hand contamination might be because of different study contexts. A laboratory or hospital setting in a high-income country is likely to be far less contaminated and have cleaner water than the study area and municipal water in Bangladesh. Scrubbing hands with soapy water, bar soap, or water alone for longer than 15 seconds may be unlikely to remove additional bacteria when the water itself is contaminated.

Several studies used stopwatches to measure handwashing duration^{6,23,39–41} but did not explore the handwashing process by separating scrubbing times and rinsing times. A range of timings of both scrubbing and rinsing hands has been recommended by previous studies.^{42–47} We recommend a 15 second scrubbing time, because it was as effective as 30 seconds in removing indicator organisms and is closer to the duration of handwashing typically carried out by persons in Bangladesh.⁶ This time is below the 20 second scrubbing time recommended by the Centers for Disease Control and Prevention (CDC)⁴² and United Nations Children's Fund (UNICEF)⁴⁷ and may improve adherence to handwashing recommendations.

Visible appearance of hand cleanliness was not associated with the level of hand contamination or the efficacy of soapy water or bar soap in removing thermotolerant coliforms and *C. perfringens* from hands. A similar result was found in a handwashing intervention with hand sanitizer and liquid soap in Dar es Salam, Tanzania, which suggested that the efficacy of handwashing with soap was not associated with visible dirt on the hands.²⁵

There are important limitations to this study. First, we used supervised handwashing regimens with pre-specified hand scrubbing times and hand lathering motions.⁹ Although this prescriptive approach strengthens the internal validity of our study, the reduction of microbial load by washing hands with soapy water or bar soap may be different if community members were to wash their hands for a shorter time or did not use the comprehensive scrubbing motions that we promoted. Additional research should explore the effectiveness of soapy water when not directly supervising community members' handwashing. Second, we used 500 mL municipal water during the handwashing procedure to rinse away foam. In settings where water is less plentiful, results may be different.

Additional research is necessary to explore the effectiveness of soapy water in settings where water is scarce. Third, viruses and specific pathogens that can also cause diarrhea were not measured in this study, and the efficacy of soapy water on removal of these pathogens could differ.

Soapy water may be promoted as a low-cost but similarly effective alternative to bar soap for cleaning hands to reduce bacterial contamination and potentially reduce enteric disease transmission. This low-cost and readily available alternative may increase handwashing frequency, which ultimately may reduce disease burden globally. This intervention may be particularly appropriate for low-income communities, where there are concerns about the cost of bar soap. Additional studies could explore the efficacy of soapy water in removing viruses and assess the effect of handwashing with soapy water on health outcomes, such as diarrhea and respiratory diseases.

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Reliability and Validity of Measures for Investigating the Determinants of Health Behaviors Among Women With a History of Gestational Diabetes

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Abstract

Aim. Assisting women with a history of gestational diabetes mellitus (GDM) to adopt healthy lifestyles is a priority for diabetes prevention. The aim of this study was to develop and evaluate measures that can be used to assess the efficacy of behavior change interventions in this group. **Method.** Measures of psychosocial influences on physical activity and diet were derived from formative research and examination of established instruments. Item reduction by principal components analysis was undertaken following telephone survey administration to 160 women with recent GDM, and the internal reliability and construct validity of the derived scales were assessed. Test–retest reliability was assessed in another sample of 97 women. **Results.** Scales with acceptable internal reliability were developed for physical activity outcome expectancies ($\alpha = .82$), perceived barriers ($\alpha = .75$), encouragement ($\alpha = .76$) and self-efficacy ($\alpha = .82$), weight control attitudes ($\alpha = .90$), and diabetes-related fear ($\alpha = .70$). Construct validity in relation to physical activity participation was found for the encouragement and self-efficacy scales. The weight control attitudes scale showed construct validity in relation to fruit and vegetable intake. The test–retest reliability of most scales was moderate to good (weighted $\kappa = 0.55$ – 0.69). **Conclusion.** Reliable and valid measures relevant to the psychosocial needs of women with GDM have been developed with a multiethnic population. These will assist future evidence generation, particularly in relation to the adoption of physical activity, which has been a challenging area of lifestyle intervention to date.

Keywords

gestational diabetes, health behaviors, measurement, reliability, validity

The development of strategies to motivate and enable healthy behaviors is of vital importance for stemming the growing burden of disease due to type 2 diabetes mellitus (T2DM). Because of this, behavioral science has a valuable role to play in building the knowledge base concerning the determinants of the recommended actions for T2DM management and prevention. Psychosocial influences make a particularly important contribution to behavior change (Delamater et al., 2001; Gonder-Frederick, Cox, & Ritterband, 2002), with evidence showing that interventions that modify these can achieve improvements in physical activity (Kahn et al., 2002) and dietary intake (Ammerman, Lindquist, Lohr, & Hersey, 2002).

In the arena of diabetes prevention and control, a priority population group is women who first develop glucose intolerance during pregnancy, known as gestational diabetes mellitus (GDM). In 2013, it was estimated that globally 14% of

women with live births had GDM (International Diabetes Federation, 2013), and numerous studies have reported that women with this medical history have a markedly elevated risk of developing T2DM later in life (Cheung & Byth, 2003; Kim, Newton, & Knopp, 2002). There is a significant public health opportunity to reduce the prevalence and costs of

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T2DM by identifying women with a history of GDM and facilitating lifestyle changes (Bentley-Lewis, Levkoff, Stuebe, & Seely, 2008; Marseille et al., 2013), and a growing number of studies are testing the efficacy of strategies to improve physical activity, dietary intake, and body weight among this risk group (Cheung, Smith, van der Ploeg, Cinnadaio, & Bauman, 2011; Ferrara et al., 2011; Hu et al., 2012; Kim, Draska, Hess, Wilson, & Richardson, 2012; Ratner, 2007; Reinhardt, van der Ploeg, Grzegorzulka, & Timperley, 2012).

The design of effective strategies to prevent T2DM among women with a history of GDM, as for other high-risk groups, will require an understanding of the determinants of their health behaviors (Kaiser & Razurel, 2013). To date, formative research undertaken with this group has identified factors such as time constraints, child care demands, stress, low levels of motivation, and lack of knowledge as barriers to physical activity and healthy eating (Downs & Ulbrecht, 2006; Hjelm, Berntorp, Frid, Åberg, & Apelqvist, 2008; Kieffer, Sinco, & Kim, 2006; Kim, McEwen, Kieffer, Herman, & Piette, 2008). Cross-sectional studies have found that self-efficacy and social support are correlates and possible facilitators of these behaviors (Kim et al., 2008; Smith, Cheung, Bauman, Zehle, & McLean, 2005; Zehle et al., 2008). This research provides helpful directions for health promotion programming, but falls short of what is required to generate models of behavioral mediators among women with a history of GDM that can be tested and refined (Peyrot, 2001). More rigorous definition and measurement of psychosocial determinants is required for knowledge building (Anderson, Funnell, & Hernandez, 2005) and for the evaluation of interventions (Brown, Hume, & Chin, 2009; Nigg, Allegrante, & Ory, 2002).

The predominant focus of measurement research in diabetes has been the determinants of self-management behaviors by people with T2DM, with psychometric properties being reported for measures of knowledge, attitudes, support, psychological distress, barriers, self-efficacy, and empowerment (Caro-Bautista, Martín-Santos, & Morales-Asencio, 2014; Colagiuri & Eigenmann, 2009). Very little attention has been given to developing robust measures of the determinants of prevention behaviors. Studies that have evaluated measures of behavioral beliefs, normative beliefs, and control beliefs related to physical activity (Blue, Marrero, & Black, 2008) and healthful eating (Blue & Marrero, 2006) among adults at risk of type 2 diabetes provide the leading examples of this research so far. These measures were based on formative research with adults who self-identified as at risk of type 2 diabetes (up to age 71 years), and while reported to have good reliability and construct validity, they did not address the needs and circumstances of younger women with parenting responsibilities who have recently been diagnosed with GDM. The aim of the study reported here was to investigate the psychometric properties of measures that could be used to strengthen diabetes prevention research among women

with a history of GDM, focusing on the determinants of physical activity and healthful eating.

Method

Study Design

A two-stage study was conducted, with the first stage using a cross-sectional analytic design to assess the internal reliability and construct validity of the measures of behavioral determinants. The second stage involved repeated administrations of the survey measures to determine their test-retest reliability.

Study Participants

Study participants were recruited from the databases of Diabetes in Pregnancy clinics conducted at Westmead, Nepean, Blacktown, and Auburn hospitals in western Sydney, Australia. Women who had a pregnancy during which they were diagnosed with GDM within the preceding 6 to 36 months were eligible, while those who had developed T2DM since their GDM pregnancy, or were pregnant at the time of recruitment, were excluded. In Stage 1 of the study, only English-speaking women were recruited, and in Stage 2, those who spoke English, Arabic, Cantonese, or Mandarin were included. Arabic- and Chinese-speaking women comprise two of the largest language groups seen in diabetes in pregnancy clinics in western Sydney. A total of 689 women were invited to participate in the study: 496 in Stage 1 and 193 in Stage 2. None of those in Stage 1 participated in Stage 2. Ethical approval for the study was obtained from the Sydney West Area Health Service Human Research Ethics Committee.

Measures

Measures were developed using data collected from preliminary semistructured interviews with 57 women with recent GDM from English-, Arabic-, and Chinese-speaking backgrounds (Razee et al., 2010), and a review of items used previously to measure social and cognitive influences on physical activity, including outcome expectations (Resnick & Jenkins, 2000), barriers (Sallis et al., 1989), self-efficacy (Marcus, Selby, Niaura, & Rossi, 1992), and social support (Biddle, Goudas, & Page, 1994). While the selection of measures was guided by formative research, their relationship with physical activity and dietary behaviors is explained by several prominent theories of health behavior, namely, social cognitive theory for self-efficacy, outcome expectations, and perceived barriers (Bandura, 1998); social network theory for social support (Heaney & Israel, 2002); theory of reasoned action for weight loss attitudes (Godin, 1993); and protection motivation theory, for the perceived risk and impact of diabetes (Wurtele & Maddux, 1987). An extensive

list of draft items were assessed for face and content validity by the authors, with a consensus approach used to exclude items.

Twelve items were chosen to measure physical activity outcome expectations. These required respondents to indicate on the 5-point Likert-type scale their level of agreement that the following were benefits of physical activity: improved mood, enjoyment, reduced risk of diabetes, ability to control weight, improved self-esteem, physical fitness, meeting new people, lower stress, better general health, greater energy, more time for self, and being a positive role model for children.

Fourteen items were chosen to measure barriers to physical activity, with respondents asked to report how often on a 5-point scale (*never* to *very often*) the selected factors prevented them from undertaking activity. These were lack of motivation, lack of time, insufficient energy, not having an activity partner, poor weather, poor health, lack of convenient locations for activity, being overweight, work demands, family demands, lack of money, not having child care assistance, putting the needs of others first, and not having family nearby to give assistance.

Self-efficacy for physical activity was measured by 10 items. Respondents were required to indicate their level of confidence on a 4-point scale (*very confident* to *not confident*) to undertake physical activity when experiencing the following situations: tiredness, not having time, poor weather, feeling stressed, managing the care of a young child, having other demands on time, extensive housework duties, feeling alone, feeling lazy, and feeling depressed.

The measures of social support for physical activity comprised nine items. Respondents were asked to report how often on a 5-point scale (*never* to *very often*) they received the following types of support: being accompanied by family or friends, assistance with child care, assistance with household chores, encouragement from friends, encouragement from partner, encouragement from others in the family, encouragement from health care professionals, encouragement from complementary health providers, and encouragement to keep up activity from family or friends.

Weight loss attitudes were measured by asking respondents to indicate their level of agreement on a 5-point Likert-type scale with 10 items reflecting their appraisal of the value of weight loss. These items addressed optimism, attractiveness, self-respect, pride of family members, being able to eat preferred foods, self-consciousness, respect of others, wearing preferred clothes, accomplishing more, and feeling that they ought to lose weight.

The measures of diabetes-related fear addressed perceived impact (five items) and risk (four items), with respondents asked to indicate their level of agreement on a 5-point Likert-type scale with statements about the disease. Those addressing impact were perception of harm, fear of the disease, worry about impacts on the child, worry about impacts on personal health, and having a significant impact on their

life. Statements related to risk concerned level of risk of the disease, the effect of family history, potential to reduce risk by personal action, and the potential to prevent diabetes through medications.

In order to assess the construct validity of the psychosocial measures, respondents were asked to self-report their physical activity and dietary behaviors. Physical activity was measured by the Active Australia Survey, which has established concurrent validity with accelerometer recordings (Timperio, Salmon, Bull, & Rosenberg, 2002). This widely used instrument measures the frequency and duration of walking and moderate- and vigorous-intensity leisure time physical activity. Short food frequency questions (Marks, Webb, Rutishauser, & Riley, 2001) were used to measure fruit, vegetable, and high-fat food intake.

Procedures

In the first stage of the study, trained interviewers administered the survey by telephone in English, which generally took 30 to 40 minutes. In Stage 2, a revised instrument based on the Stage 1 evaluation was used in repeated telephone interviews, with a 4-week interval between administrations. This survey was translated from English into both Arabic and traditional Chinese, then back translated to English, by independent accredited translators. Three trained native-speaking interviewers administered the survey to English-, Arabic-, and Chinese- (Mandarin or Cantonese) speaking women in their preferred language. Each of these interviews lasted approximately 20 minutes.

Statistical Analysis

Initial descriptive analysis of the data collected in Stage 1 examined the distribution of responses to each item, to identify those with ceiling effects (i.e., 90% to 100% agreement with the statements). Interitem correlation matrices were examined, and principal components analysis (PCA) was undertaken to identify items that formed measurement scales of the constructs. Scree plots were examined, with the breaking point in the plot line used to determine the number of factors to retain, and minimum item loadings of 0.40 were set to determine the structure of each factor. The internal reliability of the derived scales was assessed using Cronbach's alpha.

Multivariable regression modeling was undertaken using the Stage 1 data to assess the construct validity of the psychosocial determinants scales. The relationship between the physical activity determinants scales and total self-reported minutes of physical activity was examined. Modeling of the weight loss attitudes and diabetes beliefs scales examined the relationships between these variables and minutes of total physical activity, daily serves of fruit and vegetables, and daily serves of high-fat foods (high-fat meats, deep-fried chips, fast-food meals, confectionary, crisps, and sweet biscuits). Before multivariable linear regression modeling,

Box-Cox transformations were performed to normalize the distributions of the psychosocial and behavior variables. For multivariable logistic regression the psychosocial variables were recoded into tertiles (low, moderate, high), and the behavior measures were recoded as dichotomous variables; physical activity was categorized as ≥ 150 minutes per week, or less; fruit and vegetable intake as ≥ 5 serves per day, or less; and high-fat food intake as ≥ 1 serve per day, or less. The covariates included in all multivariable models were age (≤ 30 years, 31-35 years, or > 35 years), number of children (1, 2, or 3 or more), body mass index (≤ 25 kg/m², 25.1-30 kg/m², or > 30 kg/m²), educational attainment (up to school year 10, completed high school or vocational college, or university level), and language spoken at home (English or other).

The data collected in Stage 2 were used to assess the test-retest agreement of the psychosocial determinants scales derived from Stage 1. Spearman's rank order correlation coefficient (ρ) was used to assess agreement on the ordinal scale score and weighted kappa (κ) was used to assess agreement in classification of respondents into the low, moderate, and high tertiles of each scale. All analyses were performed using IBM SPSS Statistics Version 20.0.0.

Results

There were 160 women recruited in Stage 1 (response rate 32%) and 97 women in Stage 2 (response rate 50%). As shown in Table 1, the samples were similar in age, parity, educational attainment, and self-reported body mass index. In the Stage 2 sample, 54% of women were English-speaking, 28% spoke Arabic, and 18% spoke Mandarin or Cantonese. Of the 97 women recruited for Stage 2, four could not be contacted for the retest measurement.

Table 2 shows that there were six scales that met the minimal internal reliability threshold of Cronbach's $\alpha \geq .70$. The PCA identified six items for physical activity outcome expectancies with loadings $\geq .40$, six concerning barriers to physical activity, four for encouragement to undertake physical activity, nine for physical activity self-efficacy, nine for weight loss attitudes, and four for diabetes-related fear. The items excluded from each scale as a result of PCA are listed below Table 2. It was notable that the outcome expectancies scale was heavily skewed with almost 90% of respondents achieving a score that indicated agreement on all items. Because of the likely ceiling effects, this scale was not included in the construct validity or retest reliability analysis.

Retest reliability analysis with the Stage 2 sample found significant agreement in responses to each of the five scales. Table 2 shows that Spearman's ρ ranged from 0.62 for physical activity self-efficacy to 0.91 for weight loss attitudes. The weighted κ showed that the tertile classification of respondent self-efficacy had fair reliability; the classification of

Table 1. Characteristics of Women With Past Gestational Diabetes Mellitus in Stages 1 and 2 of the Study.

Characteristic	Stage 1 (N = 160)	Stage 2 (N = 97)
Age, M (SD), years	34.4 (5.3)	34.5 (5.3)
Parity, n (SD)	2.3 (1.2)	2.4 (1.4)
Education, n (%)		
Did not complete high school	33 (21)	24 (26)
Completed high school	36 (22)	17 (18)
Trade/technical certificate or diploma	40 (25)	23 (25)
University	51 (32)	29 (31)
Weight status, n (%)		
Normal weight (< 25 kg/m ²)	45 (28)	37 (40)
Overweight (25-30 kg/m ²)	48 (30)	22 (24)
Obese (> 30 kg/m ²)	65 (41)	34 (36)
Not given	2 (1)	0
Language spoken at home, n (%)		
English	160 (100)	50 (54)
Arabic	0	26 (28)
Cantonese/Mandarin	0	17 (18)

barriers to physical activity and diabetes-related fear scale had moderate reliability; and the reliability of the tertile classifications on the encouragement to be active and weight loss attitudes scales was good.

In the construct validity analysis, the barriers to physical activity score were not related to minutes of total physical activity, and it was only those in the moderate barriers category who were less likely than those in the low category to undertake the recommended amount of 150 minutes/week of moderate or vigorous activity (Table 3). The encouragement for physical activity scale also did not have a linear relationship with minutes of total activity; however, women in the high tertile on this scale were more likely than those in the low tertile to meet the physical activity recommendations (adjusted odds ratio [AOR] = 3.51, $p < .01$). The self-efficacy scale showed a significant association with both the linear and categorical measures of physical activity. Compared with respondents in the low tertile of self-efficacy, those in the moderate (AOR = 2.71, $p < .05$) and high tertiles (AOR = 7.84, $p < .01$) were more likely to report the recommended amount of physical activity.

Responses on the weight loss attitudes and diabetes-related fear scales did not show associations with physical activity participation. Weight loss attitudes were positively related to the number of serves of fruit and vegetable consumed each day, with those in the highest tertile more likely than those in the lowest tertile (AOR = 3.37, $p < .01$) to report consuming five or more serves of fruit and vegetables per day. However, the weight loss attitudes scale was not associated with the number of serves of unhealthy food consumed. The diabetes-related fear scale did not show an association with the dietary measures.

Table 2. Internal and Retest Reliability of Psychosocial Scales Related to Physical Activity, Weight Loss, and Diabetes.

Scales and item	Factor loading	Stage 1 internal reliability (N = 160), Cronbach's α	Stage 2 retest reliability (N = 93)	
			Spearman's ρ	Weighted κ^g
Physical activity outcome expectations ^a		.82	N/A	N/A
Help control weight	0.88			
Improve fitness	0.84			
Improve self-esteem	0.69			
Improve health	0.66			
Reduce diabetes risk	0.60			
Increase energy	0.57			
Barriers to physical activity ^b	—	.75	0.70	0.55
Lack of time	0.58			
Work demands	0.68			
Family demands	0.71			
Lack of help with child care	0.70			
Putting needs of others in the family first	0.61			
Not having your family nearby to help	0.63			
Encouragement to be active ^c	—	.76	0.78	0.62
Receive encouragement	0.84			
Friends encourage	0.69			
Partner encourages	0.69			
Other family members encourage	0.72			
Physical activity self-efficacy ^d	—	.82	0.62	0.38
When feeling tired	0.65			
When lack time	0.62			
When feeling stressed	0.55			
Dealing with demands of parenting	0.61			
Dealing with other demands at home	0.79			
When have household chores to do	0.74			
When feeling alone	0.62			
When feeling lazy	0.57			
When feeling depressed	0.62			
Weight loss attitudes ^e		.90	0.91	0.68
Feel more optimistic	0.81			
Feel more attractive	0.83			
Have more self-respect	0.75			
Family would be proud	0.73			
Less self-conscious	0.80			
More respect from others	0.62			
Wear nicer clothes	0.47			
Would accomplish more	0.74			
Should lose weight	0.80			
Diabetes-related fear ^f		.70	0.75	0.59
Afraid of developing type 2 diabetes	0.73			
Afraid of effect of GDM on child	0.73			
Afraid of effect of GDM on own health	0.79			
GDM had severe impact on life	0.56			

Note. GDM = gestational diabetes mellitus.

^aExcluded items: improved mood, enjoyment, meeting new people, lower stress, more time for self, being positive role model for children. ^bExcluded items: lack of motivation, insufficient energy, not having activity partner, poor weather, poor health, lack of convenient locations, being overweight, lack of money. ^cExcluded items: accompanied by family or friends, assistance with child care, assistance with household chores, encouragement from health care professionals, encouragement from complementary health providers. ^dExcluded item: poor weather. ^eExcluded item: able to eat preferred foods. ^fExcluded items: perception of harm, level of risk of disease, effect of family history, can reduce risk by personal action, can prevent diabetes by medications. ^gAgreement for classification into low, moderate, or high tertiles on scales.

Table 3. Construct Validity of Physical Activity, Weight Loss, and Diabetes Scales in Relation to Physical Activity Participation and Dietary Intake.

Scales	Total physical activity		Fruit and vegetable intake		Unhealthy food intake	
	Minutes/week, β coefficient	≥ 150 minutes/ week, adjusted odds ratio	Serves/day, β coefficient	≥ 5 serves/day, adjusted odds ratio	Serves/day, β coefficient	≥ 1 serve/day, adjusted odds ratio
Barriers to physical activity	-0.05					
Moderate versus low		0.37*				
High versus low		0.82				
Encouragement to be active	.14					
Moderate versus low		2.00				
High versus low		3.51**				
Physical activity self-efficacy	0.27**					
Moderate versus low		2.71*				
High versus low		7.84**				
Weight loss attitudes	-0.07		0.28**		-0.02	
Moderate versus low		0.79		2.41		0.88
High versus low		1.21		3.37**		0.97
Diabetes-related fear	0.02		0.02		0.08	
Moderate versus low		1.19		1.10		1.24
High versus low		1.36		1.80		0.80

* $p < .05$. ** $p < .01$.

Discussion

In order to strengthen the evidence base for diabetes prevention there is a need to develop measures of the determinants of health behaviors that can be applied to the evaluation of interventions. The present study is the first to systematically develop measures that have direct relevance to the needs and psychosocial characteristics of women with a history of GDM. The measures developed are of particular value for research and evaluation concerned with physical activity participation, which has so far proved to be a challenging area of intervention among this priority group (Cheung et al., 2011; Ferrara et al., 2011; Kim et al., 2012; McIntyre, Peacock, Miller, Koh, & Marshall, 2012).

Interventions to promote health behaviors among women with a history of GDM need to take into account the unique barriers to change that these women face (Lipscombe et al., 2014). The measures of barriers to physical activity developed in this study addressed factors identified as important in previous studies and added items for the perceived obligation to put the needs of others first and not having family members nearby who can offer assistance, that have been found to be important issues in formative research among women with a history of GDM (Razee et al., 2010). The physical activity barriers scale had good internal and retest reliability but did not show a consistent relationship with time spent in physical activity. This suggests that while it may be useful to evaluate progress in problem solving following counseling and support for physical activity adoption, it does not appear to be suitable as a predictor of the adoption of behavior changes.

Social support has been reported to be positively associated with levels of physical activity undertaken by women with a history of GDM (Koh, Miller, Marshall, Brown, & McIntyre, 2010; Smith et al., 2005) and by women generally (Eyler et al., 2002). In this study, principal components analysis of nine items concerned with social support for physical activity found that only those related to emotional encouragement had acceptable scale properties. These items also showed construct validity, demonstrating their value for intervention research. Further research is warranted to better understand the influence that other dimensions of social support may have on the lifestyle behaviors of women with a history of GDM, including instrumental, informational, and appraisal support (Heaney & Israel, 2002).

The self-efficacy measure addressed confidence about physical activity when dealing with household demands (parenting, domestic chores, other pressures at home) and psychological distress (stress, loneliness, depression), with the nine-item scale having very good internal reliability. These items directly address influences on physical activity reported by women with a history of GDM, building on generic self-efficacy measures developed previously (Marcus et al., 1992; Resnick & Jenkins, 2000; Sallis et al., 1989) and on other self-efficacy measures used in diabetes research that have concentrated on disease self-management (Rapley, Passmore, & Phillips, 2003). The clear construct validity of the scale, consistent with previous reports that self-efficacy is strongly related to physical activity participation for women with a history of GDM (Kim et al., 2008; Koh et al., 2010; Smith et al., 2005), indicates that this scale will be a useful tool in intervention research with this priority group.

The physical activity outcome expectancies scale primarily included items concerning the health benefits of activity. While the scale had good internal reliability, there was a strong positive skew in its distribution. Other researchers have observed such a positive bias in physical activity benefits measures (Carlson et al., 2012), reflecting widely held beliefs about value of exercise. This highlights that such scales are prone to ceiling effects.

The attitudes to weight loss scale had strong internal and retest reliability, and this measure showed construct validity in relation to fruit and vegetable intake. The scale did not, however, show the expected negative association with frequency of unhealthy food consumption. This may have been because the measure of unhealthy eating, which was based on frequency of consumption of selected food types, was not a sufficiently sensitive measure of dietary fat intake. The attitudes to weight loss scale also showed no relationship with physical activity, which is consistent with previous findings that even though women with a history of GDM are concerned about weight control they place greater importance on dietary intake than physical activity in relation to their health status (Graco, Garrard, & Jasper, 2009).

The measure of diabetes-related fear was developed because women with a previous diagnosis of GDM may be motivated by a higher level of personal susceptibility to future diabetes. While the measure had acceptable internal and retest reliability, it did not have an independent association with physical activity or dietary intake. Interestingly, a study undertaken in the United States (Kim et al., 2007) with a predominantly White and socioeconomically advantaged sample of women with a history of GDM found similar cross-sectional associations between diabetes fear and preventive behaviors. That study did, however, find that fear was associated with a greater likelihood of forming plans to modify behaviors, suggesting that awareness and concern about future diabetes play a role in the formation of behavioral intentions.

Strengths of this study were that measures were developed with a socially and ethnically diverse sample of women, and the retest reliability of the measurement scales was tested in English, Arabic, and Chinese languages. A limitation was that the first stage of psychometric testing of the factor structure, internal reliability, and construct validity of the measures could be conducted in English only. A further limitation was that self-reports, rather than objective measures of physical activity and dietary behaviors, were used to assess the construct validity of the scales.

Currently the measurement instruments that have been developed for the planning and evaluation of diabetes prevention strategies are generic in nature. This study has identified scales that produce valid and reliable scores for measuring emotional support and self-efficacy for physical activity and attitudes to weight loss that will be useful in future theory testing and investigation of the mediators of health behaviors among women with a history of GDM. In

addition, the scales developed to measure barriers to physical activity and diabetes-related fear showed sufficient retest reliability to indicate that they may be used as measures of the impact of diabetes education interventions for this priority group. Given that these scales primarily address determinants of physical activity participation among women with a history of GDM, there is scope for research for the development and testing of measures concerned with the determinants of dietary behaviors in this group.

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Effectiveness of a large-scale handwashing promotion intervention on handwashing behaviour in Dhaka, Bangladesh

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Abstract

OBJECTIVE The behavioural effect of large-scale handwashing promotion programmes has been infrequently evaluated, and variation in the effect over time has not been described. We assess the effect of a large-scale handwashing promotion programme on handwashing outcomes in a community setting in Dhaka, Bangladesh.

METHODS We analysed data from a cluster-randomised trial that included three arms: vaccine-and-behaviour-change intervention (VBC), vaccine-only (V) and no intervention (Control). Data collectors randomly selected different subsets of households each month during the study period and assessed: (i) temporal variation in availability of soap and water at handwashing place; (ii) the use of water and soap by participants when asked to demonstrate handwashing, and; (iii) handwashing behaviour according to structured observation. We used log-binomial regression analyses to calculate prevalence ratios (PRs) and 95% confidence intervals and compare outcomes by study arms.

RESULTS Data collectors surveyed 9325 households over 28 months. In VBC, there was a significant positive trend on availability of water and soap from baseline to 9 months after the start of the intervention (P -for-trends <0.001), and no significant trend during months 10–28 (P -for-trend = 0.297). In the entire study period, availability of water and soap was higher in VBC (43%) than in V (23%) (PR = 1.92; CI = 1.72, 2.15) and Control (28%) (PR = 1.53; CI = 1.38, 1.69) households. There were no differences between study arms with regard to use of soap during handwashing demonstrations. Observed handwashing with soap after toilet use was higher in VBC (17%) than in V (8%) (PR = 1.47, CI = 0.58, 3.75) and Control (2%) (PR = 3.47, CI = 0.48, 23.33) groups. At other possible pathogen transmission events, the prevalence of handwashing with soap was $\leq 3\%$.

CONCLUSION VBC households maintained soap and water for handwashing, but the prevalence of observed handwashing was low in all study arms. The results underscore the need to strengthen scalable behaviour change approaches.

keywords Bangladesh, handwashing, intervention, behaviour, ICVB

Introduction

Handwashing has a strong protective effect against infectious diseases, including diarrhoea [1,2] and cholera [3–6]. However, handwashing remains infrequently practiced: a systematic review of 42 studies estimated that 19% of the adults worldwide washed hands with soap after faecal contact [7].

Handwashing promotion has become an increasing priority for governments and non-governmental

organisations[8], yet there have been relatively few evaluations of large-scale handwashing promotion programmes in the community setting [9–12]. Most previous evaluations have been of small-scale interventions and thus have provided little insight for large-scale promotion efforts [13–16]. Previous studies also did not capture the effect of the intervention throughout the promotion period. For example, assessment of an intervention programme in the community in Burkina Faso only included one cross-sectional survey at baseline period and one cross-sectional

survey at 3 years after the start of the intervention [17]. An evaluation of a large-scale community WASH intervention programme in Bangladesh only included observed handwashing behaviour at baseline and at 18 months after intervention [18], so the variation in the effect of the intervention during the follow-up period was not described. Assessment of such variation can provide information on the extent and trend in the effect over time, which can contribute to planning future interventions to improve sustainability.

The Introduction of Cholera Vaccine in Bangladesh (ICVB) study was a large-scale cluster-randomised field effectiveness trial of cholera vaccine, water quality and hand hygiene interventions on diarrhoeal disease. It was conducted in the densely populated urban area of Mirpur sub-district (*thana*), Dhaka [19]. The study had three arms: vaccine with behaviour change intervention arm (VBC), vaccine-only arm (V) and the control arm. The objectives of the behaviour change intervention included increasing water disinfection, maintenance of water and soap at the handwashing station in the household and promoting handwashing with soap at potential pathogen transmission events. The ICVB study reported that the VBC arm and the V arm had significantly lower risk of diarrhoea due to *Vibrio cholera* O1 (cholera) than the control arm, but neither the risk of hospitalisation for cholera [19] nor for hospitalisation for all cause diarrhoea was significantly different between the VBC and V arms [2]. A previous study showed that during the study period, the proportion of households in the VBC arm with water and soap available at the primary handwashing place was nearly double that of the proportion in the V arm and the control arm [2]. However, these differences warrant further exploration. Temporal variation in the availability of water and soap in each study arm has not been described, which could allow for a better understanding of the factors associated with lack of effect of the intervention on cholera and diarrhoea hospitalisations. In addition, the presence of soap and water at a household's primary handwashing place is an indirect method of measuring handwashing compliance that can be prone to inaccuracy [20]. Use of additional indicators of handwashing, such as the use of water and soap during handwashing demonstration and observed handwashing behaviours using structured observation, can provide insights for handwashing outcome measurements in future programme evaluations.

We hypothesise that there are differences in handwashing outcomes between the VBC arm and the V and Control arms. In this study, we assessed the effects of the ICVB behaviour change programme on the following handwashing outcomes: (i) temporal variations in availability of soap and water at a handwashing place; (ii) the

use of water and soap by the participant when asked to demonstrate handwashing, and (iii) observed handwashing with soap at potential pathogen transmission events.

Methods

Study population

The method of the ICVB study, including participant selection, has been previously described [19]. Mirpur is comprised almost entirely by ethnic Bengalis. The total area is 8.47 sq.km, and the estimated population of the area in 2011 was 500 373 [21]. The method for the number of participating households in each study arm has been described elsewhere [19], and the total sample size was 78 780 households per study arm with three arms, thus a total of 236 340 households in the study area. In Dhaka City, including Mirpur, water demand exceeds the supply and is highly dependent on ground water, which makes water access and quality a problem [22].

Development of behaviour change intervention

The ICVB research team developed the handwashing behaviour change plan guided by the Integrated Behavioural Model for Water, Sanitation and Hygiene (IBM-WASH) [23]. Guided by the model and extensive formative research [24,25], the behaviour change intervention was designed to improve stable access to enabling technologies (handwashing stations and soapy water dispensers) placed conveniently in or around the home, increase handwashing skills of adults and children, build family and community support in maintaining the handwashing stations and replenishing supplies, influence community norms by modelling and supporting the behaviour in public, and provide periodic counselling and problem solving by trained community health workers. In Bangladesh, the cost of bar soap is perceived to be a barrier to frequent handwashing with soap [20]; a bar of soap costs 40 Taka (US \$0.50) [26] in a country where the minimum wage for a common occupation such as garment factory work is \$67 per month [27]. Soapy water is a mixture of powder detergent soap and water and is a microbiologically effective cleansing agent.[16] The cost per hand wash by soapy water is significantly less than the cost per hand wash by bar soap [24] (\$0.20–\$0.44 per 100 wash for bar soap *vs.* less than \$0.10 per 100 washes for soapy water) [28]. The behaviour change intervention also included provision of a chlorine dispenser and encouragement to treat drinking water, but this paper focuses only on the handwashing promotion components.

Randomisation procedure

The ICVB research team used a digital map of Mirpur to divide the study area into 90 clusters (neighbourhoods) of approximately 2700 residents each. The research team then randomly allocated 30 clusters each to the vaccine-only arm (V arm), the vaccine-plus-behaviour-change-communication arm (VBC arm) and the Control arm using a random number generator. Investigators also designated areas with the horizontal width of at least 30 m between clusters as the Buffer zone in order to avoid spill-over of the behaviour change intervention. Individuals residing in the VBC clusters received killed whole cell oral cholera vaccine followed by a handwashing promotion programme. Individuals residing in the V clusters only received the vaccine. Individuals residing in the Control clusters and Buffer zone did not receive any intervention.

Eligibility and informed consent

Those eligible for this study included residents of buildings that the census team determined to be at high risk of cholera: houses with poor sanitation and drainage, unhealthy living conditions and a water source shared among several families [29]. If the residence met these criteria, the census team collected verbal consent from every individual in the family to participate in the study. Study team workers also informed the household that they might or might not be included in the study interventions.

Behaviour change intervention delivery

The handwashing promotion programme was implemented by community health workers from Dushtha Shasthya Kendra, a Dhaka-based non-governmental organisation. During the first 45 days, from July to August 2011, Dushtha Shasthya Kendra community health workers aimed to make initial visits to each of the households in the VBC study arm three times. The first visit served to inform household members about the project and identify a main caretaker for the handwashing area. The second visit involved giving each participating household compound a bottle of soapy water and a sachet of laundry soap powder to demonstrate the use and maintenance of soapy water, as well as a handwashing station to those compounds or households situated outside of a compound structure that were lacking one. The handwashing station consisted of a bucket with a tap, a bowl to receive the rinse water spill and a soapy water bottle (Figure 1) [2]. Community health workers also taught the participants to make soapy water by

mixing powdered detergent with 1.5 l of water in a plastic bottle with a hole punched in the cap [2,19,24]. The handwashing station was placed in the common area of the participating household's compound, and all of the households in the compound were counselled to share the handwashing station, including households that were unrelated to each other. Participating households were counselled to buy more soap powder sachets and make soapy water on their own. During the third visit, field staff checked and sought to resolve problems with the handwashing stations and ensure that the handwashing stations were functioning and filled with water. After the initial 45 days, community health workers aimed to make three successive visits over 3 months to counsel compound residents on handwashing behaviour, and to discuss and troubleshoot problems related to making and maintaining soapy water. After the successive visits, there were follow-up visits twice per month, and the activities included working with various groups (women's groups, men's groups, tea stall owners) to model handwashing stations and handwashing behaviour in public, training mother of children under 5 on how to teach handwashing, teaching children aged 6–13 years about handwashing, visits to pregnant women, and special or holiday events in the community as part of periodic intensive efforts, such as the Global Handwashing Day festivities. Handwashing counselling and accompanying promotion materials included the importance of handwashing at two key times: after faecal contact and before food preparation. Bengali was the medium language for all intervention activities. Details of the behaviour change intervention components can be found in Table 1.



Figure 1 Handwashing station provided to households in the behaviour change intervention arm, with water bucket, tap, bowl to receive run-off and a bottle of soapy water, ICVB Study, Dhaka, Bangladesh, 2012–13. Source: Najnin *et al.* (2017)[2].

Table 1 Components of the behaviour change intervention, ICVB Study, Dhaka, Bangladesh, 2012–13

Title of activity	Intended audience	Details of the activity
Household visits		
Initial household visit: 1st round	Household members, residence of urban compound/clusters	Introductory discussion to inform people about hardware, identify interested groups among people who share latrines and kitchens, and encourage interested groups to decide on a caretaker who will refill soapy water bottles and ensure that handwashing stations are in place
Initial household visit: 2nd round		Installation of hardware and orientation about proper use and maintenance
Initial household visit: 3rd round		Ask about problems related to hardware
Successive visit: 1st round		Counsel household members and motivate them to wash hands at critical times, with handwashing demonstration
Successive visit: 2nd round		Observe household members' handwashing practice, discuss hardware-related problem, talk with handwashing station caretakers and monitor her or his performance
Successive visit: 3rd round		Use game and fun, train the mother of under-five children on teaching handwashing to the child
Follow-up visits	Household members, residence of urban compound/clusters	Follow-up on skills in handwashing station use and maintenance, identify and solve hardware-related problem, caretaker schedule and performance
Follow-up visits	Pregnant women	Communicate to motivate handwashing and handwashing device use, when caring for the new child for early habit formation
Follow-up visits	Handwashing station caretakers	Train caretakers on hardware maintenance (clean up handwashing station, refill soapy water bottle)
Community activities		
Courtyard/ compound activity sessions	Women's groups	Share knowledge, demonstrate key behaviours related to handwashing, motivate women through counselling on environmental determinants of behaviour change (location, product availability, effectiveness, ease, self-efficacy, aesthetics, etc.) to improve target behaviours
Courtyard/ compound activity sessions	Pre-school children (age 2–5 years)	Engage mothers and caregivers who learned how to teach and encourage children to wash their hands, encourage children using soapy water bottles; Place stickers at the handwashing station to grow children's interest
Courtyard/ compound-based fun activities	Children's group (age 6–13 years)	Use child games, quizzes, flip charts, puppets (soapy water bottles, global handwashing mascot, etc.) to teach children handwashing skills (age 6–13 years) and how to operate hardware and look after younger siblings (age 10–13 years)
Tea stall and club-based activities (confined within cluster)	Tea stall owners	Discuss how the new handwashing devices can help owners be perceived as health/hygiene-conscious and improve sales. Tea stall owners provided with handwashing station to display and use.
Tea stall and club-based activities (confined within cluster)	Men's group	Group discussion to promote handwashing behaviours, motivate participation in handwashing promotion, discuss resistance that may arise from men
Intensive Programme (confined within clusters)	Community	Handwashing promotion activities during holidays or special events, for example Global Handwashing Day, World Water Day, such as demonstrations, poster making and information dissemination

Outcomes

Each month, research staff from icddr,b used the census data to randomly select 200 households from the VBC arm, 100 households from the V arm, 100 households from the Control arm and 20 households from the Buffer zone during parts of the follow-up period to make

detailed outcome assessment. The number of households for monthly data collection was determined based on the need to provide continuous trend data in a logistically manageable manner. The sampling frame was updated every 6 months, and new census rounds were used for random selection of households. These assessment visits

were unannounced. Field staff sought informed consent for participation from an adult living in each sampled household. Field staff then administered a questionnaire on household demographics, duration of living in the sampled compound, socioeconomic status, and health history; observed presence of soap/soapy water and water at the primary handwashing place, that is, the place that respondent identified that they most frequently washed their hands; and asked the mother of a child aged <5 years, or an adult member of the house if a child caregiver was not present, to demonstrate how he or she normally washed their hands after defecation. The consenting process and all questionnaire interviews were conducted in Bengali. Data were collected from April to May 2011 (baseline period) and monthly from September 2011 to October 2013 (follow-up period). Field staff collected handwashing demonstration data from August 2012 to October 2013. Field staff also conducted household structured observation of handwashing behaviours in a randomly selected subset of 326 households in VBC, V and Control arms from 17 May 2013 to 6 July 2013. Each structured observation session took approximately 3 h. Field staff asked for permission from the respondent to observe the 'daily activities' of the households and surreptitiously observed the handwashing behaviour of household members after potential pathogen transmission events. Categories of events recorded under structured observation are listed in Box 1. Recorded information included type of event, number of hands washed, and the cleansing materials used. An event was considered as handwashing if at least one hand was observed as being washed with water only or with water and soap.

Statistical methods

We applied the intent-to-treat approach to evaluate the effect of the intervention on three behavioural outcomes in this study: (i) temporal variations in availability of water and any type of soap (including soapy water) in the household's primary handwashing place; (ii) the use of water and soap by the participant when asked to demonstrate handwashing, and; (iii) observed handwashing with soap at potential pathogen transmission events. Although the VBC arm was the only study arm that received the behaviour change intervention, the V arm and the control arm were not collapsed and were analysed separately because of the need to adhere to the protocol. Furthermore, after vaccination, the protective behaviour of individuals and families can regress to the level of the unvaccinated group [30–32]. Analysing the V and control arms separately allowed for assessment of differences in health behaviour

between those who received the cholera vaccine and those who did not.

We present the availability of water and soap at the household handwashing station and the use of water and soap during handwashing demonstration during each month after the start of the intervention and throughout the intervention period. We present the prevalence of observed handwashing behaviours from structured observation, overall and stratified by type of potential pathogen transmission event, and used chi-square test of independence to measure the association between study arms and observed handwashing behaviours.

As Mirpur contains a wide variety of neighbourhoods (by both socioeconomic status and ethnicity), geographic heterogeneity may exist between different clusters (neighbourhoods) that participated in the study. In addition, Dushtha Shasthya Kendra assigned only one community health worker to carry out behaviour change activities in each cluster throughout the project period; thus, there could also have been heterogeneity between clusters based on the performance of individual health workers. Therefore, we assessed data heterogeneity among clusters in the study.

To assess temporal variations in availability of water and soap at the handwashing place, based on visual inspection, we identified in the VBC arm a linear growth phase (months 0 thru 9 in the study) and a post-growth phase with stable but fluctuating availability of water and soap at the handwashing place (months 10 thru 28 in the study). We described and tested the trend during these two periods in each of the study arms using the number of month from the baseline period as the independent variable, and the availability of water and soap as the dependent variable in log-binomial regression analyses at 95% level of confidence with 95% confidence interval for number of months *vs.* prevalence of having water and soap at the handwashing place in the study arm of interest.

On the use of water and soap during handwashing demonstration and observed handwashing behaviour, we performed log-binomial regression analyses and calculated unadjusted prevalence ratios (PR) with 95% confidence intervals (CI) to compare the probability of each outcome in the VBC arm (exposed group) to each of the other arms (V arm, Control arm, and Buffer zone, as reference groups). Analyses of structured observation data also included stratification by type of pathogen transmission event and availability of water and soap at the handwashing place in the household during the household interview, prior to structured observation. In all analyses, we accounted for clustering at the neighbourhood level by specifying the cluster identification number as the repeated variable in the model.

Socioeconomic status [33–35] and ethnicity [36] are associated with handwashing behaviour. We used principal component analysis (PCA) to rank participating households using measures of socioeconomic status, which included self-reported literacy, education level, asset ownership, and construction materials of the participating household. We then used the ranking scores to classify households into socioeconomic status tertiles. Ethnicity (Bengali majority *vs.* non-Bengali minority) was defined based on self-reported language spoken in the home.

We assessed whether socioeconomic status and ethnicity confounded the relationship between the intervention and handwashing outcomes by applying log-binomial regression models and retaining the variables that changed the crude PR by 10 per cent or more. We then included all confounders in multivariate log-binomial regression models.

The ICVB study was registered at ClinicalTrials.gov number, NCT01339845.

Results

Characteristics of study participants

Between April 2011 and October 2013, study team members collected data from 4265 households in the VBC arm, 2145 households in the V arm, 2165 households in the control arm and 750 households in the Buffer zone (Table 2). The age distribution of study participants was similar across study arms and the Buffer zone. The VBC arm had higher percentages of female participants and Bengali-only households than the V and Control arms and had lower percentage of households in the lowest tertile of socioeconomic status than households in the V and Control arms and the Buffer zone.

The presence of water and soap at the primary handwashing place

In the VBC arm, the presence of water and soap at the handwashing place had a significant positive trend between baseline and 9 months after the start of the intervention (Figure 2), while the V and control arms had a significant downward trend, and the buffer zone had no significant trend (*P*-for-trends: $P < 0.001$ for VBC arm, $P = 0.014$ for V arm, $P = 0.001$ for control arm, $P = 0.355$ for Buffer zone). From month 10 to 28, the presence of water and soap at the handwashing place had no significant trend in the VBC arm, control arm or buffer zone and had a marginally significant positive trend in the V arm (*P*-for-trends: $P = 0.297$ for VBC arm,

Box Classification of handwashing events for structured observations of handwashing behaviour, ICVB Study, Dhaka, Bangladesh, 2012–13.

Toileting

- After toileting
- Other faecal contact events
 - After removing child faeces
 - After cleaning the child's anus

Food preparation

- During food preparation
- Preparing food for direct consumption
- Preparing salad
- Mashing food
- Cutting fruit
- Before making roti/chapatti
- Preparing food for subsequent cooking
- Before cutting vegetables
- After cutting onion, garlic, etc.
- After cutting fish or meat or chicken

Food contact

- Before serving food
- Before eating
- Before feeding the child

Respiratory fluid contact

- After cleaning running nose
- After sneezing
- After coughing
- After feeding child
- After removing child cough

Before breastfeeding

Others

- Before handling child >2 years
- Bathing
- After eating
- Others

$P = 0.021$ for V arm, $P = 0.126$ for control arm, $P = 0.140$ for Buffer zone).

In the entire study period, 43% of households in the VBC arm had water and soap at the primary handwashing place, *vs.* 23% in the V arm, 28% in the control arm and 27% in the buffer zone. Households in the VBC arm had a significantly higher probability of having water and soap at the handwashing place than households in the V

Table 2 Characteristics of study participants from combined monthly assessments of handwashing behaviour, ICVB Study, Dhaka, Bangladesh, 2012–13 (*n* = 9325)

Item	Study arm			
	VBC (<i>n</i> = 4265)	V (<i>n</i> = 2145)	Control (<i>n</i> = 2165)	Buffer (<i>n</i> = 750)
Demographics				
Sex of the respondent (% female)	3607 (85%)	1765 (82%)	1835 (85%)	617 (83%)
Age of the respondent (median (1st quartile, 3rd Quartile))	29 (23, 38)	29 (23, 38)	29 (23, 39)	30 (22, 40)
Language spoken at home				
Bengali	4002 (94%)	1967 (92%)	1961 (91%)	720 (96%)
Bengali and Urdu	173 (4%)	165 (8%)	144 (7%)	21 (3%)
Urdu or other languages only	90 (2%)	13 (1%)	60 (3%)	9 (1%)
Socioeconomic Status (SES)*				
Lowest tertile	704 (33%)	969 (23%)	658 (30%)	211 (28%)
Medium tertile	1124 (52%)	2545 (60%)	1208 (56%)	432 (58%)
Highest tertile	317 (15%)	749 (18%)	298 (14%)	106 (14%)

VBC, Vaccine-and-behaviour-change arm; V, Vaccine-only arm.

*SES tertiles based on principal component analysis of the following indicators of SES: (i) Having a refrigerator; (ii) Using non-biomass fuel; (iii) Having a water-sealed latrine.

arm (PR = 1.92; 95% CI = 1.72, 2.15), households in the Control arm (PR = 1.53; 95% CI = 1.38, 1.69) and households in the Buffer zone (PR = 1.62; 95% CI = 1.47, 1.78). Adjusting for the duration from the start of intervention did not significantly alter the association between study arms and presence of water and soap at the primary handwashing place (Table S1). The most common types of soap at the primary handwashing place were soapy water (26%) and body/hand soap (25%) in VBC arm households, body/hand soap (20%) and laundry bar soap (7%) in V arm households, body/hand soap (25%) and laundry bar soap (8%) in Control arm households, and body/hand soap (24%) and laundry bar soap (7%) in Buffer zone households. The presence of water and soap was similar in all study arms when soapy water was excluded from the analysis (Figure S1). Drums/buckets with tap (provided by icddr,b) were observed at the primary handwashing place in 41.8% of VBC arm households, 4.4% of V arm households, 3.2% of Control arm households and 2.8% of Buffer area households. Among the drums at primary handwashing places of households in the VBC arm, 72.7% contained water. When enumerators asked household respondents to show the second place where household members washed their hands (if any), 25.1% of VBC arm households, 11.6% of V arm households, 13.0% of Control arm households and 12.1% of Buffer zone households reported a secondary handwashing place. Among households with secondary handwashing places, drums/buckets with tap (provided by icddr,b) were available at 51.8% of households in

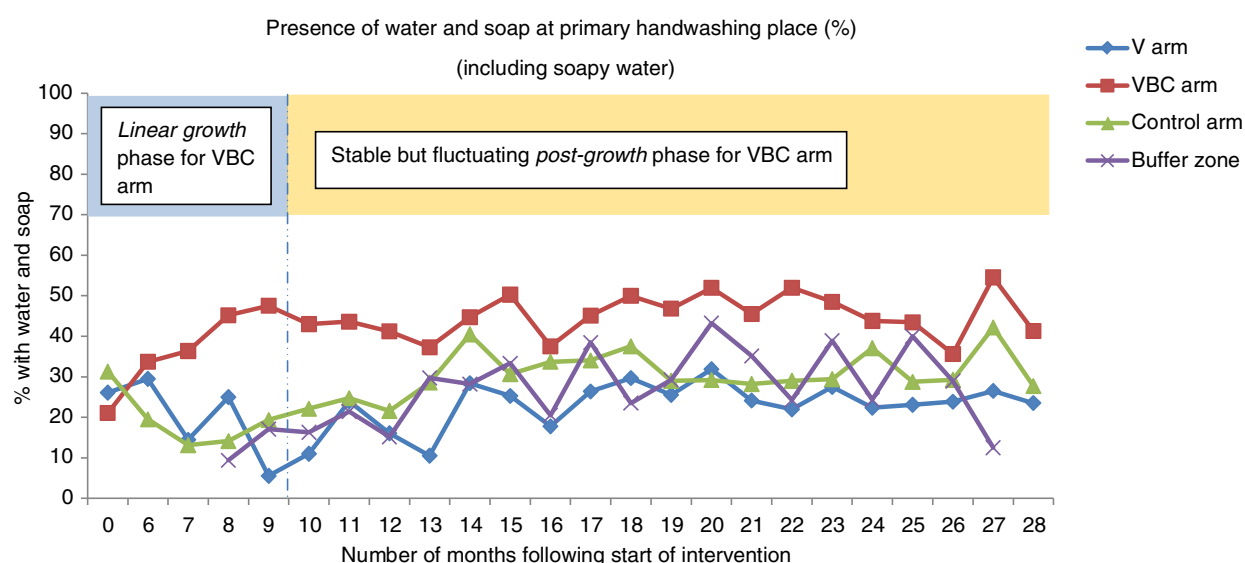
VBCC arm, 2.5% of households in V arm, 0.8% of households in Control arm and 1.2% of households in the Buffer zone. Among households in the VBC arm, 84.6% of drums/buckets with tap at secondary handwashing places contained water.

In cluster-level analysis, the median prevalence of soap and water at the primary handwashing station among the 30 VBC clusters was 47% (IQR: 34%, 54%), *vs.* 24% (16%, 27%) among 30 clusters in the V arm and 26% (23%, 33%) among 30 clusters in the Control arm across the follow-up period (Figure 3). The association between study arms and presence of water and soap at the primary handwashing place was strongest among households in the second tertile of socioeconomic status compared to those in the first and third tertiles and was stronger in households that spoke Bengali only compared to households that spoke languages other than Bengali.

Households in VBC arm clusters with lower prevalence of water and soap at primary handwashing place had similar characteristics to those with higher prevalence (Table S3), although households with lower prevalence had fewer non-Bengali households.

Use of water and soap when asked to demonstrate handwashing

When asked to demonstrate handwashing, 83% of participants in the VBC arms washed their hands with soap and water, compared to 78% of participants in the V arm, 78% of participants in the Control arm and 81% of



Remark:

VBC= Vaccine-and-behavior-change-communication arm; V = Vaccine-only arm

Figure 2 Per cent of households with water and soap present at the house's primary handwashing place, by study arm and time since the start, ICVB Study, Dhaka, Bangladesh, 2012–13. VBC, Vaccine-and-behaviour-change communication arm; V, Vaccine-only arm.

participants in the Buffer zone. Participants in the VBC arm had slightly higher probability of using soap when demonstrating handwashing than participants in the V arm (PR = 1.06; 95% CI = 1.02, 1.11), participants in the Control arm (PR = 1.06, 95% CI = 1.03, 1.09) and the Buffer zone (PR = 1.03; 95% CI = 0.99, 1.06). There was no confounding by socioeconomic status or ethnicity. Time also did not have a statistically significant effect on the association (Table S1). There was little between-cluster heterogeneity in demonstrated use of soap for handwashing within each treatment arm.

Observed handwashing at events of possible pathogen transmission

Field staff conducted structured observations in 326 households, of which 294 households could be linked to the monthly questionnaire data set. Households included in structured observation were similar to households not included in structured observations with regard to distribution of respondent demographics, language spoken at home and socioeconomic status tertiles (Table S2). We observed 3028 events of possible pathogen transmission (Table 3). Among the observed events in structured observation, 54% involved no handwashing, 29% involved washing one hand with water only, 7% involved

washing both hands with water only, <1% involved washing one hand with water and soap, 2% involved washing both hands with water and soap and 8% could not be observed.

Participants in the VBC arm washed their hands with water and soap after 17% of toileting events, compared to 8% in the V arm (PR = 1.47; 95% CI = 0.58, 3.75) and 2% in the control arm (PR = 3.47; 95% CI = 0.48, 25.33). Participants in the VBC arm washed their hands with water and soap after 50% of other faecal contact events ($N = 8$ events), while participants in the VBC and Control arms did not wash their hands with water and soap at all after such events (PR cannot be calculated). Participants in the VBC arm washed their hands with water and soap before 3% of food preparation events, compared to 2% in the V arm (PR = 1.62; 95% CI = 0.29, 9.03) and 2% in the control arm (PR = 1.91; 95% CI = 0.35, 10.32). When stratified by availability of water and soap at the handwashing place during the interview, we found that handwashing with water and soap also occurred in households where there was no observed water and soap during the interview. We also found that households in all study arms had similar probabilities of handwashing within their specific stratum. None of the covariates were found to affect the association between

intervention arm and observed handwashing with soap and water.

Discussion

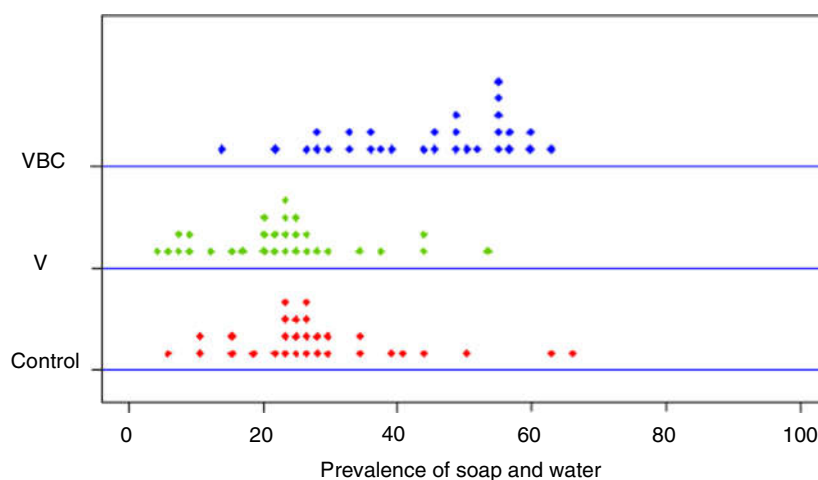
In a large-scale intervention in Dhaka, Bangladesh, the behaviour change intervention in the ICVB study was associated with higher prevalence of soap and water at the handwashing place, but handwashing with water and soap was infrequent after toilet use/faecal contact and rare at other times of possible pathogen transmission. The prevalence of observed handwashing with water and soap in the vaccine-and-behaviour-change (VBC) arm was higher than the prevalence in the vaccine-only (V) arm and the control arm, but the risks of hospitalisation for cholera [19] and diarrhoea [2] were similar between the VBC arm and the V arm. These discrepancies suggest that the increased availability of soap and water was insufficient to substantially interrupt enteropathogen transmission.

Approximately a quarter of VBC arm households made and maintained soapy water using their own resources. Community health workers from Dushtha Shasthya Kendra did not provide powder soap sachets beyond the initial visit, or any monetary support for maintaining soapy water over the 2-year intervention period. The availability of water and soap in the VBC arm increased sharply after the intervention was delivered and then was sustained throughout the study period; thus, there was long-term adherence to maintenance of water and soap in the VBC arm. The difference in availability of water and soap in the VBC arm when soapy water container was included *vs.* excluded as a type of soap suggested that the higher availability of soap in the VBC arm could be attributed to the uptake of the soapy water innovation (the container and the replenishment of spent soapy water) rather than simply the information, education and communication components of the intervention. The lower cost per hand wash by soapy water compared to that by bar soap [28] might have contributed to the maintenance of soapy water at handwashing stations. The maintenance of soapy water in a proportion of the intervention compounds in the VBC arm might suggest that in, at least some instances, households were willing to share the responsibility for maintaining the handwashing station for communal use, and not just the household's own benefit. This contrasts with a previous smaller study in urban Bangladesh, where residents expressed concerns regarding lack of a person in charge of maintaining soap and water, and reported quarrels between households [24]. Considering this adherence to maintaining water and soap in the VBC arm, it is possible that

the lack of effect of the VBC intervention on cholera and all-cause diarrhoea hospitalisations could be due to other determinants of cholera and diarrhoea in addition to lack of available water and soap for handwashing. Availability of the drums/buckets with tap in V and Control arms households suggested that there was a low level of spillover between study arms. The high availability of water in the drums/buckets with tap in the VBC arm households suggested that households in the VBC arm used, or at least maintained, the water in the handwashing stations.

Participants from all study arms had the same probability of using soap during handwashing demonstration, while the probability of using soap during structured observation was higher in the VBC arm compared to other study arms. Demonstration of soap use is a measure of knowledge and skill in handwashing [37], so it was possible that all study arms had the same level of handwashing knowledge and skill, but different prevalence of handwashing practice. The similar level of demonstrated soap use could be attributed to social desirability bias, and calls into question the utility of elicited demonstration as an indicator of handwashing behaviour to measure practices.

Prevalence of handwashing during structured observation was low. The prevalence of observed handwashing after toileting in VBC arm households was 17%, similar to the prevalence without behaviour change intervention in rural Bangladesh [37] and the global prevalence [7], but this prevalence was nonetheless higher than in other study arms. Discrepancies between availability of water and soap at a household's handwashing place compared to structured observation of household members' behaviours suggest that the availability of materials for handwashing is a necessary but not sufficient condition to motivate handwashing at key times. Our results suggested a limitation of availability of water and soap at handwashing place as an indicator. Availability of water and soap may indicate replenishment of materials yet does not imply the use of the material for handwashing, and the lack of water and soap at the handwashing place during the interview did not preclude household members from handwashing with soap during structured observation. Discrepancies between use of soap when asked to demonstrate handwashing and handwashing with water and soap during structured observation implied that household members in the study setting seemed to be aware of the recommended behaviour and have the resources for behavioural compliance, but the prevalence of actual practice was lower than the awareness. Future intervention programmes that aim to increase handwashing should consider changing other



Remark:

*VBC= Vaccine-and-behavior-change arm; V = Vaccine-only arm; Buffer zone not included: only one code was used to denote all households in the Buffer zone, irrespective of geographic location; ◇ - represents one study cluster

Figure 3 Prevalence of soap and water at the household's primary handwashing station across the follow-up period by study arms and clusters*, ICVB Study, Dhaka, Bangladesh, 2012–13. *VBC, Vaccine-and-behaviour-change arm; V, Vaccine-only arm; Buffer zone not included: only one code was used to denote all households in the Buffer zone, irrespective of geographic location; ◇ - represents one study cluster.

physical and psychosocial drivers of handwashing in addition to the ones addressed in the ICVB study. Multiple factors can affect handwashing with soap: contextual (having a shared courtyard and the associated inconvenience), psychosocial (perceived value of handwashing), and technological (ease of use, handwashing station wear and tear) [25]. In a qualitative study in rural Bangladesh, key informants stated that they purchased bar soap primarily for bathing and laundry because soap was perceived to be an expensive items that could not be used for all purposes, including handwashing, and some informants did not keep soap at the handwashing place in order to conserve soap [20]. The practice of keeping soap away from handwashing place may not be as common in urban settings, where latrines have a place to keep soap and water [20]. Visual or tactile sensations (having hands that were sticky and covered in grease or oil) and activities of daily living (handling unwashed vegetables or starting a meal) are behavioural antecedents to handwashing [38], and it may be possible to incorporate these sensations to drive handwashing behaviours. A community-based intervention study in India [39] used disgust and nurturing among mothers as drivers of handwashing behaviour, and the observed prevalence of handwashing after the intervention was higher than the

prevalence observed in this study. However, structured observations in our study were conducted in only a small subset of participating households at more than 2 years after baseline, which may affect the comparability of study results.

Structured observation of handwashing in this study included washing one hand as well as both hands. Whether washing only one hand is sufficient depends on whether the unwashed hands are involved in pathogen transmission. In Bangladesh, eating is done only by the right hand. If the right hand is washed immediately before eating and the left hand was never used, then there could be some protective effect from washing only the right hand. At other events (such as breastfeeding, preparing food, and cooking), washing only one hand may not be enough. In Bangladesh, dried snacks and uncooked food that accompany curry and rice are typically hand-mixed or mashed by hands. Even when only the right hand was used by the food preparer, the hand would be contaminated due to other interrupting events (toileting, adding cow dung fuel to the fire, etc.) which may not be followed by handwashing before going back to food preparation [40]. If washing both hands is required in order for an observed behaviour to be considered as handwashing, the prevalence of handwashing

Table 3 Observed handwashing behaviour (washing at least one hand) among all household members during structured observations in select households, ICVB Study, Dhaka, Bangladesh, 2012–13 ($n = 3028$ observations from 326 households)

Description of events from structured observations	Number of observed events ($n = 3028$)			PR (95%CI)† VBC <i>vs.</i> V (Ref.)	PR (95% CI)† VBC <i>vs.</i> Control (Ref.)
	VBC ($n = 1449$)	V ($n = 768$)	Control ($n = 811$)		
Type of events observed					
Toileting	98 (7%)	52 (7%)	41 (5%)	N/A	N/A
Other faecal contact	12 (1%)	8 (1%)	8 (1%)	N/A	N/A
Food related	784 (54%)	386 (50%)	426 (53%)	N/A	N/A
Respiratory fluid contact	58 (4%)	57 (7%)	48 (6%)	N/A	N/A
Before breastfeeding	26 (2%)	12 (2%)	7 (1%)	N/A	N/A
Other‡	471 (33%)	253 (33%)	281 (35%)	N/A	N/A
Handwashing behaviour at all events of possible pathogen transmission	($n = 1449$)	($n = 768$)	($n = 811$)		
Did not wash	757 (52%)	415 (54%)	433 (53%)	Ref.	Ref.
Washed with water only	532 (37%)	285 (37%)	297 (37%)	1.02 (0.76, 1.37)	1.02 (0.74, 1.42)
Washed with water and soap	44 (3%)	14 (2%)	18 (2%)	1.72 (0.89, 3.35)	1.40 (0.68, 2.89)
Couldn't observe	116 (8%)	54 (7%)	63 (8%)	N/A	N/A
Handwashing behaviour, stratified by type of event					
Handwashing behaviour at toileting events	($n = 98$)	($n = 52$)	($n = 41$)		
Did not wash	32 (33%)	13 (25%)	9 (22%)	Ref.	Ref.
Washed with water only	12 (12%)	9 (17%)	12 (29%)	0.67 (0.31, 1.42)	0.48 (0.27, 0.84)
Washed with water and soap	17 (17%)	4 (8%)	1 (2%)	1.47 (0.58, 3.75)	3.47 (0.48, 25.33)
Couldn't observe	37 (38%)	26 (50%)	19 (46%)	N/A	N/A
Handwashing behaviour at other faecal contact events§	($n = 12$)	($n = 8$)	($n = 8$)		
Did not wash	4 (33%)	6 (75%)	4 (50%)	Ref.	Ref.
Washed with water only	1 (8%)	2 (25%)	4 (50%)	0.8 (0.09, 7.48)	0.4 (0.06, 2.55)
Washed with water and soap	6 (50%)	0 (0%)	0 (0%)	N/A	N/A
Couldn't observe	1 (8%)	0 (0%)	0 (0%)	N/A	N/A
Handwashing behaviour at food preparation events	($n = 232$)	($n = 102$)	($n = 113$)		
Did not wash	156 (67%)	72 (71%)	85 (75%)	Ref.	Ref.
Washed with water only	69 (30%)	28 (28%)	24 (21%)	1.14 (0.62, 2.08)	1.57 (0.86, 2.85)
Washed with water and soap	7 (3%)	2 (2%)	2 (2%)	1.62 (0.29, 9.03)	1.91 (0.35, 10.32)
Couldn't observe	0 (0%)	0 (0%)	2 (2%)	N/A	N/A
Handwashing behaviour at food contact events other than preparation	($n = 552$)	($n = 284$)	($n = 313$)		
Did not wash	337 (61%)	172 (61%)	182 (58%)	Ref.	Ref.
Washed with water only	200 (36%)	107 (38%)	119 (38%)	0.95 (0.65, 1.39)	0.91 (0.63, 1.31)

Table 3 (Continued)

Description of events from structured observations	Number of observed events (<i>n</i> = 3028)			PR (95%CI)† VBC <i>vs.</i> V (Ref.)	PR (95% CI)† VBC <i>vs.</i> Control (Ref.)
	VBC (<i>n</i> = 1449)	V (<i>n</i> = 768)	Control (<i>n</i> = 811)		
Washed with water and soap	6 (1%)	2 (1%)	6 (2%)	1.53 (0.30, 7.86)	0.54 (0.14, 2.03)
Couldn't observe	9 (2%)	3 (1%)	6 (2%)	N/A	N/A
Handwashing behaviour at respiratory fluid contact events	(<i>n</i> = 58)	(<i>n</i> = 57)	(<i>n</i> = 48)		
Did not wash	52 (90%)	56 (98%)	43 (90%)	Ref.	Ref.
Washed with water only	5 (9%)	1 (2%)	2 (4%)	5.38 (0.53, 54.79)	2.06 (0.31, 13.56)
Washed with water and soap	0 (0%)	0 (0%)	0 (0%)	N/A	N/A
Could not observe	1 (2%)	0 (0%)	3 (6%)	N/A	N/A
Handwashing behaviour at Breastfeeding events	(<i>n</i> = 26)	(<i>n</i> = 12)	(<i>n</i> = 7)		
Did not wash	26 (100%)	11 (92%)	6 (86%)	Ref.	Ref.
Washed with water only	0 (0%)	1 (8%)	1 (14%)	N/A	N/A
Washed with water and soap	0 (0%)	0 (0%)	0 (0%)	N/A	N/A
Couldn't observe	0 (0%)	0 (0%)	0 (0%)	N/A	N/A
Handwashing behaviour at toileting event, stratified by availability of water and soap at handwashing place during interview (<i>n</i> = 2746 observations from 294 households)					
No water and soap observed at handwashing place	(<i>n</i> = 116)	(<i>n</i> = 133)	(<i>n</i> = 77)		
Did not wash	55 (47%)	69 (52%)	37 (48%)	Ref.	Ref.
Washed with water only	47 (41%)	50 (38%)	29 (38%)	1.10 (0.81, 1.48)	1.05 (0.74, 1.48)
Washed with water and soap	1 (1%)	4 (3%)	2 (3%)	0.33 (0.04, 2.84)	0.35 (0.03, 3.71)
Couldn't observe	13 (11%)	10 (8%)	9 (12%)	N/A	N/A
Only water or soap observed at handwashing place	(<i>n</i> = 453)	(<i>n</i> = 391)	(<i>n</i> = 308)		
Did not wash	234 (52%)	210 (54%)	142 (46%)	Ref.	Ref.
Washed with water only	174 (38%)	145 (37%)	141 (46%)	1.04 (0.88, 1.24)	0.86 (0.73, 1.01)
Washed with water and soap	15 (3%)	6 (2%)	11 (4%)	2.17 (0.86, 5.49)	0.84 (0.4, 1.78)
Couldn't observe	30 (7%)	30 (8%)	14 (5%)	N/A	N/A
Water and soap observed at handwashing place	(<i>n</i> = 705)	(<i>n</i> = 207)	(<i>n</i> = 344)		
Did not wash	382 (54%)	117 (57%)	204 (59%)	Ref.	Ref.
Washed with water only	244 (35%)	73 (35%)	100 (29%)	1.01 (0.83, 1.25)	1.18 (0.98, 1.43)
Washed with water and soap	20 (3%)	4 (2%)	4 (1%)	1.5 (0.52, 4.32)	2.59 (0.9, 7.47)
Couldn't observe	59 (8%)	13 (6%)	36 (11%)	N/A	N/A

VBC, Vaccine-and-behaviour-change arm; V, Vaccine-only arm.

For chi-square test of independence for association between prevalence of handwashing behaviours and study arms.

†For outcome in the row *vs.* no handwashing.

‡Other events included before handling child >2 years, bathing, after eating and other non-pathogen transmission events.

§Other faecal contact events included after removing child faeces, and after cleaning the child's anus.

with water would be reduced to 6.9%, and prevalence of handwashing with soap would be reduced to 2.1%. Nonetheless, given the discrepancies between availability of water and soap at the handwashing place and observed handwashing behaviours, the results of this study suggest that structured observation should be considered for measurement of handwashing behaviours in addition to proxy measures, such as rapid observations, albeit the time-consuming and labour-intensive nature of the observation [41].

At toileting events, the prevalence of no handwashing was similar between study arms, but the VBC arm had higher prevalence of handwashing with water and soap and lower prevalence of handwashing with water only than the other study arms. In other words, the intervention apparently shifted handwashing with water only to handwashing with water and soap, but did not reduce the prevalence of no handwashing. The effect of shifting handwashing with water to handwashing with water and soap appeared to be absent at food preparation, respiratory fluid contact and breastfeeding events. The shifting effect at toileting events should be interpreted with care, as there could be reactivity during the observation process [42], and the differences in prevalence of handwashing with water and soap between study arms could be lower if the participants were not observed.

The handwashing adherence rate in our study was lower than in the WASH Benefits Bangladesh cluster randomised trial that enrolled pregnant women in Bangladesh and promoted handwashing for >2 years afterwards [43,44]. However, the WASH Benefits Bangladesh was an efficacy study where community health workers averaged six visits per month to the participants in the intervention households, and each intervention household received two handwashing stations and a regular supply of detergent sachets for making soapy water. The ICVB Study was an effectiveness study where community health workers made monthly visits to compounds, and households in the same compound received a shared handwashing station with no re-supply of detergent sachets. A low level of adherence to handwashing was detected in the WASH Benefits Kenya cluster randomised trial, also an efficacy study, but WASH Benefits Kenya targeted compounds instead of individual households, where community health promoters provided compounds with two handwashing stations each, made monthly follow-up visits, and refilled handwashing soap every 3 months [45].

This study has limitations. Firstly, we conducted structured observation only in one session per selected household over a limited time period, so as mentioned earlier the observed prevalence of handwashing in the study might not represent the observable prevalence during the earlier

months of the follow-up period. Secondly, the Mirpur area had high rates of migration that may have adversely affected uptake. Thirdly, the small number of structured observations could have introduced a Type 2 error due to low statistical power, especially as some of the observations (handwashing behaviour before breastfeeding, handwashing after respiratory fluid contact) were rare. Fourthly, structured observations did not include details on the handwashing location; thus, it was not possible to determine whether the higher prevalence of handwashing after defecation and faecal contact in VBC arm compared to other study arms was due to the use of soapy water at the provided handwashing stations. Lastly, the proportion of unobserved handwashing behaviours during structured observations was high and differed across study arms (38% in VAC arm, 50% in V arm, 46% in Control arm). VBC arm households received handwashing stations in a public place, and so we were able to publicly observe handwashing behaviour of people who may be washing hands in the latrine where we could not observe them, and thus, the proportions of non-observation in VBC arm were lower than in V and Control arms. The characteristics of participating households (i.e. proxy for underlying behavioural determinants) were similar in all study arms, and data collectors adhered to the same protocol during structured observation, thus any potential bias would likely have pulled the PR towards the null and not affected the validity of the findings.

A large-scale handwashing promotion programme in Dhaka, Bangladesh, showed that some households which received a behaviour change intervention were willing to purchase detergent and share the responsibility in maintaining handwashing station with soapy water, and the use of soap when asked to demonstrate handwashing showed that household residents knew how to wash hands properly. However, the prevalence of observed handwashing with water and soap was low in all study arms. Future programmes should consider addressing other physical and psychosocial drivers of handwashing in addition to the use of soapy water and motivational follow-up visits in order to further increase handwashing with water and soap at pathogen transmission events.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Percent of households with water and soap present at the house's primary handwashing place (excluding soapy water), by study arms and time since the start, ICVB Study, Dhaka, Bangladesh, 2012–13.

Table S1. Association between study arms and study outcomes, stratified by socioeconomic status tertile and speaking Bengali at home, with and without adjustment for time (number of months following start of intervention)*.

Table S2. Attributes of the participating households with structured observations and without structured observations (excluding 750 households in the Buffer zone).

Table S3. Characteristics of VBC (Vaccine-and-behavior-change) arm households in neighborhoods (clusters) with lower prevalence of water and soap at handwashing place ($\leq 44.4\%$), and VBC arm households in neighborhoods (clusters) with higher prevalence of water and soap at handwashing place ($> 44.4\%$) ($n = 4265$).

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Appendix 2: Data collection tools used in the study

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Appendix 2.1: Data collection tool used for collecting data for research objective 1

Measuring siphon water filter's sustained use and study motivators and barriers to sustained use in the medium term (up to six months)

Questionnaire:

ID1. Survey Number at parent study []

ID2. Was this (1) original HH/ (2) Neighbour HH

ID3. Camp ID:

ID4: Address:

ID5. Interviewer's name: _____

ID6: Date of interview (dd/mm/yyyy): _____

Section-0: Identification of participant

Q101. Did anyone from ICDDR, B ever talk with you or any of you family members regarding some of the water purifying products?

1. Yes
2. No
3. Don't know

Interviewer tells the respondent: According to our record, your household received free/ bought a filter from the ICDDR, B team about three months ago.

Q101a. Are you/ any of your family members are aware of this filter?

1. Yes
2. No (probe further or ask some other household members to confirm this issue)
3. Don't know (probe further or ask some other household members to confirm this issue)

Q101b. Before buying/getting this filter how many times an ICDDR, B staff visited you to talk with you about various water purifying products and issues related to water and health?

1. Never visited before buying the filter
2. Visited only once about a long time ago before buying this filter
3. Visited for several times before buying the filter
4. Cannot remember

Q101c. Did they give you the water purifying products to use at free of cost for several months before buying this filter?

1. Yes
2. No
3. Don't know

Section 1: Background Information

Q102. Name of the respondent? -----

Q102a. Are you the same respondent with whom the ICDDR, B staffs talked during previous visit(s)?

1. Yes (skips to 107a)
2. No

Q102c. What is your relationship with the youngest child at home?

1. Mother
2. Father
3. Grandfather/Grandmother
4. Aunt
7. Other

Q103. Ethnic background of the respondent

1. Bengali [Skip to question 103]
2. Bihari
7. Others (specify)

Q.103a. In case of non-Bengali respondents, what is the language predominantly spoken at home?

1. Bengali only
2. Urdu and Bengali
3. Urdu only

Q104. Sex of the respondent (Record by observation)

1. Male
2. Female

Q105. Your age in years? In full Years [-----]

Q106. Your marital status? []

1. Married
2. Divorced/Separated
3. Widow(er)
4. Never married

Q107a. Level of education of mother of the youngest child

1. Cannot read and write
2. No schooling but can read and write
3. Has not completed primary school
4. Completed primary school
5. Some secondary school
6. Completed High School
7. Some college /university
8. Don't know

Q107b. Level of Education of father of the youngest child

1. Cannot read and write
2. No schooling but can read and write
3. Has not completed primary school
4. Completed primary school
5. Some secondary school
6. Completed High School
7. Some college /university
8. Don't know

Q108: How many persons dine in your house every day? [-----]

Q109. How many children less than five years old live in your household?

a. Male.....

--	--

b. Female.....

--	--

Q110. What kind of toilet facility does the household have?

1. Flush toilet
2. Water sealed slab
3. Slab latrine
4. Open latrine
7. Others -----

Q111. How many of the following does your household/family own? (Write 1 for 'Yes' and 2 for 'No')

- ☐ (A) Bicycle
- ☐ (B) Electricity
- ☐ (C) Radio/Cassette Player/CD player
- ☐ (D) Television/VCD
- ☐ (E) Motor Cycle
- ☐ (F) Mobile Phone

Q112: What is the main source of income for the household?

1. Formal employment
2. Self employed/own business
3. Casual/contract job
4. Remittance
5. Domestic work
6. Pension
7. Agricultural income
8. Day Laborer / Rickshaw puller
77. Others-----

Q113. For the purpose of our research, would you please tell us your total monthly household income? - please sum up your income from all sources like, wage, rent, agriculture etc.

- a. UP TO 4000 Taka
- b. 4001-6000 Taka
- c. 6001- 8000 Taka
- d. 8001- 10000 Taka
- e. 10001- 12000 Taka
- f. 12001- 15000 Taka
- g. 15001-20000 Taka
- h. 20001- 25000 Taka
- i. 25001- 30000 Taka
- j. Above 30000 Taka

Section 2: Household Hygiene Knowledge And Behaviours

Q201a. Is there soap for washing hands in this house?

1. Yes
2. No [Go to question 202]
9. Don't Know [Go to question 202]

Q201b. Can you show me the type of soap you use for hand-washing?

1. Yes [Respondent shown soap]
2. No (Cannot find soap, Soap is missing, Admitted no soap, No)

Q202. How does your household dispose of most of its rubbish? (observation)

1. Throw in a specified place
2. Throw in any vacant lots
3. Throw in drains/ lakes/streams
7. Other (specify)

Q203. When do you wash your hands with water only? (This is an open-ended question)(Please do not remind the respondent about the answers)

After filling up answer of this open-ended question, check appropriate code to the boxes below

[Yes]...1, No]...2

- | | |
|--|--------------------------|
| a. Before preparing food | ☐ |
| b. Before eating | ☐ |
| c. After eating | ☐ |
| d. Before feeding a child | ☐ |
| e. After cleaning child's anus | ☐ |
| f. After disposal of child feces: | ☐ |
| g. After defecation | ☐ |
| h. After handling cow-dung | ☐ |
| i. After returning from outside compound:..... | ☐ |
| j. Never | ☐ |
| k. Others (Specify) | ☐ |

Q203a. When do you wash your hands with soap? (This is an open-ended question)(Please do not remind the respondent about the answers)

After filling up answer of this open-ended question, check appropriate code to the boxes below

[Yes]...1, No]...2

- | | |
|--|--------------------------|
| a. Before preparing food | ☐ |
| b. Before eating | ☐ |
| c. After eating | ☐ |
| d. Before feeding a child | ☐ |
| e. After cleaning child's anus | ☐ |
| f. After disposal of child feces: | ☐ |
| g. After defecation | ☐ |
| h. After handling cow-dung | ☐ |
| i. After returning from outside compound:..... | ☐ |
| j. Never | ☐ |
| k. Others (Specify) | ☐ |

Q206. Did any children of your household had diarrhea within last two weeks?

1. Yes
2. No
3. Don't know

Section 3. Water Collection and Storage

Q301. What is the main source of drinking water for the people in your household during the current season? DO NOT READ RESULTS.

- a. Piped water directly from public tap
- b. reservoir where piped water is accumulated
- c. Water vendor
- d. underground water
- e. protected well

7. Other (Specify) -----

Q301a. Does other household in the courtyard share the same source for their drinking water?

1. Yes
2. No

Q302. Do you think the water from this current source is safe to drink without doing anything else to it?

1. Yes
2. No [Go to question 303]
8. Refuse to answer
9. Don't Know

Q302a. Do you think it remains safe to drink throughout the year?

1. Yes
2. No

Q302b. Which time of the year do you think the water from this source become unsafe to drink?

1. Summer
2. Monsoon
3. Winter
7. Other

Q302c. Do you treat your water before your child get to drink it?

1. Yes
2. No [Go to question 303]
9. Don't Know [Go to question 303]

Q302d What do you do to make your **child's** drinking water safe? (Do not read. Multiple responses possible. Probe for answers. Indicate 1=NAMED; 2=NOT NAMED.)

- [-----]a. Boiling
- [-----]b. Using CrystalPur filter (skips to Q303)
- [-----]c. Sedimentation
- [-----]d. Aluminum sulphate (fitkiri)
- [-----]e. Chlorine tablets
- [-----]f. Chlorine powder
- [-----]g. pur
- [-----]h. Sieving/filtering water using cloth before drinking
- [-----]i. Solar disinfection
- [-----]j. Other [specify]: -----

Q302e. How frequently do you treat your drinking water?

- 1. Every time we collect water/always
- 2. Most of the time when we collect water
- 3. Occasionally/sometimes
- 4. Only during dry season/summer
- 5. Only during rainy season
- 6. Never
- 7. Other (SPECIFY) _____
- 9. Don't know

Q302f. Is the drinking water stored in your household today treated by any means?

- a. Yes, all of it
- b. Yes, some of it
- c. No
- d. No water in the house
- 9. Don't know

Q303. On average, how many trips do you or other household members make to collect drinking water in a typical day? _____ times

Q304a. For how many people in your household generally drinking water is collected? _____

Q304b. How many other people other than your household came to your household in last two days to drink water from your stored water? _____

Section 4: Current Filter Usage

Q401. Do you have the CrystalPur filter at home that you bought about three/six months ago from an ICDDR, B field staff?

1. Yes
2. No (Skip Q403, Q404a to Q404e)

Q402. Did you ever use it within last three/six months?

1. Yes
2. No (skips to Q418)

Q402a. To what extent do you agree that you knew about how to use the filter?

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q403. Is the drinking water stored in your household today treated with Filter?

1. Yes, all of it
2. Yes, some of it
3. No
4. No water in the house
9. Don't know

Q404. When was the last time you or another household member used Filter?

- 1 Today (skips to 406)
- 2 Yesterday (skips to 406)
- 3 In the past seven days
- 4 One week ago
- 5 Two weeks ago
- 6 Last month
- 7 The first week we bought the product
77. Others (specify)_____

To what extent do you agree with the following statements?

Q404a. Using the water filter makes me feel 'I am a person who takes good care of her children'

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q404b. Using the water filter makes me feel 'I am a modern person who does not drink untreated water'

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q404c. Using the water filter makes me feel 'I am treating water like a rich person'

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q404d. Using the water filter makes me feel 'I am setting a good example for my community so that they also follow me in treating their drinking water'

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q404e. Using the water filter makes me feel ‘I am improving my health’

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q405. Why didn't you use the filter after that?

1. Filter was broken
2. Filter was clogged
3. Filter was lost
4. Did not like filter treated water
5. Too complicated to use the product: specify_____
6. It was additional task to treat water with filter
7. Other: specify_____

Q406. How often does your household treat your drinking water with filter? |_____|

- 1) Every time we collect water/always
- 2) Most of the time when we collect water
- 3) Occasionally/sometimes
- 4) Only during dry season/summer
- 5) Only during rainy season
- 6) Never
- 7) OTHER (SPECIFY)_____
- 9) DON'T KNOW

Q407: What did you like best about using Filter? [DO NOT READ; INDICATE 1=NAMED; 2=NOT NAMED].

- |_____|(a) Filter was easy to use
- |_____|(b) Using Filter made my water safe to drink
- |_____|(c) Using Filter reduced diarrhea (OR other diseases)
- |_____|(d) Filter improved my family's / childrens' health
- |_____|(e) Filter improved the taste of water
- |_____|(f) Water looks better / clear / clean
- |_____|(g) OTHER (Specify) : _____

Q408. What were the biggest obstacles to use the **Filter** every time water was collected? DO NOT READ. INDICATE 1=NAMED; 2=NOT NAMED.

☐ (a) Too much time to use Filter every time water was collected

☐ (b) Had to wait for long after using Filter to have safe water

☐ (c) Didn't like taste of the treated water

☐ (d) Didn't like smell of the treated water

☐ (e) Didn't notice any changes in health of family

☐ (f) Family's health deteriorated

☐ (g) Didn't notice any changes in child's health

☐ (h) Child's health deteriorated

☐ (i) Don't believe that Filter will work

☐ (j) Don't believe that I could use Filter properly

☐ (k) Filter was broken

☐ (l) Filter was lost

☐ (n) Water still looked dirty

☐ (o) Filter was clogged

☐ (p) Saving product for special occasions

☐ (q) OTHER (Specify): _____

ENUMERATOR SAY: *In the next few questions I am interested in hearing about your experience with **filter**. Please tell me if you "agree" or "disagree". NOTE: Interviewer to probe if they "agree strongly" or "agree somewhat", and if they "disagree strongly" or "disagree somewhat".*

Q409. Using the filter to clean drinking water makes the water taste bad.

1. Strongly agree

2. Agree somewhat

3. Neither agree nor disagree

4. Disagree somewhat

5. Strongly disagree

Q410. Using the filter to clean drinking water makes the water smell bad

1. Strongly agree

2. Agree somewhat

3. Neither agree nor disagree

4. Disagree somewhat

5. Strongly disagree

Q411. Using the filter to treat water is an effective way of preventing diarrhea.

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q412. Using the filter every time water is collected is too much work.

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q413. It takes too long time to get clean water when using a the filter

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q414. Using the 'filter' is easy.

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q415. How happy are you that you have purchased/received the filter?

1. very happy
2. somewhat happy
3. neither happy nor unhappy
4. somewhat unhappy/
5. very unhappy/

Q416. I am proud that I own a water filter that I use to treat my drinking water.

1. Strongly agree
2. Agree somewhat
3. Neither agree nor disagree
4. Disagree somewhat
5. Strongly disagree

Q417. Have you mentioned about your use of filter to others?

1. yes
2. no
3. I did not think about mentioning it to other
4. unwilling to answer

Q418. How satisfied are you in using the filter

1. very satisfied
2. somewhat satisfied
3. neither satisfied nor unsatisfied
4. somewhat dissatisfied
5. very unsatisfied

Q419: What else should we know about your experience with your safe water product?

.....

Q420. Can you show me the filter? (observation)

1. Currently using
2. Upper pot wet, both pots have water
3. Lower pot wet, both pots have water
4. Other signs of using the filter (specify)_____
5. There is no filter
6. Dry or dusty
7. Broken ceramic
8. Pipe is broken
9. Pumper is broken
10. Nozzle is broken
11. Other indications of not using (specify)_____

Section-5: Willingness to purchase a new filter (applicable for people whose filter was broken/lost):

Q501. Given that you have lost or broken your water filter, would you be interested to buy a new filter today?

1. Yes
2. No
3. Have to consult with household members[add a follow-up asking if the respondent wanted you to come back at a certain time after. DONOT CONTINUE WTP QUESTION]
4. Other _____

If yes,

For you to buy a filter TODAY, we have now set a price which is drawn from a list of prices in the range between 50 Taka - 250Taka. The price that is pre-drawn for you is written in this sealed envelope [show the envelope]. If your stated price exceeds the price we have drawn [show envelope], then you will get to buy the filter at our price. This means you will get the filter at a price lower than what you actually wanted to pay. If however, your stated price is equal or less than the price we have drawn [show envelope], you will miss the opportunity to buy the filter today. So for you the best approach is to say a price that you actually wanted to pay.

Q502. One filter will last on average one year(?), if you regularly use it to treat drinking water, _how much money at most you would be willing to pay for a filter here today?

_____ taka

If no money at home: TO ADDRESS THE LIQUIDITY CONSTRAINT

Had you been given an opportunity to buy a filter in credit today, would you then be interested to buy?

1. yes
2. No

Q502. Did the respondent purchase the filter from our FRA?

1. yes
2. No
3. wanted to buy on credit
7. Other _____

Q503. If wanted to buy on credit, did the respondent finally purchased the product?

1. Yes
2. No

Section-6: Water sample collection for H₂S test

Q601. Ask & observe how drinking water is stored? ☐ ☐

- a. Bucket . 1.....
- b. Drum .2
- c. Kalashi . 3
- d. Hari .4
- e. Matka . 5
- f. Bottle . 6
- g. Jerry can7
- h. Jug8
- i. Mini water tank.....9
- j. Other wide-mouthed container 10
- k. Other narrow-mouthed container 11
- l. No water stored 12
- m. Refused to say & show 98

Skip Note: If 6 is 12 skips to next section. If 98 skips question 602

Q602. Observe stored water's covering status ☐

- a. Completely uncovered 1
- b. Partially covered 2
- c. Completely covered 3

Q603. Ask to give a glass of water like they give their child to drink.

(Observe water handling behavior; from your asking to getting water check the following questions.

Yes = 1, No = 2)

- a. Glass/container washed before water obtained? ☐
- b. Hands washed before water obtained? ☐
- c. Hands washed with soap before water obtained? ☐
- d. Hands came into contact with water? ☐
- e. Glass dipped into water? ☐
- f. Ladle used to obtain water? ☐
- g. Water poured from container? ☐
- h. Other (Specify) ☐

Q604. Did you treat your drinking water with filter? ☐

Yes 1

No 2

Skip Note: If 604 is 2, skip question Q605

Q605. How long ago did you treat this water with POU product: _____:_____ (h:m)

Q606. Time of collection of water sample: _____:_____ (h:m)

SECTION 8: Interviewer's Discreet Observations

(ENUMERATOR: Before leaving THE HOME take note of the following. Please answer the following questions DISCREETLY. Do not ask the respondent to answer these questions. Simply note your observations.)

Q801: Is the respondent wearing shoes or slippers?

1. Shoes
2. Slippers
3. None

Q802: Condition of the clothing?

1. No holes/tears
2. A few holes/tears
3. Many holes/tears

Q803: Cleanliness of the face/hands?

1. Clean
2. A bit dirty
3. Very dirty

Q804: Are there animal/child feces visible in the compound (other than in a designated pile)?

1. Yes
2. No

Enumerator's signature _____

Appendix 2.2: Questionnaires used to collect data for objective 2-4

Appendix 2.2.1: ICVB Baseline Census Questionnaire

Household visiting status

Household ID:

GIS ID:

Ward number:

Area/Para/Bosti name:

Sec/Block:

House:

Road:

3. The household belongs to highrisk group. 1=yes 2=No

4. Information on this project was given to respondent. 1=Yes 2=No

5. Verbal consent was taken to participate in the interview. 1=Yes 2=No

6. Visit status :

1. Continued

2. Refused

3. Absent

4. Not eligible

5. Other

7. Respondent's name:

8. Family size:

9. Permanent Address:

District name:

Upazila/Thana name:

Village/Area name:

10. Contact phone number:

Respondent:

Head:

Other member:

Neighbour:

Social, Economic & Health related characteristics of the household

[Respondent: Household head or adult household member]

1. Religion:

1= Muslim

2= Hindu

3= Christian

4= Buddhist

5= Others

2. How many months have you been living here?

(<1 month will be taken as 1 month)

3. Type of Household ownerships?

1= Own;

a) Monthly rent: Tk_____ b) Don't know

2= Rented

a) Monthly rent: Tk_____ b) Don't know

3= Supplied by employer

1- Number of rooms (excluding Kitchen):

2- Do your HH share the kitchen?: 1=Yes, 2=No

3- Do your HH share the toilet?: 1=Yes, 2=No

4- Type of adult toilet:

1= Sanitary with flush

2= Sanitary without flush

3= Non sanitary (without water seal)

4= Use open space

7. Type of children toilet:

1= Sanitary with flush

2= Sanitary without flush

3= Non sanitary (without water seal)

4= Use open space

5=Use plastic/cane pot

8=No <5 yrs child in the HH

8. Source of the following water:

Drinking:

Washing:

Bathing:

1= Own tap, 2=Own well, 3=Own hand pump, 4= Communal tap , 5= Communal well,

6= Communal hand pump, 7= Bottled water, 8= Water vendor, 9= Stored in reservoir,

10=Pond/canal/river, 77=Others

4. Distance of the source of drinking water (In feet.):

5. Type of drinking water:

1= Boiled

2= Filtered

3= Chemicals treated

4= Not treated 9= Don't know

6. Type of utensils cleaning water:

1= Boiled

2= Filtered

3= Chemicals treated

4= Not treated 9= Don't know

7. Place of waste disposal:

1= Fixed place

2= Indiscriminate

8. Monthly average HH expenditure:

Don't know

1. Residential (rent, repair etc): ☐

2. Fooding : ☐

3. Clothing: ☐

4. Transport: ☐

5. Education: ☐

6. Others: ☐

7. Total cost: ☐

9. Average monthly savings:

☐

10. Do you know about Cholera vaccine (CV)?

1=yes

2=No

11. Will your family take CV if it is given free?

1=yes

2=No

Observation by the Interviewer

12. Construction materials of the main building:

Roof:

Wall:

Floor:

1=Mud/Kacha, 2=Patkathi/Chhon, 3=Bamboo, 4=Wood , 5=Tin, 6= Brick/Cement, 7=Others

13. Is there water filter in the household?

1- Yes

2- No

14. Is there any water in filter device?

1- Yes

2- No

3- Refused

15. Is there any water treatment chemical in the household?

1- Yes

2- No

3- Refused

16. Is hand washing water available at the visiting time?

1- Yes

2- No

3- Refused

17. Is hand washing soap available at the visiting time?

1- Yes

2- No

3- Refused

18. Observe the type of latrine of HH:

1= Sanitary with flush

2= Sanitary without flush

3= Non sanitary

4= Use open space

MEMBER LIST

Household:

Member SL.:

Sex:

1-Male

2-Female

Date of birth:

Relationship with head:

Codes for Relationship with Household Head-

1-Household head

2-Spouse of head

3-Son/daughter

4-Son/daughter-in-law

5-Brother/sister

6-Brother/sister-in-law

7-Father/mother

8-Father/mother-in-law

9-Grand son/grand daughter

10-Other relation

11-Helping hand

12-No relation

Mother's SL.:

Father's SL.:

Education:**Codes for Education Level -**

- 1-Class 1 passed
- 2-Class 2 passed
- 3-Class 3 passed
- 4-Class 4 passed
- 5-Class 5 passed
- 6-Class 6 passed
- 7-Class 7 passed
- 8-Class 8 passed
- 9-Class 9 passed
- 10-SSC passed
- 12-HSC passed
- 14-BA/BCOM/BSc passed
- 16-Hons/MBBS/BSc Eng passed
- 17-MA/MSc/MCOM/MS/MD/FCPS passed
- 77-No formal education
- 88-No education

Occupation:**Codes for Occupation Status -**

- 1-Unemployed
- 2-Housewife
- 3-Beggar
- 4-Pensioners
- 5-Household helping hand
- 6-Driver
- 7-Rickshaw/van/cart puller
- 8-Daily wage earner/laborer
- 9-Farmer/fisherman
- 10-Tailor/barber/craftsman
- 11-Traders/business owner
- 12-Service
- 13-Teacher
- 14-Doctor
- 15-Engineer
- 16-Paid/unpaid apprentice
- 17-Student
- 18-Hawker
- 77-Other
- 99-Unkonwn

Marital Status:

Codes for Marital Status -

- 1-Married
- 2-Divorced
- 3-Widowed
- 4-Separated
- 5-Unmarried

Spouse SL-1:

Spouse SL-2:

Spouse SL-3:

Pregnancy status:

1-Yes

2-No

Diarrhoea within 48 hours:

1-Yes

2-No

Diarrhoea within 6 months:

1-Yes

2-No

Health care utilization:

Codes for Health seeking behavior

- 1-Home treatment
- 2-Qualified doctor
- 3-Clinic/hospital
- 4-Pharmacy
- 5-Homeopathy
- 6-Ayurvedic
- 7-Quack
- 77-Other
- 99-No treatment

Appendix 2.2.2: ICVB Census update Questionnaire

Introduction of Cholera Vaccine in Bangladesh

International Centre for Diarrhoeal Disease Research, Bangladesh

ICVB Census update Questionnaire

1. Information on this project was given to respondent. 1=Yes 2=No
2. Verbal consent is taken to participate in the interview. 1=Yes 2=No

The following events will be collected during ICVB census update

Table 1. Features of the demographic and health events

Code and event	Date of event	Info
<i>For existing members</i>		
1= No event	Date of visit (auto filling)	--
7=Death	Date of death	1=Hospital, 2=Home, 3=Away
8=Migration-out	Date of migration out	Destination of migration (ward and section number) 88=Outside
9=Internal migration-out	Date of internal migration-out	--
10=Resident's whereabouts could not be traced in current census	Date of entry of the member (auto filling)	--
11=Change of marital status	Date of change in the marital status	New marital status
14=Pregnancy status	Yes=1 No=2 Not sure=3	For 2 or 3 LMP
12=Change of relationship to the household head	Date of death/migration-out of the former head	New relationship to head
13=Diarrhea in last 48 hours	Date of onset of diarrhea	--

Code and event	Date of event	Info
<i>For new entrants</i>		
2=Birth	Data of birth	--
3=Migration-in	Date of migration-in	Origin of migration (codes are same as “destination of migration” given above)
4=Internal migration-in	Date of internal migration-in	--
5=Remigration	If a migrated-out individual came back to the study area: date of remigration is the date of event	--
6=Residents who were missed to register in previous census	For a new member in an existing household: Date of entry of the household (auto filling) For a new household: date of last census visit in the area (auto filling)	--

Note, the internal migrations will done through computer search as described in the text

Appendix 2.2.3: Disease Surveillance Questionnaire

Introduction of Cholera Vaccine in Bangladesh

International Centre for Diarrhoeal Disease Research, Bangladesh

Disease Surveillance Questionnaire

Health Facilities for Disease Surveillance Sl. No.	Hospital Name
1	Shishu Hospital
2.	Sarwardy Hospital
3.	Mohakhali Cholera Hospital
4.	Mirpur Treatment Centre
5.	Kalshi Shisu Hospital
6.	Adhunic Hospital Mirpur
7.	Shishu Hospital Mirpur-2
8.	Radda Barnen (Mirpur-10)
9.	UJMC (Ibrahimpur)
10.	The Marks ENT clinic and General Hospital
11.	Waida Hospital (Ibrahimpur)
12.	Al-Helal Hospital

Introduction of Cholera Vaccine in Bangladesh (ICVB), 2011-13
Assessment of uptake of handwashing and Point of use water treatment intervention
International Centre for Diarrhoeal Diseases Research, Bangladesh

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Section-A: Identification		
ID001a	আর্ম ID (Arm ID) Instruction for the PDA programmers: If arm 1, 3 and 4 then show the spillover assessment questionnaire otherwise will not/if arm 2 skip all spillover assessment questionnaire	1. Vaccine only arm 2. Vaccine plus behavior change arm 3. Control arm 4. Buffer zones
FRA-র জন্য নির্দেশনা: প্রথমে চিহ্নিত করার চেষ্টা করুন এটা আমাদের তালিকাভুক্ত বাড়ি কি না? উত্তর দাতাকে নীচের প্রশ্নটি করুন: (Instruction for the FRA: First try to identify if this is our enlisted household or not. Ask the respondent the following question :) NID 1. কলেরা হাসপাতালের লোকদের আপনাকে/আপনার পরিবারের কোন সদস্যকে দেয়া কার্ড টি আমাকে দেখাবেন? Can you show me the card given to you/to any of your family member by Cholera hospital people? 1. হ্যাঁ (Yes) 2. না (No) ID 001b, 002a এবং 003a-এর তথ্য গুলো কার্ড থেকে লিখুন। যদি কার্ড দেখাতে ব্যর্থ হয়, ID 001b, 002a এবং 003a-তে '999' লিখুন। (Please record information in ID 001b, 002a and 003a from the card. If the person is unable to show a card, write '999' in ID 001b, 002a and ID 003a.)(If migrated then ID 003 would be 333)(যদি মাইগ্রেশন হয় তাহলে আইডি ০০৩ টা ৩৩৩ হবে)		
ID001b	ক্লাস্টার ID (Cluster ID- as shown in the respondent's ID card/members ID card)	
ID001	Cluster ID (as shown in the PDA)	
ID002a	খানা ID (Household ID- as shown in the respondent's ID card /members ID card)	
ID002	Household ID (as shown in the PDA)	
ID003a	উত্তরদাতার ID (Individual ID-as shown in the respondent's ID card)	
ID003	Individual ID-as shown in the PDA	
ID004	খানা প্রধানের নাম (Name of household head)	
ID005	খানার ঠিকানা (বিস্তারিত ঠিকানা) [Household address (detailed)]	
ID006	তথ্য সংগ্রহকারীর নাম (Interviewer name)	
ID007	তথ্য সংগ্রহকারীর ক্রমিক নং (Interviewer Number)	
ID008	তথ্য সংগ্রহের তারিখ (দিন/মাস/বছর) (Date)	

ID003a যদি 999 হয় তাহলে 101a প্রশ্নটি করুন। এফআর এর জন্য নির্দেশনা: Instruction to the FRA's:		
101a. উত্তরদাতা কার্ড দেখাতে না পারলে তাকে জিজ্ঞেস করুন If the person unable to show the id card, please ask him/her: কার্ড দেখাতে না পারার কারণ কি? What are the reasons of not being able to show the card? a) কখনই কার্ড ছিল না Never have the card b) কার্ড ছিল হাড়িয়ে গেছে Has lost the card. c) কার্ড আছে কিন্তু সেই মুহুর্তে দেখানো সম্ভব হয়নি Has the card, but unable to show. d) অন্যান্য Other _____. 101a এর উত্তর যদি b, c অথবা d হয় তাহলে 101b নং প্রশ্ন জিজ্ঞেস করুন If the response is either b, c or d, then ask: 101b. আপনি কি কলেরার টিকা খেয়েছেন? Have you taken Cholera vaccine orally? (এফআর এর জন্য নির্দেশনা: উত্তরদাতাকে কলেরার টিকা বিষয়টি তাদের স্থানীয় ভাষায় বুঝিয়ে বলুন Instruction to FRAs: please make them understand what is meant by the cholera vaccine according to their local understanding) a) হ্যাঁ Yes b) না No c) জানিনা Not sure/Don't know		
Section-B: Demographic information FRA: আমি আপনার এবং এই বাড়িতে বসবাসকারী লোকদের কিছু তথ্য সংগ্রহের মাধ্যমে শুরু করতে চাই। FRA: I would like to begin by collecting a bit of information on you and the people that live in this household.		
101	উত্তরদাতার নাম (Name of the respondent)	
102	বাড়ীতে প্রধানত কোন ভাষায় কথা বলেন? (Primary language spoken in the home)	1. শুধুমাত্র বাংলা (Bengali only) 2. উর্দু এবং বাংলা (Urdu and Bengali) 3. শুধুমাত্র উর্দু (Urdu only) 7. অন্যান্য (নির্দিষ্ট করুন) [Other (specify)]: _____
103	প্রধান উত্তরদাতার লিঙ্গ (পর্যবেক্ষণ করে লিখতে হবে) [Sex of the respondent (record by observation)]	1. পুরুষ (Male) 2. মহিলা (Female)
104	আপনার বয়স কত? (Your age in years?)	বয়স পূর্ণ বছরে (Full Years)
105	আপনার বৈবাহিক অবস্থা (Marital status)	1. বিবাহিত (Married) 2. তালাকপ্রাপ্ত / বিবাহিত কিন্তু আলাদা থাকেন (Divorced / Separated) 3. বিধবা/বিপত্নিক [Widow(er)] 4. অবিবাহিত (Never married)
105a	আপনার পরিবারে/খানায় কতজন গর্ভবতী মহিলা আছে? How many pregnant women are in your household?	_____ জন

106	বর্তমানে কোনটি আপনার বাড়ির খাবার পানির প্রধান উৎস? (FRA-র জন্য নির্দেশনা: যে কোন একটিতে গোল চিহ্ন দিন; উত্তর যদি 3 অথবা 4 হয় সঠিক উত্তর যাচাই করে লিখুন) (অপশন ২ বাদে সাবভিশনগুলির ক্ষেত্রে একাধিক উত্তর গ্রহণযোগ্য) (At present which of these is the principal source of drinking water for your household? (Instruction for the FRA: Circle only one option; if the options are either 3 or 4, investigate further to ensure the correct response))(Multiple answer allowed for the subdivision accept option 2)	1. বসত বাড়িতে ব্যবহারের জন্য নির্দিষ্ট মিউনিসিপ্যাল লাইন (Municipal supply for individual household level use) 2. বাড়ির বাহিরের সম্মিলিত ট্যাপ/হ্যান্ড পাম্প/ মিউনিসিপ্যাল লাইন Common tap/hand pump (Municipal supply) outside the house.....a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound 3. টিউবওয়েলের পানি (Shallow Tube well water) a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound C. শুধু এই পরিবারের জন্য/ সন্মিলিত নয় individual level use/not shared 4. গভীর নলকূপ/বোরিং-এর পানি (deep tubewell/Boring water) a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound C. শুধু এই পরিবারের জন্য/ সন্মিলিত নয় individual level use/not shared 5. পানি বাহক দ্বারা সরবরাহকৃত(বালতি) [Supplied by water bearer (in buckets/barrels)] 6. কুয়া (Well).....a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound C. শুধু এই পরিবারের জন্য/ সন্মিলিত নয় individual level use/not shared 7. বোতলজাত পানি (Bottled water) 8. রিজার্ভারে সংরক্ষিত মিউনিসিপ্যাল লাইনের পানি Municipality water storage in reservoir (Both for underground cistern or overhead tank)a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound C. শুধু এই পরিবারের জন্য/ সন্মিলিত নয় individual level use/not shared 77:অন্যান্য (নির্দিষ্ট করুন)Other (specify)a. কম্পাউন্ডের ভিতরে সন্মিলিত shared within the compound b. কম্পাউন্ডের বাইরে সন্মিলিত shared outside the compound C. শুধু এই পরিবারের জন্য/ সন্মিলিত নয় individual level use/not shared	
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106a.(applicable for if 106 is 1/2/8)		যদি মিউনিসিপ্যাল এর সরবরাহকৃত পানি ব্যবহার করেন, দিনে কত ঘন্টা পানি থাকে? If you use municipal water supply, how many hours a day do you have water?	a) ১ ঘন্টার ও কম less than 1 hour b) ১-৫ ঘন্টা 1-5 hours c) ৫-১০ ঘন্টা 5-10 hours d) ১০-১৫ ঘন্টা 10-15 hours e) ১৫-২০ ঘন্টা 15-20 hours f) সবসময় পানি থাকে It is available all the time	
106b.(applicable for if 106 is 1/2/8)		যদি মিউনিসিপ্যাল এর সরবরাহকৃত পানি ব্যবহার করেন, পানি চলে যাওয়ার আগে দিনে কত কলসী পানি ভরে নিতে পারেন? If you use municipal water supply, how many kolshis could you fill before it runs out?(only for drinking water)	a) ৫ কলসীর ও কম less than 5 kolshis b) ৫-১০ কলসী 5-10 kolshis c) ১০-১৫ কলসী 10-15 kolshis d) ১৫-২০ কলসী 15-20 kolshis e) ২০-২৫ কলসী 20-25 kolshis f) ২৫ কলসীর বেশী More than 25 kolshis g) সবসময় পানি থাকে it is available all the time	
107		আপনি কত দিন যাবৎ এই কম্পাউন্ডে বসবাস করছেন? (For how long have you been living in this compound?)	সপ্তাহ (weeks) মাস _____(Months) বছর _____(Years)	
108SA		আপনি কি এই কম্পাউন্ডে নভেম্বরের প্রথম সপ্তাহ থেকে (২০১১) বাস করছেন? Have you been living in this compound since the first week of November 2011?	1. হ্যাঁ Yes 2. না, কার্ড আছে No with card 3. না, কার্ড নেই No without card	

Section C: হাতের পরিষ্কার-পরিচ্ছন্নতা পর্যবেক্ষণ (Observation of Hand cleanliness)

501. হাতের পরিষ্কার পরিচ্ছন্নতা [-----] (Cleanliness of the palms/fingerpads?) May I please look at your hands?

কোড সমূহ (Codes):

ময়লা স্পষ্টভাবে দেখা যাচ্ছিল (Visible dirt)1

ময়লা স্পষ্টভাবে দেখা না গেলেও অপরিচ্ছন্ন ভাব ছিল (No visible dirt but unclean appearance) 2

পরিষ্কার ছিল (Clean)..... 3

পর্যবেক্ষণ করা সম্ভব হয়নি/প্রত্যাখান (Observation was not possible/refused). 4

- a. হাতের নখ (Fingernails) ☐
- b. করতল (Palms)..... ☐
- c. আঙ্গুলের সম্মুখভাগ (Fingerpads)..... ☐

502. যদি বাসায় <5 এর বাচ্চা থাকে, অনুসন্ধান করে বাচ্চার করতল/আঙ্গুলের সম্মুখভাগ এর পরিষ্কার পরিচ্ছন্নতার অবস্থা লিখুন। যদি একের বেশী বাচ্চা থাকে, ছোট বাচ্চাটির হাত পর্যবেক্ষণ করুন। (If there is a child <5 at home, inspect and record the cleanliness of the palms/finger pads of that child. If there are more than one child, inspect the hands of the younger child.)

কোড সমূহ: (Codes:)

- ময়লা স্পষ্টভাবে দেখা যাচ্ছিল (Visible dirt) 1
- ময়লা স্পষ্টভাবে দেখা না গেলেও অপরিচ্ছন্নতা ছিল (No visible dirt but unclean appearance) 2
- পরিষ্কার ছিল (Clean)..... 3
- পর্যবেক্ষণ করা সম্ভব হয়নি/প্রত্যাখান (Observation was not possible/refused). 4
- প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)..... 8

- a. হাতের নখ (Fingernails) ☐
- b. করতল (Palms)..... ☐
- c. আঙ্গুলের সম্মুখভাগ (Fingerpads)..... ☐

Section D: Diarrhoea, respiratory disease and acute hepatitis in the household

এখন আমি আপনাকে এই বাড়িতে বসবাসকারীদের স্বাস্থ্য সম্পর্কে জিজ্ঞেস করব। আপনি কি আমাকে কার্ডটি দেখাবেন যা আপনাদের প্রত্যেক বাড়ির সদস্যকে মহাখালী কলেরা হাসপাতাল থেকে দেয়া হয়েছে? (পর্যবেক্ষণ করে **unique card ID(a2)** লিখুন। যদি কেহ কার্ড দেখাতে না পারে, ৯৯৯ লিখুন **unique card ID (a2)** পরিবর্তে)(যদি মাইগ্রেটেড হয় তাহলে **a1 333** লিখুন) আর্ম ৪ হলে কার্ড না থাকলে **a2 888** হবে। **a1-এ HHID-** এর সাথে ০০ থেকে সদস্য আইডি শুরু হবে। ২৪ ঘন্টায় তিনবার অথবা তিনের অধিকবার পাতলা পায়খানা করলে আমরা ডায়রিয়া হিসেবে বিবেচনা করব। [Now I would like to ask you about the health of the people that live in this household. Could you please show me the cards that have been given to each of your household members from Mohakhali Cholera Hospital? (Check and note the unique card IDs (a2). If someone cannot show the card, write '999' instead of the unique card ID)(a2)] [If migrated then a1 would be 333] If arm 4 and has not card then a2 will be 888. Member ID will be start from HHID+00, We will consider diarrhoea if three or more loose stool pass in 24 hours

ক্রমিক নং (Serial number)	a1. ইউনিক পিডিএ আইডি PDA ID (Unique ID in the PDA)	a2. ইউনিক কার্ড আইডি(Unique ID in the respondent's ID card)	b. নাম (Name)	c. বয়স (Age) দিন _____ (Days) মাস _____ (Months) বছর _____ (Years)	d. গত দুই দিনের মধ্যে ডায়রিয়া হয়েছিল (Diarrhoea in the last 2 days)	e. গত দুই দিনের মধ্যে জ্বর হয়েছিল (Fever in the last 2 days)	f. গত দুই দিনের মধ্যে কাশি হয়েছিল (Cough in the last 2 days)	g. গত দুই দিনের মধ্যে নাক বন্ধ বা নাক দিয়ে পানি পড়েছিল (Nasal congestion or a runny nose in the last two days)	h. গত দুই দিনের মধ্যে শ্বাসকষ্ট হয়েছিল(Breathing difficulties in the last two days)	h1. দুই দিনের মধ্যে কি কোন মারাত্মক আঘাত পেয়েছেন? (Any serious injury in the last two days)
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ক্রমিক নং (Serial number)	a1. ইউনিক পিডিএ আইডি(PDA A ID (Unique ID in the PDA)	a2. ইউনিক কার্ড আইডি(Unique ID in the responden t's ID card)	b. নাম (Name)	c. বয়স (Age) দিন _____ (Days) মাস _____ (Months) বছর _____ (Years)	i. গত দুই মাসের মধ্যে মধ্যে চোখ অথবা গায়ের চামড়া হলুদ হয়েছিল (Did you have any yellow coloratio n of eyes and skin in the last two months?) 1. Yes 2. No (skip to sec E)	j. চোখ হলুদ হয়েছিল (Did you have yellow colorati on of eyes) 1. Yes 2. No (skip to l)	k. কখন হয়েছিল (When was this) 1. In the last 2 weeks 2. 2-4 weeks 3. 5-8 weeks	l. তখন কি গায়ের চামড়া হলুদ হয়েছিল (Did you have yellow skin colorati on at that time) 1. Yes 2. No	m. সেই সময় কি জ্বর ছিল (Did you have fever at that time) 1. Yes 2. No	n. দিনের বেলাতে কি পরিবারের প্রাপ্তবয়স্ক সদস্যরা বাইরে কাজ করে কিনা Whether the member (≥17 y) work away from home during the day? 1. Yes 2. No
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Section E: Treatment, storage and handling of drinking water; treated water testing; reported drinking water practice

503. আপনি কি আমাকে দেখাতে পারেন আপনি কিভাবে খাবার পানি সংরক্ষণ করেন? (প্রশ্ন করুন এবং পর্যবেক্ষণ করুন)। (একাধিক উত্তর গ্রহণযোগ্য)

গ্রহণযোগ্য] □□

Can you please show me how you store your drinking water? (Ask & observe how drinking water is stored? (>1 response allowed))

- a. বালতি (Bucket) 1
- b. ড্রাম (Drum) 2
- c. কলস (Kalashi) 3
- d. হাড়ি (Hari) 4
- e. মটকা (Matka) 5
- f. বোটল (Bottle) 6
- g. জেরিকেন / গ্যালন (Jerry can) 7
- h. জগ (Jug) 8
- i. ছোট পানির ট্যাংক (Mini water tank) 9
- j. ক্লোরিন ডিসপেনসারসহ সংরক্ষণ পাত্র (Reservoir with chlorine dispenser) 10
- k. অন্যান্য প্রশস্ত মুখের পাত্র (Other wide-mouthed container) 11
- l. অন্যান্য সরু মুখের পাত্র (Other narrow-mouthed container) 12

- m. দুই চেম্বারবিশিষ্ট ফিল্টার (Double chambered filter).....13
- n. এই মুহুর্তে ঘরে সংরক্ষিত পানি নেই (No water stored)14
- o. বলতে এবং দেখাতে রাজি হয়নি (Refused to say & show)98
- } Skip to 508

যদি ৫০৩এর উত্তর ১৪ অথবা ৯৮ হয়, তাহলে ৫০৮ নং প্রশ্নে চলে যান
(If 503 is 14 or 98, skip to 508)

504. সংরক্ষণকৃত পানির পাত্রটি ঢেকে রাখা আছে কিনা (একাধিকপাত্র হলে বড় পাত্রটি পর্যবেক্ষণ করুন).....□

Observe stored water's covering status (if >1 storage containers, then document the status of the largest one)

1. সম্পূর্ণ খোলা (Completely uncovered)
2. আংশিক ঢাকা (Partially covered)
3. সম্পূর্ণ ঢাকা (Completely covered)

504a. পর্যবেক্ষণ করুন পানির পাত্রে সিএইচ পির দেয়া পানি মাপার কোন দাগ আছে কিনা Observe if there is any measuring mark made by CHP on the storage container?

1. হ্যাঁ (Yes)(Skips to 505)
2. না (No)
8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)_____

504b. অন্য কোন পাত্রে কি সিএইচ পি পানি মাপার জন্য দাগ দিয়ে গিয়েছে ? Is there any other container with measuring mark made by CHP?

1. হ্যাঁ (Yes)
2. না (No) (Skips to 505)
8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)_____ (skip to 505)

504c. পাত্রটি দেখাতে বলুন Ask to show the container

1. পাত্রটি দেখাতে পেরেছে Has shown the container
2. পাত্রটি দেখাতে পারেনি(Skips to 505) Could not show the container
3. পাত্রটি দেখাতে রাজী নয়(Skips to 505) Did not agree to show the container

504d. পাত্রটি দিয়ে কি করেন? What do you do with the container?

1. ক্লোরিন দ্বারা বিশুদ্ধকৃত পানি রাখে To store chlorinated water
2. ফুটানো পানি রাখে To store boiled water
3. অন্য কাজে ব্যবহার কও Use for other purpose specify----purpose Specify:_____
4. ব্যবহার করে না Does not use

505. আপনার বাড়িতে কি আজ পরিশোধিত পানি আছে? (Do you have boiled or treated drinking water at home today?)

1. হ্যাঁ (Yes)

2. না (No) [Skips to 508]
8. বলতে অস্বীকৃতি জানানো (Refused to say) [Skips to 508]
9. জানিনা (Don't know) [Skips to 508]

506. আপনি কিভাবে খাওয়ার পানি পরিশোধন করেছেন? (একাধিক উত্তর গ্রহণযোগ্য) (How did you treat this water?) (Multiple answers allowed)

1. হ্যাঁলোট্যাব ব্যবহার করে (Used halotab) (skip to 508)
2. ওয়াটারগার্ড ব্যবহার করে (Used waterguard) (skip to 508)
3. ক্লোরিন ডিসপেনসার ব্যবহার করে (Used Chlorine dispenser) (skip to 508)
4. ফিল্টার ব্যবহার করে (Used filter) (skip to 508)
5. পানি ফুটিয়ে (Boiled water)
6. ফিটকিরি ব্যবহার করে (Used fitkiri) (skip to 508)
7. পানি পরিশোধন করে না (Do not treat water) (skip to 508)
77. অন্যান্য (Other) (skip to 508)

507. যদি বলে 'পানি ফুটিয়ে', জিজ্ঞেস করুন: গত দুই দিনে কতবার আপনি পানি ফুটিয়েছেন? (If the person reports about boiling, ask: How many times within last 2 days you boiled your water? _____ times)

508. আপনি যেভাবে আপনার বাচ্চাকে খাওয়ার পানি দেন অনুগ্রহ পূর্বক আমাকে সেভাবে এক গ্লাস খাবার পানি দিন

(পানি আনার সময় লক্ষ্য করুন এবং নীচের প্রশ্নগুলো চেক করুন এবং যথাযথ কোড বসান। হ্যাঁ = 1 এবং না = 0 বসান)

[Ask to give a glass of water like they give their child to drink. (Can you please give me a glass of water like you would give to your child to drink?)

(Observe water handling behavior from your asking to getting water and check following questions.

Yes = 1, No = 0]

a. গ্লাস বা পাত্রটিতে পানি ঢালার পূর্বে গ্লাস/পাত্রটি ধুয়েছিল কিনা? Glass/container washed before water obtained?.....□

উত্তর যদি হ্যাঁ হয় তাহলে জিজ্ঞাসা করুন If the answer is yes then observe(multiple answers allowed)

a1. ক্লোরিন পানি দিয়ে ধুয়েছিল Washed with chlorinated water

a2. ক্লোরিন ছাড়া পানি দিয়ে ধুয়েছিল Washed with unchlorinated water

a3. সাবান দিয়ে ধুয়েছিল Washed with soap

a4. অন্য কোন উপাদান দিয়ে ধুয়েছিল Washed with other materials

- b. পানি ঢালার পূর্বে হাত ধুয়েছিল কিনা ? Hands washed with water (no soap) before water obtained? ☐
- c. পানি ঢালার পূর্বে সাবান দিয়ে হাত ধুয়েছিল কিনা ? Hands washed with soap before water obtained? ☐
- d. গ্লাস বা পাত্রটিতে ঢালা পানির ভিতরে তার হাত বা হাতের আঙ্গুল লেগেছিল কিনা? Hands/fingers came into contact with water? ☐
- e. গ্লাস বা পাত্রটিতে পানি ভরার সময় তা পানির পাত্রের ভিতর ডুবিয়ে পানি ভরা হয়েছিল কিনা? Glass dipped into water? ☐
- f. গ্লাসে পানি ভরার জন্য লম্বা হাতলযুক্ত কোন চামচ/মগ ব্যবহার করা হয়েছিল কিনা? Ladle used to obtain water? ☐
- g. পানির পাত্র থেকে সরাসরি পানি ঢেলেছিল কিনা ? Water poured from container? ☐
- i. সরাসরি পানির উৎস থেকে এনেছিল কিনা? Collected water from source directly ☐
- h. অন্যান্য (লিখুন)? Other (Specify) ☐
- ☐

509. FRAএফআরএকী H₂S পরীক্ষার জন্য সংরক্ষিত পানির নমুনা সংগ্রহ করেছিল? (FRA collected stored water sample for H₂S test?)

1. হ্যাঁ Yes
2. না (কি কারণে সংগ্রহ করেনি)-----[No (reason of not collecting water)_____]

510. FRA এফআরএঅবশিষ্ট ক্লোরিনের পরীক্ষার জন্য সংরক্ষিত পানির নমুনা সংগ্রহ করেছিল? (FRA collected stored water sample to check residual chlorine?) (applicable for arm 1,2 and 3)

1. হ্যাঁ Yes
2. না No (skip to 819)
8. পানির নমুনা দিতে রাজী হয় নাই (Refused to provide water sample)(skip to 819)

816. বাড়ির সংরক্ষনকৃত পানিতে অবশিষ্ট ক্লোরিনের পরিমাণ কত? _____ (মিলিগ্রাম/লিটার) [Range: 0.01 to 3.5]
(Level of residual chlorine in the household stored water _____)(mg/L) [Range:0.01 to 3.5] (applicable for arm 1,2 and 3)

817. আনুমানিক কত সময় আগে পানি বিশুদ্ধ করার জন্য ক্লোরিন ব্যবহার করা হয়েছে? -----: _____ : _____ দিন : _____ ঘন্টা : _____ মিনিট
আগে(প্রযোজ্য হবে যদি ৫০৬=১/২/৩ হয়) (উত্তরদাতা যদি না জানে তাহলে পরিবারের অন্য কারও সাহায্য নিন) (প্রযোজ্য নয়=৮৮৮)(Not applicable=৮৮৮)

(Approximately how long ago chlorine was used to treat water? _____: _____ Day :hh:mm ago)
(Applicable if 506=1/2/3) (get help from others in in the household if participant doesn't know)

819.. FRA কি মেমব্রেন ফিল্ট্রেশনের জন্য সংরক্ষিত পানি সংগ্রহ করেছিল? (Did the FRA collect stored water to do membrane filtration tests?)

1. হ্যাঁ (Yes)
2. না, সংগ্রহ করতে না পারার কারণ No (reason for not collecting the sample)_____
8. প্রযোজ্য নয় (Not applicable)(specify):_____

Assessment of practice of drinking treated water by chlorine dispenser/chlorine product:

How often does (Name) drink Chlorinated water? (কত ঘন ঘন (নাম ধরে বলুন) ক্লোরিন দিয়ে বিস্কদ্ধকৃত পানি পান করে (শুধুমাত্র পরিশোধিত পানির তথ্য সংগ্রহ করা হবে(col:o) এবং অপরিশোধিত (p) পানির তথ্য অটোমেটিকভাবে সংগৃহীত হয়ে যাবে Only

treated data will be obtained (col:o)And untreated (col:p) will be obtained automatically by the above instruction.(a1, a2, b এবং c কলামের তথ্যগুলি অটোমেটিকভাবে সেকশন D থেকে সংগৃহীত হয়ে যাবে Serial number and a1, a2, b and c columns information will be obtained automatically from section D.

যখন বিস্কদ্ধ পানি নির্বাচন করা হবে When select treated	সবসময় Always=1	বেশিরভাগ সময় Most times=2	কখনও কখনও Sometimes=3	কখনই না Never=4
তখন অটোমেটিকভাবে অবিস্কদ্ধ পানির ক্ষেত্রে Auto untreated	কখনই না Never=4	কখনও কখনও Sometimes=3	বেশিরভাগ সময় Most times=2	সবসময় Always=1

ক্রমিক নং (Serial number)	a1. ইউনিক পিডিএ আইডিPDA ID (Unique ID in the PDA)	a2. ইউনিক কার্ডআইডি(Uni que ID in the respondent's ID card)	b. নাম (Name)	c. বয়স (Age) দিন____ মাস ____ (Months) বছর ____ (Years)	n. পরিচর্যা কারী (Caregiver) •Yes = 1 •No = 2	o. কতবার নিরাপদ পানি পান করেন (Frequency of drinking treated water) •Always=1 •Most times =2 •Sometimes =3 •Never =4 (ask p and skip q)	p. কতবার নিরাপদ না করা পানি পান করেন (Frequency of drinking untreated water) •Always=1(skip to next sec) •Most times =2 •Sometimes =3 •Never =4 (opposite code of column e)	q.আপনি শেষ বার কখন নিরাপদ পানি পান করেছিলেন? (When did you drink treated water last time?) •Today =1 •Yesterday=2 •Within last 7 days=3 •within 1 month=4 • Above 1 month=5 •Don't know=9
201.								
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Section F: Chlorine Dispenser recognition and reported usage

(FRA-এফআরএ একটি ফ্লিপ চার্ট রাখবে যাতে ইন্টারভেনশন এর সকল পণ্য থাকবে)(FRA will carry a flip chart with all the intervention products)

(FRA-উত্তর দাতাকে ক্লোরিন ডিসপেন্সারের ছবি দেখাবে এবং জিজ্ঞেস করবে:) (The FRA will show the respondent the picture of chlorine dispenser and will ask :)

401	আপনি কি চিনেন এটা কি? (Do you know what this is?)	1. হ্যাঁ (Yes) 2. না (No)
401a	আপনি/আপনার কম্পাউন্ড কি আইসিডিডিআরবি থেকে এই পণ্যগুলির কোনটি (ক্লোরিন ডিসপেনসার) গ্রহণ করেছিলেন? Did you or your compound receive any of these products (Chlorine dispenser) from ICDDR,B?	1. হ্যাঁ (Yes) 2. না (No)
401b	আপনি কোন কম্পাউন্ডে এটি গ্রহণ করেছিলেন? [: Did you receive this chlorine dispenser in the compound you are currently living, or in the compound you were living previously?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)
402	আপনি বর্তমানে যে কম্পাউন্ডে আছেন সেখানে কি এটি আছে অথবা আগে যে কম্পাউন্ডে থাকতেন সেখানে কি ছিল? [Is there one (or was there one) in the compound you are currently living or in the compound you were living previously?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)
403	আপনি কি এটা অন্য কোন কম্পাউন্ডে দেখেছেন? (Have you seen this in another compound?)	1. হ্যাঁ (Yes) 2. না (No)
404	আপনি কি বলতে পারেন আপনি এটা কি কাজে ব্যবহার করবেন? (Can you tell me what you would use this for?)	1. খাবার পানি বিশুদ্ধ করার কথা উল্লেখ করেছে (Mentions to treat drinking water) 7. অন্যান্য Other -> Skip to 801 9. জানি না (Don't know) Skip to 801
405.	আপনি/অথবা আপনার পরিবারের কেউ কি পানি বিশুদ্ধ করার জন্য এটা নিজে একবারও ব্যবহার করেছেন? (Did you yourself or anybody of your household use it at least once to treat drinking water?)	1. হ্যাঁ (Yes) 2. না (No)-> Skip to 407 9. জানি না (Don't know)-> Skip to 407
406	পানি বিশুদ্ধ করার জন্য শেষ বার কখন আপনি/অথবা আপনার পরিবারের কেউ এটা ব্যবহার করেছিলেন? (উত্তরগুলি পড়ে শোনান)(When was the last time you or anybody of your household used it to treat drinking water?)(Read the answers to the participant)	1. আজই (Today) 2. গতকাল (Yesterday) 3. এক সপ্তাহের মধ্যে (Within one week) 4. এক মাসের মধ্যে (Within one month) 5. 1 – 6 মাস (1 – 6 months) 6. ছয় মাস আগে (More than six months ago) 99. মনে নাই (Don't remember)

407	সাধারণত, আপনার বাসায় ক্লোরিন ডিসপেন্সার দিয়ে কতবার পানি বিশুদ্ধ করা হয়? (উত্তরগুলি পড়ে শোনান) (In general, how often does your household treat your drinking water with the chlorine dispenser?)(Read the answers to the participant)	1. প্রত্যেকবার পানি সংগ্রহের পর/সবসময় [Every time we collect water/always] 2. পানি সংগ্রহের পর বেশিরভাগ সময়ই (Most of the time when we collect water) 3. মাঝে মাঝে/কখনও কখনও (Occasionally/sometimes) 4. শুধুমাত্র শুষ্ক মৌসুমে / গ্রীষ্মকালে/ গরমকালে (Only during dry season/summer) 5. শুধুমাত্র বর্ষাকালে (Only during rainy season) 6. শুধুমাত্র যখন এই এলাকায় ডায়রিয়ার রোগী বৃদ্ধি পায় (Only when there is increase in diarrhoeal patients in the community) 7. অন্যান্য (নির্দিষ্ট করুন): ----- [OTHER (SPECIFY___)] 9. জানি না (DON'T KNOW) 8.প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable) (specify)_____
512SA	ক্লোরিন দিয়ে পানি বিশুদ্ধ করার পর পান করার জন্য কত সময় অপেক্ষা করেন? (এটি একটি উন্মুক্ত প্রশ্ন)। How long do you wait after treating your water with chlorine to drink it? (This is a free response.	1. ৩০ মিনিট থেকে ৪৫ মিনিটের মধ্যে যেকোন সময় _____ Any time between 30 and 45 minutes____ 2. অন্য সময় কাঠামো _____ Other time frame ____ 8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable) (specify)_____
513SA	১৫ লিটার পাত্রের জন্য ডিসপেন্সার কতবার ঘুরাতে হয়?(উন্মুক্ত প্রশ্ন) How many turns of the chlorine dispenser would be appropriate for a 15-liter container? (Free response)	9. জানি না (DON'T KNOW) 1. তিনবার _____ Three____ 3. একবার _____ One____ 4. দুইবার _____ Two____ 2. ভিন্ন পরিমাণ অথবা জানি না _____ Other value or Don't Know____
513SB.	আপনার খাওয়ার পানি ক্লোরিন দিয়ে বিশুদ্ধ করার জন্য আপনার পানি সংরক্ষণ করার পাত্রে আপনি কতবার চাবিটি ঘুরান? How many turn/s do you use for treating your water with chlorine in the water storage container?	_____বার turns(জানি না=৯৯৯) (প্রযোজ্য নয়=৮৮৮) (Not applicable=৮৮৮)(Don't know=৯৯৯)
513SC	এফআরএ পানি সংরক্ষণ করার পাত্র যেটিতে ক্লোরিন মেশানো হয় সেটি কত লিটারের তা পর্যবেক্ষণ করুন FRA, estimate the volume of the water storage container which is used to treat water with chlorine in litres	_____লিটার ltr (প্রযোজ্য নয়=৮৮৮) (Not applicable=৮৮৮)

412	কে বেশীর ভাগ সময় আপনার পানির ক্লোরিন ডিসপেনসারে ক্লোরিন পূনঃভার কাজ করে? (পড়ে শোনাবেন না) (Who is responsible for refilling the chlorine in your Chlorine dispenser most of the time?)(Not for read out)	1. কেয়ারটেকার/কমিউনিটি ভলান্টিয়ার / কম্পাউন্ড ম্যানেজার (The compound manager/care taker/community volunteer) 2. পর্যায়ক্রমে প্রত্যেক পরিবার(যারা এই পানির উৎস ব্যবহার করে) Every family (who use this water source) by rotation 3. সব সময়ই পরিবারের একজন স্বেচ্ছা সেবক (A family volunteers all the time) 4. সবসময়ই আমার পরিবার এটা করে (My family does it all the time) 5. আইসিডিডিআরবি/ডিএসকের কমিউনিটি স্বাস্থ্য কর্মী CHP of ICDDR,B/DSK 7. অন্যান্য (Other) 8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)_____ 9. জানি না (Don't know)
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412b.. ক্লোরিন ডিসপেন্সারটি যিনি রক্ষণাবেক্ষণ করেন তিনি কি কম্পাউন্ডের অন্যান্যদেরকে পানি বিপণ্ড করার জন্য এটি ব্যবহার করতে দেন?
 Do the person who maintain the Chlorine Dispenser allow others in the compound to use it to treat water?

- a) হ্যাঁ, সবসময় Yes, always
- b) হ্যাঁ, কখনও কখনও Yes, sometimes
- c) না No

8 . প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)_____

9) জানি না Don't know

412c. ক্লোরিন ডিসপেন্সার আমার এবং আমার পরিবারের খাবার পানিকে নিরাপদ করে

The chlorine dispenser makes water safe for me and my household

- 1. ফুটানোর চেয়ে সহজভাবে easier than boiling
- 2. ফুটানোর চেয়ে কঠিনভাবে harder than boiling
- 3. প্রায় একইভাবে about the same

8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable) (specify)_____

Section G: ক্লোরিন ডিসপেনসারের জন্য তাৎক্ষণিক পর্যবেক্ষণ (Spot check for chlorine dispensers; source water testing):

801. আপনি কি অনুগ্রহ করে দেখাবেন ক্লোরিন ডিস্পেন্সারটি কোথায় রয়েছে? (যদি কম্পাউন্ডটিতে >1 Chlorine Dispensers থাকে, পানির উৎসের নিকটবর্তী Chlorine Dispenser র তথ্য লিপিবদ্ধ করুন যেটা উত্তর দাতা ব্যবহার করে। যদি একই পানির উৎসের কাছে >1 Chlorine Dispensers থাকে, যেটা সম্পূর্ণ ভাবে কার্যরত সেই Chlorine Dispenser-র তথ্য সংগ্রহ করুন। যদি উভয়টিই কার্যরত হয়, তাহলে যেটা সম্প্রতি পূর্ণ:ভরা হয়েছে সেই Chlorine Dispenser-র তথ্য সংগ্রহ করুন) (Can you please show me where the CD is located? (If there are >1 Chlorine Dispensers within the compound, record the status of the Chlorine Dispenser that is near the water source that the respondent use. If there are >1 Chlorine Dispensers near the same water source, collect the status of the Chlorine Dispenser that is fully functional. If both are functional, then collect the status of the Chlorine Dispenser that has been refilled most recently)

1. পানির উৎসের কাছেই যেখান থেকে লোকেরা খাবার পানি সংগ্রহ করে (Near the water source from where people collect drinking water)
2. রান্না ঘরের কাছে (Near the cooking area)
3. কম্পাউন্ডের লেইন/বারান্দায় (In the alley/corridor of the compound)
4. একটা রুমের ভিতরে (Inside a room)
5. কোন ক্লোরিন ডিস্পেন্সার নাই(নির্দিষ্ট করুন) (There is no Chlorine Dispenser)[Skip to 818]
(specify): _____
7. অন্যান্য (নির্দিষ্ট করুন) Other (specify): _____

802. পানির উৎস যেখান থেকে লোকেরা পানি সংগ্রহ করে সেখান থেকে ক্লোরিন ডিস্পেন্সার কত দূরে? _____ কদম দূরে (How far is the Chlorine Dispenser from the water source from where people usually get water? _____ steps away.)

803. আপনি আমাকে এইমাত্র যে ক্লোরিন ডিস্পেন্সার টি দেখালেন, কতজন লোক এটার সেবা নিতে আসে? (How many people Use this Chlorine Dispenser that you just showed me?)

1. প্রত্যেকে যারা সাধারণত কাছের পানির উৎস থেকে পানি সংগ্রহ করে (Everyone who usually collects water from this nearby source)
2. বেশীর ভাগ লোক যারা সাধারণত কাছের পানির উৎস থেকে পানি সংগ্রহ করে (Most of the people who usually collect water from this nearby source)
3. তাদের মধ্যে অল্প সংখ্যক যারা সাধারণত কাছের পানির উৎস থেকে পানি সংগ্রহ করে (Only a few among those who usually collect water from this nearby source)
4. সাধারণত যে কোন কেউ এমনকি কাছের পানির উৎস থেকে যারা পানি সংগ্রহ করে না (Anyone who even do not usually collect water from this nearby source)
5. বর্তমানে কেউ ব্যবহার করে না Now nobody use it

7. অন্যান্য (নির্দিষ্ট করুন)(others)(specify): _____

9. জানিনা Don't know

804. ক্লোরিন ডিসপেন্সারের হোল্ডারের উপর কোন ঢাকনা ছিল কি? (পর্যবেক্ষণ করে লিখুন) [Is there lid on the Chlorine Dispenser holder? (Observe and record)]

1. হ্যাঁ (Yes)
2. না (No)

805. সেখানে ক্লোরিন ট্যাংক ছিল কি? [Is there chlorine tank present? (Observe and record)]

1. হ্যাঁ (Yes)
2. না (No)

806. ক্লোরিন ট্যাংক এর উপর কি কোন ঢাকনা ছিল? (পর্যবেক্ষণ করে লিখুন) [Is there a cap on the chlorine tank? (Observe and record)]

1. হ্যাঁ (Yes)
2. না (No)
3. পর্যবেক্ষণ করা সম্ভব হয়নি (Not possible to check it)

807. ট্যাংকে কোন ক্লোরিন ছিল কি? (পর্যবেক্ষণ করে লিখুন) [Is there chlorine in the tank? (Observe and record)]

1. হ্যাঁ (Yes)
2. না (No)

807a. ক্লোরিন ডিসপেন্সারটি কতটা পূর্ণ আছে পর্যবেক্ষণ করুন Please observe how full chlorine dispenser is:

1. খালি Empty
3. আংশিক পূর্ণ Partly full
4. সম্পূর্ণ ভরা Full
5. পর্যবেক্ষণ করা সম্ভব হয়নি Not possible to observe

808. চাবি টি ঠিক জায়গায় ছিল কি? (পর্যবেক্ষণ করে লিখুন) [Is the valve in place? (Observe and record)]

1. হ্যাঁ (Yes)
2. না (No)

808a. ক্লোরিন ডিসপেন্সারে কোন ছিদ্র আছে কিনা? (পর্যবেক্ষণ করে লিখুন) Is there any leakage in the chlorine dispenser?

1. হ্যাঁ (Yes)
2. না (No)

809. শেষ বার কখন ক্লোরিন ডিসপেন্সারটি ভরা হয়েছে? _____ সপ্তাহ, _____ দিন _____ ঘন্টা আগে (When was the Chlorine Dispenser refilled last time? _____ weeks, _____ Days, _____ Hour ago)

809a. ক্লোরিন ডিসপেন্সারটির কাছে কি কোন কিউ কার্ড আটকানো আছে কিনা? (Is the cue card currently present near on/near the chlorine/chlorine dispenser?)

1. হ্যাঁ (Yes)
2. না (No)

811. ক্লোরিন ডিস্পেন্সারের কাছে/নির্দিষ্ট করা স্থানে কোন রিজার্ভার আছে [Is there a reservoir available near the chlorine dispenser/to the designated place?]

1. হ্যাঁ (Yes)
2. না (No)-> Skip to 818
8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable)(specify): _____ -> Skip to 818

812. রিজার্ভারে কি পানি আছে? (FRA-পর্যবেক্ষণ করে লিখবেন) [Is there water in the reservoir (FRA will check and record)]

1. হ্যাঁ (Yes)
2. না (No)-> Skip to 818
8. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable)(specify): _____ -> Skip to 818

813. রিজার্ভারের(বালতি/কলসি/পাতিল/অন্যান্য) পানি কি ক্লোরিন দিয়ে বিশুদ্ধ করা হয়েছিল? (Is the water in the reservoir (Any type of vessel)treated with chlorine?

1. হ্যাঁ (Yes)
2. না (No)-> Skip to 818
8. প্রযোজ্য নয়(নির্দিষ্ট করুন)(Not applicable)(specify): _____ -> Skip to 818

814. আনুমানিক কত সময় আগে রিজার্ভারে পানি বিশুদ্ধ করার জন্য ক্লোরিন ব্যবহার করা হয়েছে? _____:_____ ঘন্টা : মিনিট আগে

(Approximately how long ago was chlorine used to purify water in the reservoir? _____:_____ hh:mm ago)

815.রিজার্ভারে সংরক্ষণকৃত পানিতে অবশিষ্ট ক্লোরিনের পরিমাণ কত? _____(মিলিগ্রাম/লিটার) [Range:0.01 to 3.5]

Level of residual chlorine in the water stored in the reservoir _____ (mg/L) [Range: 0.01 to 3.5]

818. FRAএফআরএকি উৎস থেকে H₂S পরীক্ষার জন্য পানি সংগ্রহ করেছিল? (Did the FRA collect water from the source to do H₂S tests?)

1. হ্যাঁ (Yes)
2. না, সংগ্রহ করতে না পারার কারণ(No) (reason for not collecting the sample)_____
8. প্রযোজ্য নয়(নির্দিষ্ট করুন)(Not applicable)(specify): _____

Section H: হাত ধোয়ার অভ্যাস গ্রহণ/গড়ে উঠা (Spot checks for handwashing stations and uptake of hand washing behaviour):

উত্তরদাতাকে জিজ্ঞেস করুন: আপনি প্রধানত কোথায় হাত ধোন তা আমাকে দেখান Ask the respondent: “Can you please show me where you most often wash your hands?”

1101. পর্যবেক্ষণ করুন/প্রয়োজনে জিজ্ঞাসা করুন: প্রাথমিক হাত ধোয়ার স্থানটি কি একাধিক পরিবার কর্তৃক ব্যবহৃত হয় কিনা?

Observation/ask if needed: primary handwashing station is shared between multiple households?

1. হ্যাঁ (Yes)
2. না (No)
9. জানি না (Don't know)

1102. পর্যবেক্ষণ: হাত ধোয়ার প্রাথমিক স্থান কোথায় তা লিপিবদ্ধ করুন (Observation: Record the location where the primary handwashing station is located)

1. ঘরের মধ্যে Indoors
2. ঘরের বাহিরে কোন নির্দিষ্ট স্থানে Outdoors in a specific place
3. নির্দিষ্ট কোন স্থান নেই(১১০৯ নং প্রশ্নে চলে যান) No specific place (skips to 1109)
4. দেখাতে রাজী না (১১০৯ নং প্রশ্নে চলে যান) No permission to see (skips to 1109)
7. অন্যান্য (নির্দিষ্ট করুন)(Other, specify) _____

1103a. পর্যবেক্ষণকরুন এবং কদম মাপুন:(এফআরএদের জন্য নির্দেশনা: অনুগ্রহ করে ঐ খানার খাবার তৈরীর স্থানটি কোথায় তা খুঁজে বের করুন এবং এরপর প্রকৃত দূরত্ব পরিমাপ করুন) Observe and count steps Instruction: FRA please find out where the food preparation area is for that household and then count actual steps from that area).

1. রান্নাঘরের থেকে দূরত্ব Distance from kitchen _____Steps
2. টয়লেট থেকে দূরত্ব -----কদম Distance from toilet _____Steps
3. খাবার তৈরীর স্থান থেকে দূরত্ব -----কদম Distance from food preparation area -----steps

1105. পর্যবেক্ষণ: হাত ধোয়ার জন্য নির্ধারিত স্থানে পানি আছে কী? বক্সে কোড লিপিবদ্ধ করুন (পানি দেখলেই শুধুমাত্র “ হ্যাঁ ” লিপিবদ্ধ করুন). Observation: Is water present at the specific place for handwashing? (Record code in box) (You must actually see water to record “yes”):

1. হ্যাঁ (Yes)

2. না (No)

1106. পর্যবেক্ষণ: হাত ধোয়ার স্থানে নিম্ন লিখিত কোন উপাদানগুলো আছে? (দেখলে “ হ্যাঁ ” এর জন্য নিম্নের বক্সে “1” লিখুন এবং না দেখলে “ না ” এর জন্য নিম্নের বক্সে “0” লিখুন) Observation: Which of the following are present at the handwashing station? (If you observe the listed item, write “1” for “yes” in the box below. If you do not observe the listed item, write “0” for “no” in the box below)

Yes = 1

No = 2

|_____| 1.গোসলের/হাত ধোয়ার সাবান(Body/hand soap)

|_____| 2. কাপড় ধোয়ার সাবান (laundry bar)

|_____| 3. ডিটারজেন্ট (পাউডার)(Detergent (powder))

|_____| 4. তরল সাবান (Liquid soap other than soapy water)

|_____| 5. থালাবাসন ধোয়ার সাবান(Dishwashing soap)

|_____| 6. ছাই (Ash)

|_____| 7. মাটি/বালু (Mud/Sand)

|_____| 8. বালতি (Bucket)

|_____| 9. বেসিন (Basin)

|_____| 10. ট্যাপ/টিউবওয়েল (Tubewell)

|_____| 11. কলসহ লাল বালতি(ICDDR কতৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)

|_____| 12. সাবান পানি (soapy water in bottle provided by icddr)

|_____| 13. কলসি Kolshi or other containers

|_____| 14. কোনকিছুই নাই (Nothing is there)

|_____| 15. দেয়ালের সাবান (Soap pasted on the wall)

|_____| 16. কিউকার্ড (Cuecard)

1|_____| 17.আইসিডিডিআরবির দেয়া গামলা Basin provided by icddr

|_____| 18.আইসিডিডিআরবির দেয়া টুল Stool provided by icddr

|_____| 19. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি Soapy water in some other container, not the one provided by icddr.

|_____| 77. অন্যান্য (নির্দিষ্ট করুন) _____ other, specify _____

1107. হাত ধোয়ার স্থানে নিম্নলিখিত যেউপাদানগুলো থাকবে সাক্ষাৎকারপ্রদানকারীকে জিজ্ঞাসা করুন সেগুলো কম্পাউন্ডের সকলের ব্যবহারের জন্য নাকি কেবল তার নিজের বা অন্য কারও ব্যক্তিগত ব্যবহারের জন্য। পর্যবেক্ষণকৃত উপাদানটি যদি তার নিজের ব্যবহারের জন্য হয় তাহলে ০ লিখুন আর যদি কম্পাউন্ডের সকলের ব্যবহারের জন্য হয় তাহলে ১ লিখুন। Whatever is present in the handwashing station, ask the respondent if that is for communal use or for personal use. If the observed item is for personal use, write 1, if for communal use write 2.

|_____| 1.গোসলের/হাত ধোয়ার সাবান(Body/hand soap)

|_____| 2. কাপড় ধোয়ার সাবান (laundry bar)

|_____| 3. ডিটারজেন্ট (পাউডার)(Detergent (powder))

|_____| 4. তরল সাবান (Liquid soap)

|_____| 5. থালাবাসন ধোয়ার সাবান(Dishwashing soap)

|_____| 6. ছাই (Ash)

|_____| 7. মাটি/বালু (Mud/Sand)

|_____| 8. বালতি (Bucket)

|_____| 9. বেসিন (Basin)

|_____| 10. ট্যাপ/টিউবওয়েল (Tubewell)

|_____| 11. কলসহ লাল বালতি (ICDDR B কতৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)

|_____| 12. সাবান পানি (Soapy water in bottle provided by icddr)

|_____| 13. কলসি Kolshi or other containers

|_____| 14. কোনকিছুই নাই (Nothing is there)

|_____| 15. দেয়ালের সাবান (Soap pasted on the wall)

|_____| 16. কিউকার্ড (Cuecard)

17. আইসিডিডিআরবির দেয়া গামলা Basin provided by icddr

18. আইসিডিডিআরবির দেয়া টুল Stool provided by icddr

19. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি Soapy water in some other container, not the one provided by icddr

|_____| 77. অন্যান্য (নির্দিষ্ট করুন)_____ Other, specify_____

Instruction for PDA team: If 1107-12 is 2 then have to show these questions below

1107a1. সাবানপানি তৈরীতে আপনার বা আপনার পরিবারের কি কোন ছমিকা আছে? Do you or your family have made any contribution to make this soapy water?

1. Always সবসময়
2. Sometimes কখনও কখনও
3. Never কখনই না (skip to 1107a)

আপনি অথবা আপনার পরিবার কিভাবে সাবানপানি তৈরীতে সাহায্য করেন? How you or your family have contributed to make this soapy water?

1107b1. আপনি কি সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কেনার টাকা শেয়ার করেন? Do you share money for buying the soap/detergent for making soapy water?

1. হ্যাঁ Yes
2. না No

1107c1. আপনি কি নিজে সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কিনেন? Do you yourself buy the soap/detergent for making soapy water?

1. হ্যাঁ Yes
2. না No

1107d1. আপনি কি সাবানপানি তৈরীতে সাহায্য করেন? Do you help prepare the soapy water ?

1. হ্যাঁ Yes
2. না No

1107a. আইসিডিডিআরবির দেয়া সাবানপানির বোতলটি পর্যবেক্ষণ করুন এবং দেখুন সেটিতে কি পরিমাণ সাবানপানি আছে “Observe volume of soapy water in bottle provided by icddr (যদি ১১০৬ নং প্রশ্নে ১২ নং অপশন সিলেক্ট করা হয় তাহলে প্রযোজ্য) (If in q1106 option 12 is selected then applicable)

1. পূর্ণ বোতল Bottle full
2. আংশিক পূর্ণ বোতল Bottle partly full
3. বোতলের নীচে অল্প পরিমাণ সাবানপানি Only small amount of soapy water at the bottom
4. খালি বোতল Empty
5.

1107aa1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষণ করুন Please observe the status of the cap on the soapy water bottle.

- a) কার্যত ব্যবহার উপযোগী ঢাকনা, ছিদ্র নেই Functional usable cap, not leaking
- b) ঢাকনা আছে কিন্তু ছিদ্র হয়ে গেছে Cap is present, but leaking
- c) ঢাকনা ভেঙ্গে গেছে/হারিয়ে গেছে Cap is broken/missing
- d) কোন সাবানপানির বোতল নেই No soapy water bottle is present

1107a2. সাবানপানির বোতল কেমন পরিষ্কার আছে তা পর্যবেক্ষণ করুন এবং লিপিবদ্ধ করুন Please observe and record how clean is the soapy water bottle?

a) খুব পরিষ্কার Very clean (0)

b) পরিষ্কার Clean (1)

c) পরিষ্কার ও না অপরিষ্কারও না Neither clean nor dirty (2)

d) অপরিষ্কার Dirty (3)

e) খুব অপরিষ্কার Very dirty (4)

Instruction for PDA team: If 1107-19 is 2 then have to show these questions below

1107e1. সাবানপানি তৈরীতে আপনার বা আপনার পরিবারের কি কোন ভূমিকা আছে? Do you or your family have made any contribution to make this soapy water?

4. Always সবসময়
5. Sometimes কখনও কখনও
6. Never কখনই না (skip to 1107b)

আপনি অথবা আপনার পরিবার কিভাবে সাবানপানি তৈরীতে সাহায্য করেন? How you or your family have contributed to make this soapy water?

1107f1. আপনি কি সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কেনার টাকা শেয়ার করেন? Do you share money for buying the soap/detergent for making soapy water?

- 3. হ্যাঁ Yes
- 4. না No

1107g1. আপনি কি নিজে সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কিনেন? Do you yourself buy the soap/detergent for making soapy water?

- 3. হ্যাঁ Yes
- 4. না No

1107h1. আপনি কি সাবানপানি তৈরীতে সাহায্য করেন? Do you help prepare the soapy water ?

- 3. হ্যাঁ Yes
- 4. না No

1107b. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি থাকলে তা পর্যবেক্ষন করুন এবং দেখুন সেটিতে কি পরিমাণ সাবানপানি আছে “Observe volume of soapy water in other type of container provided by icddr” (যদি ১১০৬ নং প্রশ্নে ১৯ নং অপশন সিলেক্ট করা হয় তাহলে প্রযোজ্য) (If in q1106 option 19 is selected then applicable)

- 1.পূর্ণ বোতল Bottle full
- 2.আংশিক পূর্ণ বোতল Bottle partly full
- 3.বোতলের নীচে অল্প পরিমাণ সাবানপানি Only small amount of soapy water at the bottom
- 4.খালি বোতল Empty

1107bb1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষন করুন Please observe the status of the cap on the soapy water bottle.

- a) কার্যত ব্যবহার উপযোগী ঢাকনা,ছিদ্র নেই Functional usable cap, not leaking
- b) ঢাকনা আছে কিন্তু ছিদ্র হয়ে গেছে Cap is present, but leaking
- c) ঢাকনা ভেঙ্গে গেছে/হারিয়ে গেছে Cap is broken/missing
- d) কোন সাবানপানির বোতল নেই No soapy water bottle is present

1107bb2. সাবানপানির বোতল কেমন পরিষ্কার আছে তা পর্যবেক্ষন করুন এবং লিপিবদ্ধ করুন Please observe and record how clean is the soapy water bottle?

- a) খুব পরিষ্কার Very clean (0)

b) পরিষ্কার Clean (1)

c) পরিষ্কার ও না অপরিষ্কারও না Neither clean nor dirty (2)

d) অপরিষ্কার Dirty (3)

e) খুব অপরিষ্কার Very dirty (4)

1108. আপনি কি দয়া করে আপনার নিজের সাবানটি নিয়ে আসবেন যে সাবানটি আপনি সাধারণত এই হাত ধোয়ার স্থানে হাত ধোয়ার কাজে ব্যবহার করেন। (যদি সাবানটি সেখানে না থাকে) Can you please bring your own soap that you normally use for washing hands to this handwashing station, if not already there?

হাত ধোয়ার স্থানে সাবানটি আনতে কত সময় লেগেছিল? _____ সেকেন্ড How long did it take to bring the soap to the handwashing station? _____ seconds (প্রযোজ্য নয়=888) (দেখাতে রাজী না=666)((Not applicable=888) (Do not agree to bring soap=666)

1109. যদি লাল বালতি থাকে, তবে তাতে কি পানি আছে? If the Red bucket is there, does it have water in it?

1. হ্যাঁ (Yes)

2. না (1110a নং প্রশ্নে চলে যান) (No) (skip to 1110a)

8. প্রযোজ্য নয় (নির্দিষ্ট করুন) (যদি আর্ম ২ হয় তাহলে 1110a নং প্রশ্নে চলে যান অন্যথায় 1111 নং প্রশ্নে চলে যান) (Not applicable)(specify): _____ (if arm 2 skip to 1110a otherwise skip to 1111)

1110. সেখানে কতটুকু পানি আছে? How much water is in there?

1. বালতি সম্পূর্ণ ভর্তি The container is full

2. বালতি কিছুটা ভর্তি The container is partly full

3. নীচের অংশে সামান্য পানি আছে Only small amount of water at the bottom

4. খালি Empty

1110a. আইসিডিডিআরবি দেয়া কলসহ লাল বালতি যদি সেখানে (যেখানে বসিয়ে দেয়া হয়েছিল) না থাকে এবং যদি এই কম্পাউন্ডে সেটি দেয়া হয়ে থাকে তাহলে জিজ্ঞেস করুন লাল বালতিটি কোথায়?

If the red bucket with tap provided by ICDDRDB is not there (where it was installed), and if the compound was given it, ask the respondent where the red bucket is?

1. এটি কামউনিটি স্বাস্থ্য কর্মীকে দেয়া হয়েছে ঠিক করবার জন্য It was returned to the CHP to fix it
2. এটি কম্পাউন্ড ম্যানেজারের /বাড়িওয়ালার ঘরে রাখা হয়েছে It is kept in the compound manager's/landowner's house
3. এটি আমার /অন্য কারো ঘরে রাখা হয়েছে It is kept at my/some other person's home
4. রান্নাঘরের ভিতরে It is kept in kitchen
5. কম্পাউন্ডের মধ্যে অন্য কোন জায়গায় It is kept in other place of the compound
6. বিক্রি করে দিয়েছে It has been sold
7. চুরি হয়ে গেছে It has been stolen
8. ব্যবহার করে না বলে সিএইচপিকে ফেরত দিয়েছে It was returned to the CHP as they don't use it
77. অন্যান্য (নির্দিষ্ট করুন) _____ Other _____
specify _____
88. প্রযোজ্য নয় (যেখানে বসিয়ে দেয়া হয়েছিল সেখানে আছে) Not applicable (It is there where it was installed)
9. জানিনা Don't know

1110b. কলসহ লাল বালতিটি থাকলে সেটি কি অবস্থায় আছে?

If red bucket with tap is there, what is the status of the Red bucket?

1. কাজ করছে functional
2. কাজ করছে না (একাধিক উত্তর গ্রহণযোগ্য) not functional: (Multiple answer is allowed only for option 2)
 - a. ছিদ্র হয়ে গেছে leaking
 - b. কল নাই tap missing
 - c. কল ভেঙে গেছে tap broken
 - d. অন্যান্য নির্দিষ্ট করুন Others specify:-----
8. প্রযোজ্য নয় Not applicable

1110c. কলসহ লাল বালতির ঢাকনাটি কি অবস্থায় আছে? What is the status of the lid of the red bucket with tap ?:

1. ঢাকনাটি ভেঙে গেছে lid cracked -broken
2. আছে কিন্তু বালতিটি ঢাকেনি Is there but not covering the bucket
3. এটি সম্পূর্ণভাবে বালতিটি ঢেকে রেখেছে It covers the bucket completely
4. বালতিটি আংশিকভাবে ঢেকে রেখেছে It covers the bucket partially
5. হারিয়ে গেছে Is missing
8. প্রযোজ্য নয় Not applicable

1110d. কে এতে (কলসহ লাল বালতি) পানি ভরে? (Who refills the water in the red bucket?)

1. কম্পাউন্ডের কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (the compound caretaker/manager/community volunteer)
2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)
3. প্রত্যেক খানাই পালাক্রমে এটা করে (Every household does it in shift)
4. শুধুমাত্র আমার পরিবারই এটা করে Only I or my family do it
5. নির্দিষ্ট কেউ নেই No specific person but its gets done
6. কেউ ভরে না No one refills it
7. অন্যান্য (Other)
8. প্রযোজ্য নয় Not applicable

1110e. আপনি কি কখনও হাত ধোয়ার স্টেশনের রিজার্ভারটি(বালতি) পুনরায় ভরেছেন? Have you ever refilled the reservoir (Bucket) of the handwashing station with water?

1. হ্যাঁ Yes.
2. না No
3. মনে করতে পারছি না Cant remember
4. প্রযোজ্য নয় Not applicable.

1110f. প্রশ্ন 1110e যদি হ্যাঁ হয়, আপনি কি বিগত সপ্তাহে হাত ধোয়ার স্টেশনের রিজার্ভারটি পুনরায় ভরেছেন? If Yes to q1110e, did you refill the reservoir of the handwashing station during the past week?

1. হ্যাঁ Yes
2. না No
3. প্রযোজ্য নয় Not applicable

1110g. আপনি কি কখনও হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছেন? Have you ever emptied the basin under the handwashing station?

1. হ্যাঁ Yes
2. না No
3. মনে করতে পারছি না Cant remember

4. প্রযোজ্য নয় Not applicable (888)if basin absent

1110h. প্রশ্ন 1110g যদি হ্যাঁ হয়, আপনি কি বিগত সপ্তাহে হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছেন? If Yes to q1110g
Did you empty the basin under the handwashing station during the past week?

1. হ্যাঁ Yes

2. না No

3. মনে করতে পারছি না Cant remeber

4. প্রযোজ্য নয় Not applicable

1111. যদি অন্য কোন পাত্র থাকে তাহলে সেগুলোর কোনটিতে কি পানি আছে? If there are other kinds of containers, is there water in any of those?

1. হ্যাঁ (Yes)

2. না(১১১৫ নং প্রশ্নে চলে যান) (No) (skip to 1115)

8. প্রযোজ্য নয়(নির্দিষ্ট করুন)(১১১৫ নং প্রশ্নে চলে যান) (Not applicable)(specify):_____ (skip to 1115)

1112. সেখানে কতটুকু পানি আছে? একাধিক পাত্রে পানি থাকলে বড় পাত্রটি পর্যবেক্ষণ করুন How much water is in there? [If there are >1 container with water, record the status of the largest container]

1. ড্রাম/ বালতি/অন্য কোন পাত্র সম্পূর্ণ ভর্তি The container is full

2. ড্রাম/ বালতি/ অন্য কোন পাত্র কিছুটা ভর্তি The container is partly full

3. নীচের অংশে সামান্য পানি আছে Only small amount of water at the bottom

4. খালি Empty

1113.এর মধ্যে (আইসিডিডিআরবির দেওয়া লাল বালতি ছাড়া) কোন পাত্র কি কম্পাউন্ডের সবাই ব্যবহার করে? Is any of these containers (other than the red bucket given by ICDDR,B) for communal use?

1. হ্যাঁ (Yes)

2. না (No) (১১১৫ নং প্রশ্নে চলে যান)

8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable)(specify):_____ (skip to 1115)

1114. কে এতে পানি ভরে? (আইসিডিডিআরবির দেওয়া লাল বালতি ছাড়া) একাধিক পাত্র থাকলে বড়টির কথা জিজ্ঞাসা করুন (Who refills the water in it/them?) (Other than the red bucket given by ICDDR, B) If more than one, ask about the largest container .

1. কম্পাউন্ডের কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (the compound caretaker/manager/community volunteer)
2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)
3. প্রত্যেক খানাই পালাক্রমে এটা করে (Every household does it in shift)
4. নির্দিষ্ট কেউ নেই No specific person but its get done
5. কেউ ভরে না No one refills it
6. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it
7. অন্যান্য (Other)

1115. যদি সাবান পানি থাকে, তবে বোতলটি খালি হলে কে পূর্ণ করে? (If soapy water bottle is there, who refills the soapy water bottle?)

1. কম্পাউন্ডের কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (the compound caretaker/manager/community volunteer)
2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)
3. প্রত্যেক খানাই এতে অংশ নেয় (Every household contributes for it)
4. এই বোতলটি ব্যক্তিগতভাবে ব্যবহারের জন্য (This bottle is for personal use)
5. নির্দিষ্ট কেউ নেই No specific person but its get done
6. কেউ ভরে না No one refills the bottle
7. অন্যান্য (Other)
8. প্রযোজ্য নয়(নির্দিষ্ট করুন)Not applicable(specify):_____
9. জানিনা Don't know
10. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it

1116. উত্তরদাতাকে জিজ্ঞেস করুন: এই স্থান ছাড়া আপনি কী অন্য কোথাও হাত ধোঁন?

(Ask the respondent: “Is there anywhere else you wash your hands?”)

1. হ্যাঁ (Yes)
2. না (১১৩০ নং প্রশ্নে চলে যান) (No) (skip to question 1130)

1117. পর্যবেক্ষণ করুন/প্রয়োজনে জিজ্ঞাসা করুন: হাত ধোয়ার দ্বিতীয় প্রধান স্থানটি কি একাধিক পরিবার কর্তৃক ব্যবহৃত হয় কিনা?

(Observation/ask if needed: secondary handwashing station is shared between multiple households?)

1. হ্যাঁ (Yes)
2. না (No)
9. জানি না (Don't know)

1118. পর্যবেক্ষণ: হাত ধোয়ার দ্বিতীয় প্রধান স্থান কোথায় তা লিপিবদ্ধ করুন (Observation: Record the location of the secondary handwashing station.)

1. ঘরের মধ্যে Indoors
2. ঘরের বাহিরে কোন নির্দিষ্ট স্থানে Outdoors in a specific place
3. নির্দিষ্ট কোন স্থান নেই(১১৩০ নং প্রশ্নে চলে যান) No specific place (skips to 1130)
4. দেখাতে রাজী না(১১৩০ নং প্রশ্নে চলে যান) No permission to see (skips to 1130)
7. অন্যান্য (নির্দিষ্ট করুন)----- Other, specify

1119a. পর্যবেক্ষণ করুন এবং কদম মাপুন:(এফআরএদের জন্য নির্দেশনা: অনুগ্রহ করে ঐ খানার খাবার তৈরীর স্থানটি কোথায় তা খুঁজে বের করুন এবং এরপর প্রকৃত দূরত্ব পরিমাপ করুন) Observe and count steps Instruction: FRA please find out where the food preparation area is for that household and then count actual steps from that area).

1. রান্নাঘরের থেকে দূরত্ব Distance from kitchen _____Steps
2. টয়লেট থেকে দূরত্ব -----কদম Distance from toilet _____Steps
3. খাবার তৈরীর স্থান থেকে দূরত্ব -----কদম Distance from food preparation area -----steps

1121. পর্যবেক্ষণ: হাত ধোয়ার জন্য নির্ধারিত স্থানে পানি আছে কী? (বক্সে কোড লিপিবদ্ধ করুন) (পানি দেখলেই শুধুমাত্র “হ্যাঁ ” লিপিবদ্ধ করুন)

Observation: Record if water is present at the specific place for handwashing? (Record code in box) (You must actually see water to record “yes”):

1. হ্যাঁ Yes
2. না No

1122. পর্যবেক্ষণ: হাত ধোয়ার স্থানে নিম্ন লিখিত কোন উপাদানগুলো আছে? (দেখলে “হ্যাঁ” এর জন্য নিম্নের বক্সে “1” লিখুন এবং না দেখলে “না” এর জন্য নিম্নের বক্সে “0” লিখুন)

Observation: Which of the following are present at the handwashing station? (If you observe the listed item, write “1” for “yes” in the box below. If you do not observe the listed item, write “0” for “no” in the box below.) হ্যাঁ = 1, না = 0 [Yes = 1, No = 0]

|_____| 1. গোসলের/হাত ধোয়ার সাবান Body/hand soap

|_____| 2. কাপড় ধোয়ার সাবান laundry bar

|_____| 3. ডিটারজেন্ট (পাউডার) Detergent (powder)

|_____| 4. তরল সাবান Liquid soap

|_____| 5. থালাবাসন ধোয়ার সাবান Dishwashing soap

|_____| 6. ছাই Ash

|_____| 7. মাটি/বালু Mud/Sand

|_____| 8. বালতি Bucket

|_____| 9. বেসিন Basin

|_____| 10. ট্যাপ/টিউবওয়েল Tubewell

|_____| 11. কলসহ লাল বালতি (ICDDR কতৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)

|_____| 12. সাবান পানি Soapy water in bottle provided by icddr

|_____| 13. কলসি Kolshi or other container (s)

|_____| 14. কোনকিছুই নাই nothing is there

|_____| 15. দেয়ালের সাবান (Soap pasted on the wall)

|_____| 16. কিউকার্ড (Cuecard)

|_____| 17. আইসিডিডিআরবির দেয়া গামলা Basin provided by icddr

|_____| 18. আইসিডিডিআরবির দেয়া টুল Stool provided by icddr

|_____| 19. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি Soapy water in some other container, not the one provided by icddr

|_____| 77. অন্যান্য (নির্দিষ্ট করুন) _____ other, specify

1123. হাত ধোয়ার স্থানে নিম্নলিখিত যে উপাদানগুলো থাকবে সাক্ষাৎকারপ্রদানকারীকে জিজ্ঞাসা করুন সেগুলো কম্পাউন্ডের সকলের ব্যবহারের জন্য নাকি কেবল তার নিজের ব্যবহারের জন্য। পর্যবেক্ষণকৃত উপাদানটি যদি তার নিজের ব্যবহারের জন্য হয় তাহলে ০ লিখুন আর যদি

কম্পাউন্ডের সকলের ব্যবহারের জন্য হয় তাহলে ১ লিখুন। Whatever is present in the handwashing station, ask the respondent if that is for communal use or for personal use. If the observed item is for personal use, write 1, if for communal use write 2.

- |____| 1.গোসলের/হাত ধোয়ার সাবান(Body/hand soap)
- |____| 2. কাপড় ধোয়ার সাবান (laundry bar)
- |____| 3. ডিটারজেন্ট (পাউডার)(Detergent (powder))
- |____| 4. তরল সাবান (Liquid soap)
- |____| 5. থালাবাসন ধোয়ার সাবান(Dishwashing soap)
- |____| 6. ছাই (Ash)
- |____| 7. মাটি/বালু (Mud/Sand)
- |____| 8. বালতি (Bucket)
- |____| 9. বেসিন (Basin)
- |____| 10. ট্যাপ/টিউবওয়েল (Tubewell)
- |____| 11. কলসহ লাল বালতি (ICDDR B কতক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)
- |____| 12. সাবান পানি (Soapy water in bottle provided by icddr)
- |____| 13. কলসি Kolshi or other containers
- |____| 14. কোনকিছুই নাই (Nothing is there)
- |____| 15. দেয়ালের সাবান (Soap pasted on the wall)
- |____| 16. কিউকার্ড (Cuecard)
- |____| 17.আইসিডিডিআরবির দেয়া গামলা Basin provided by icddr
- |____| 18.আইসিডিডিআরবির দেয়া টুল Stool provided by icddr
- |____| 19. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি Soapy water in some other container, not the one provided by icddr
- |____| 77. অন্যান্য (নির্দিষ্ট করুন) _____ other, specify

Instruction for PDA team: If 1123-12 is 2 then have to show these questions below

1123a1. সাবানপানি তৈরীতে আপনার বা আপনার পরিবারের কি কোন ভূমিকা আছে? Do you or your family have made any contribution to make this soapy water?

1. Always সবসময়
2. Sometimes কখনও কখনও
3. Never কখনই না (skip to 1123a)

আপনি অথবা আপনার পরিবার কিভাবে এটি তৈরীতে সাহায্য করেন? How you or your family have contributed to make this soapy water?

1123b1. আপনি কি সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কেনার টাকা শেয়ার করেন? Do you share money for buying the soap/detergent for making soapy water?

1. হ্যাঁ Yes
2. না No

1123c1. আপনি কি নিজে সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কিনেন? Do you yourself buy the soap/detergent for making soapy water?

1. হ্যাঁ Yes
2. না No

1123d1. আপনি কি সাবানপানি তৈরীতে সাহায্য করেন? Do you help prepare the soapy water?

1. হ্যাঁ Yes
2. না No

1123a. আইসিডিডিআরবির দেয়া সাবানপানির বোতলটি পর্যবেক্ষণ করুন এবং দেখুন সেটিতে কি পরিমাণ সাবানপানি আছে “Observe volume of soapy water in bottle provided by icddr (যদি ১১২২ নং প্রশ্নে ১২ নং অপশন সিলেক্ট করা হয় তাহলে প্রযোজ্য) (If in q1122 option 12 is selected then applicable)

1. পূর্ণ বোতল Bottle full
2. আংশিক পূর্ণ বোতল Bottle partly full
3. বোতলের নীচে অল্প পরিমাণ সাবানপানি Only small amount of soapy water at the bottom
4. খালি বোতল Empty

1123a1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষণ করুন Please observe the status of the cap on the soapy water bottle.

- e) কার্যত ব্যবহার উপযোগী ঢাকনা, ছিদ্র নেই Functional usable cap, not leaking
- f) ঢাকনা আছে কিন্তু ছিদ্র হয়ে গেছে Cap is present, but leaking
- g) ঢাকনা ভেঙ্গে গেছে/হারিয়ে গেছে Cap is broken/missing
- h) কোন সাবানপানির বোতল নেই No soapy water bottle is present

1123a2. সাবানপানির বোতল কেমন পরিষ্কার আছে তা পর্যবেক্ষণ করুন এবং লিপিবদ্ধ করুন Please observe and record how clean is the soapy water bottle?

- a) খুব পরিষ্কার Very clean (0)
- b) পরিষ্কার Clean (1)
- c) পরিষ্কার ও না অপরিষ্কারও না Neither clean nor dirty (2)
- d) অপরিষ্কার Dirty (3)
- e) খুব অপরিষ্কার Very dirty (4)

Instruction for PDA team: If 1123-19 is 2 then have to show these questions below

1123e1. সাবানপানি তৈরীতে আপনার বা আপনার পরিবারের কি কোন ছমিকা আছে? Do you or your family have made any contribution to make this soapy water?

- 1. Always সবসময়
- 2. Sometimes কখনও কখনও
- 3. Never কখনই না (skip to 1123b)

আপনি অথবা আপনার পরিবার কিভাবে এটি তৈরীতে সাহায্য করেন? How you or your family have contributed to make this soapy water?

1123f1. আপনি কি সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কেনার টাকা শেয়ার করেন? Do you share money for buying the soap/detergent for making soapy water?

- 1. হ্যাঁ Yes
- 2. না No

1123g1. আপনি কি নিজে সাবানপানি তৈরীর জন্য সাবান/গুঁড়া সাবান কিনেন? Do you yourself buy the soap/detergent for making soapy water?

1. হ্যাঁ Yes
2. না No

1123h1. আপনি কি সাবানপানি তৈরীতে সাহায্য করেন? Do you help prepare the soapy water?

- 1.হ্যাঁ Yes
- 2.না No

1123b. আইসিডিডিআরবির দেয়া সাবানপানির বোতল ছাড়া অন্য কোন বোতলে সাবানপানি থাকলে তা পর্যবেক্ষন করুন এবং দেখুন সেটিতে কি পরিমাণ সাবানপানি আছে “Observe volume of soapy water in other type of container provided by icddr”
(যদি ১১২২ নং প্রশ্নে ১৯ নং অপশন সিলেক্ট করা হয় তাহলে প্রযোজ্য) (If in q1122 option 19 is selected then applicable)

- 1.পূর্ণ বোতল Bottle full
- 2.আংশিক পূর্ণ বোতল Bottle partly full
- 3.বোতলের নীচে অল্প পরিমাণ সাবানপানি Only small amount of soapy water at the bottom
- 4.খালি বোতল Empty

1123bb1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষন করুন Please observe the status of the cap on the soapy water bottle.

- i) কার্যত ব্যবহার উপযোগী ঢাকনা,ছিদ্র নেই Functional usable cap, not leaking
- j) ঢাকনা আছে কিন্তু ছিদ্র হয়ে গেছে Cap is present, but leaking
- k) ঢাকনা ভেঙ্গে গেছে/হারিয়ে গেছে Cap is broken/missing
- l) কোন সাবানপানির বোতল নেই No soapy water bottle is present

1123bb2. সাবানপানির বোতল কেমন পরিষ্কার আছে তা পর্যবেক্ষন করুন এবং লিপিবদ্ধ করুন Please observe and record how clean is the soapy water bottle?

- a) খুব পরিষ্কার Very clean (0)
- b) পরিষ্কার Clean (1)
- c) পরিষ্কার ও না অপরিষ্কারও না Neither clean nor dirty (2)
- d) অপরিষ্কার Dirty (3)

e) খুব অপরিষ্কার Very dirty (4)

1124. আপনি কি দয়া করে আপনার নিজের সাবানটি নিয়ে আসবেন যে সাবানটি আপনি এই হাত ধোয়ার স্থানে হাত ধোয়ার কাজে ব্যবহার করেন। Can you please bring your own soap that you use for washing hands to this handwashing station if not already here?

হাত ধোয়ার স্থানে সাবানটি আনতে কত সময় লেগেছিল? How long did it take to bring the soap to the handwashing station? _____seconds(প্রযোজ্য নয়=888) (দেখাতে রাজী না=666)((Not applicable=888) (Do not agree to bring soap=666)

1125. যদি কলসহ লাল বালতি থাকে, তবে তাতে কি পানি আছে? If the Red bucket with tap is there, does it have water in it?

1. হ্যাঁ (Yes)
2. না (No) (skip to 1126)
8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable)(specify): _____(skip to 1126)

1125a সেখানে কতটুকু পানি আছে? How much water is in there?

1. বালতি সম্পূর্ণ ভর্তি The container is full
2. বালতি কিছুটা ভর্তি The container is partly full
3. নীচের অংশে সামান্য পানি আছে Only small amount of water at the bottom
4. খালি Empty

1125b. কে এতে(কলসহ লাল বালতি) পানি ভরে? (who refills the water in it?)

1. কম্পাউন্ডের কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (the compound caretaker/manager/community volunteer)
2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)
3. প্রত্যেক খানাই পালাক্রমে এটা করে (Every household does it in shift)
4. নির্দিষ্ট কেউ নেই No specific person but its get done
5. কেউ ভরে না No one refills it

6. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it

7. অন্যান্য (Other)

1125c. আপনি কি কখনও হাত ধোয়ার স্টেশনের রিজার্ভারটি(বালতি) পূরণায় ভরেছেন? Have you ever refilled the reservoir (Bucket) of the handwashing station with water?

1. হ্যাঁ Yes.

2. না No

3. মনে করতে পারছিনা Cant remember

4. প্রযোজ্য নয় Not applicable.

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1125d. প্রশ্ন 1125c যদি হ্যাঁ হয়, আপনি কি বিগত সপ্তাহে হাত ধোয়ার স্টেশনের রিজার্ভারটি পূরণায় ভরেছেন? If Yes to q1125c, did you refill the reservoir of the handwashing station during the past week?

1. হ্যাঁ Yes

2. না No

3. প্রযোজ্য নয় Not applicable

1125e. আপনি কি কখনও হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছেন? Have you ever emptied the basin under the handwashing station?

1. হ্যাঁ Yes

2. না No

3. মনে করতে পারছিনা Cant remember

4. প্রযোজ্য নয় Not applicable (888)

1125f. প্রশ্ন 1125f যদি হ্যাঁ হয়, আপনি কি বিগত সপ্তাহে হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছেন? If Yes to q1125f Did you empty the basin under the handwashing station during the past week?

1. হ্যাঁ Yes

2. না No

3. মনে করতে পারছিনা Cant remember

4. প্রযোজ্য নয় Not applicable

1126. যদি অন্য কোন পাত্র থাকে তাহলে সেগুলোর কোনটিতে কি পানি আছে? If there are other kinds of containers, is there water in any of those?

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1. হ্যাঁ (Yes)

2. না (No) 8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable)(specify):_____

1127. এর মধ্যে (আইসিডিডিআরবির দেওয়া কলসহ লাল বালতি ছাড়া) কোন পাত্র কি কম্পাউন্ডের সবাই ব্যবহার করে? Is any of these containers (other than the Red bucket with tap given by ICDDR,B) for communal use?

1. হ্যাঁ (Yes)

2. না (1129 নং প্রশ্নে চলে যান) No(skip to 1129)

8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable)(specify):_____ (1129 নং প্রশ্নে চলে যান) No(skip to 1129)

1128. কে এতে পানি ভরে?(আইসিডিডিআরবির দেয়া লাল বালতি ছাড়া) who refills the water in it? (Other than the Red bucket with tap given by ICDDR, B) একাধিক পাত্র থাকলে বড়টির কথা জিজ্ঞাসা করুন If more than one, ask about the largest container .

1. কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (the compound caretaker/manager/community volunteer)

2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)

3. প্রত্যেক খানাই পালাক্রমে এটা করে (Every household does it in shift)

4. নির্দিষ্ট কেউ নেই No specific person

5. কেউ ভরে না No one refills it

6. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it

7. অন্যান্য (Other)

1129. যদি সাবান পানি থাকে, তবে বোতলটি খালি হলে কে পূর্ণ করে? (If soapy water bottle is there, who refills the soapy water bottle?)

1. কেয়ারটেকার/ ম্যানেজার/কমিউনিটি ভলান্টিয়ার (caretaker/manager/community volunteer)

2. কম্পাউন্ডের কেউ কেউ আছে যারা স্বেচ্ছায় এটা করে (There are someone in the compound who are willingly doing this)

3. প্রত্যেক খানাই এতে অংশ নেয় (Every household does it in shift)

4. এই বোতলটি ব্যক্তিগতভাবে ব্যবহারের জন্য (This bottle is for personal use)

5. নির্দিষ্ট কেউ নেই No specific person but it gets done

6. কেউ ভরে না No one refills the bottle
7. অন্যান্য (Other)
8. প্রযোজ্য নয়(নির্দিষ্ট করুন) (Not applicable)(specify):_____
10. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it

সাক্ষাৎকার গ্রহণকারী এই খানার একজন বাচ্চাকে (≥ 5 বছর ≤ 13 বছর) পায়খানার পর সাধারণত সে যেখানে হাত ধোয় এবং যেভাবে হাত ধোয় তা দেখাতে বলবে। প্রথমে জিজ্ঞাসা করুন সাধারণত সে পায়খানার পর কোথায় হাত ধোয়। তারপর বাচ্চাটিকে সেখানে যেতে বলুন এবং পায়খানার পর সে যেভাবে হাত ধোয় সেভাবে হাত ধুতে বলুন। মাঠকর্মী নোট করবে---

Field workers will now ask one child (≥ 5 years to ≤ 13 years) of the household to demonstrate where and how he/she usually washes his or her hands after defecation. They will first ask where he/she usually washes hands after defecation. Then they will ask the child to go to that place and handwash as usual after defecation. The field worker will note

1130. এখন এই খানায় কি ৫-১৩ বছরের কোন বাচ্চা আছে? Is there any child aged (≥ 5 years to ≤ 13 years) present now at home?

1. হ্যাঁ Yes
2. না, এরকম কোন বাচ্চা নেই No, there is no such child in this home (skip to 1139)
3. না, বাচ্চাটি এই মুহূর্তে বাসায় নেই No, the child is not present at this moment (skip to 1139)

1131. বাচ্চাটির বয়স কত? _____ বছর what was the age of the child? _____ Years

1132. বাচ্চাটির লিঙ্গ? What was the sex of the child?

1. পুরুষ (Male)
2. নারী (Female)

1133. বাচ্চাটি কী তার হাত ধুয়েছিল? (Did the child wash his/her hand?)

1. হ্যাঁ Yes
2. না, নির্দিষ্ট করুন----- (১১৩৯ নং প্রশ্নে চলে যান) No, (Skip to 1139) specify-----

1134. বাচ্চাটিকী দুই হাত ধুয়েছিল? (Did he/she wash both the hands?)

1. হ্যাঁ (Yes)
2. না (No)

1134a. বাচ্চাটি কোথায় হাত ধুয়েছিল? Where (the place) did the child demonstrate washing his/her hands?

1. প্রধান হাত ধোয়ার স্থানে At the primary handwashing station spot checked earlier
2. দ্বিতীয় প্রধান হাত ধোয়ার স্থানে At the secondary handwashing station spot checked earlier
3. পর্যবেক্ষণকৃত হাত ধোয়ার স্থানগুলো ব্যতীত অন্য কোন হাত ধোয়ার স্থান At another handwashing station not spot checked earlier
4. পায়খানার ভিতরে In the latrine
5. রান্নাঘরের ভিতরে In the kitchen
6. ঘরের ভিতরে inside his/her room
7. অন্যান্য নির্দিষ্ট করুন Other (specify)

1135. বাচ্চাটি তার হাত ধোয়ার জন্য কী ব্যবহার করেছিল? (What did he/she use to wash his/her hands)

একাধিক উত্তর গ্রহণযোগ্য (Check all that apply)

1. সাবান (Soap)
 - a. Body/hand soap গোসলের/হাত ধোয়ার সাবান
 - b. Laundry bar কাপড় ধোয়ার সাবান
 - c. Dish washing soap থালাবাসন ধোয়ার সাবান
 - d. তরল সাবান Liquid soap
2. সাবান পানি (Soapy water in bottle provided by icddr)
3. ছাই Ash
4. সাবান অথবা ছাই ছাড়া অন্য উপাদান; নির্দিষ্ট করুন (Material other than soap or ash; specify __)
5. শুধু পানি Only water
6. দেয়ালের সাবান (Pasted soap on the wall)
7. মাটি/বালু (Mud/Sand)
8. বালতি (Bucket)
9. বেসিন (Basin)
10. ট্যাপ/টিউবওয়েল (Tubewell)
11. কলসহ লাল বালতি (ICDDR B কতৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR, B)

12. কলসি Kolshi or other containers

13. গুঁড়া সাবান Detergent powder

1136. সাবানের ফেনা কি অবস্থায় ছিল? To what extent lather was formed?

1. অনেক ফেনা A lot of lather
2. অল্প ফেনা A little lather
3. ফেনা দেখা যায়নি No visible lather
8. প্রযোজ্য নয় Not applicable (Those who did not use soap for washing hands)

1137. কত সময় ধরে হাত ধুয়েছিল? (স্টপ ওয়াচের সাহায্যে গণনা) _____সেকেন্ড The total time to spend for washing hands? (Timed with a stop watch) _____sec

1137a. বাচ্চাটি কোথা থেকে পানি নিয়েছিল? From where did he/she use water to wash her hands?

1. সরাসরি মিউনিসিপাল কল/হ্যান্ড পাম্প/টিউবওয়েল থেকে Directly from the municipal tap/hand pump/tubewell (skip to 1137f)
2. লাল বালতির সংরক্ষিত পানি দিয়ে Water stored in Red Bucket provided by icddr
3. ঘরে সংরক্ষিত পানি দিয়ে water stored in another container within household (skip to 1137f)
4. মিউনিসিপাল লাইনের সংরক্ষিত পানি দিয়ে Water stored from municipal line(skip to 1137f)
7. অন্যান্য নির্দিষ্ট করুন Other (specify) _____(skip to 1137f)

1137b. বাচ্চাটি কি লাল বালতির কল থেকে পানি ঢেলেছিল? Did he/she use pour water through the tap of the red icddr bucket?

1.হ্যাঁ Yes
2.না No

1137c. বাচ্চাটি কি লাল বালতির উপর থেকে পানি নিয়েছিল? Did he/she draw water from the top?

1.হ্যাঁ Yes
2.না No

1137d. বাচ্চাটি কি চলমান পানিতে হাত ধুয়েছিল? Did he/she wash hand(s) under running water?

1.হ্যাঁ Yes

2.....না No

1137e. বাচ্চাটি টি কি আইসিডিডিঅরবির দেয়া হাত ধোয়ার বেসিনে হাত ডুবিয়ে ধুয়েছিল? Did he/she wash hand(s) by dipping in washbasin?

1.....হ্যাঁ Yes

2.....না No

1137f. বাচ্চাটি হাত ধোয়ার জন্য যে উপাদানগুলি ব্যবহার করেছিল সেগুলি কোথায় ছিল?একাধিক উত্তর গ্রহণযোগ্য Where were the materials that the child used for HW? (Check all that apply)

1. প্রধান হাত ধোয়ার স্থানে_At the primary handwashing station spot checked earlier

2.দ্বিতীয় প্রধান হাত ধোয়ার স্থানে_At the secondary handwashing station spot checked earlier

3. পর্যবেক্ষণকৃত হাত ধোয়ার স্থানগুলো ব্যতীত অন্য কোন হাত ধোয়ার স্থানে At another handwashing station not spot checked earlier

4. পায়খানার ভিতরেIn the latrine

5.রান্নাঘরের ভিতরে In the kitchen

6.ঘরের ভিতরে inside his/her room

7.অন্যান্য নির্দিষ্ট করুন Other (specify)

1137g.হাত ধোয়ার সময় বাচ্চাটির বাবা-মা অথবা অন্য কোন প্রাপ্ত বয়স্ক ব্যক্তি কি তাকে হাত ধোয়ার উপকরণ দিয়ে সাহায্য করেছিল? Was a parent/adult helping child with providing handwashing materials to him/her during the demonstration?

1.....হ্যাঁ Yes

2.....না No (Skip to 1138)

1137h বাচ্চাটির বাবা-মা অথবা অন্য কোন প্রাপ্ত বয়স্ক ব্যক্তিটি হাত ধোয়ার জন্য যে উপাদানগুলি এনে দিয়েছিল সেগুলি কোথায় ছিল? were the materials that the parent/caregiver/adult bring to the child for HW? Check all that apply একাধিক উত্তর গ্রহণযোগ্য

1. প্রধান হাত ধোয়ার স্থানে_At the primary handwashing station spot checked earlier

2.দ্বিতীয় প্রধান হাত ধোয়ার স্থানে_At the secondary handwashing station spot checked earlier

3. পর্যবেক্ষণকৃত হাত ধোয়ার স্থানগুলো ব্যতীত অন্য কোন হাত ধোয়ার স্থানে At another handwashing station not spot checked earlier
4. পায়খানার ভিতরে In the latrine
5. রান্নাঘরের ভিতরে In the kitchen
6. ঘরের ভিতরে inside his/her room
7. অন্যান্য নির্দিষ্ট করুন Other (specify)

1137i. বাচ্চাটির বাবা-মা অথবা অন্য কোন প্রাপ্ত বয়স্ক ব্যক্তি কি বাচ্চাটি কিভাবে হাত ধুবে তার কোন নির্দেশনা দিয়েছিল বা মনে করিয়ে দিয়েছিল? Did an adult gave instructions or reminded the child about how to wash hands?

1.হ্যাঁ Yes
2. না No

1138. কিভাবে হাত শুকিয়েছিল? How were hands dried?

- 1) নিজের পরিধেয় কাপড়ব্যতীত অন্য কোন কাপড়ে Cloth other than own clothing
- 2) নিজের পরিধেয় কাপড়ে own clothing
- 3) বাতাসে শুকিয়েছে(অন্য কাজে যাওয়ার আগে বা অন্যকিছু করবার আগে ইচ্ছাকৃতভাবে হাতটি শুকিয়েছে) Air dry (reflects intentional drying before moving on to other activities or touching anything else)
- 4) অন্য কাজ করবার আগে বা অন্য কিছু ধরবার আগে হাত শুকায়নি Did not dry hands before moving on to other activities or touching anything else

এই খানাটিতে যদি ৫ বছরের নীচে কোন বাচ্চা থাকে তাহলে মার্কস্মী সেই বাচ্চার মাকে পায়খানার পর সাধারণত যেখানে হাত ধোয় সেখানে যেতে বলবে এবং পায়খানার পর কিভাবে হাত ধোয় তা দেখাতে বলবে। যদি এই বয়সের কোন বাচ্চা না থাকে তাহলে মার্কস্মী ১৭ বছর বা তার চেয়ে বেশি বয়সের মহিলাকে পায়খানার পর সাধারণত যেখানে হাত ধোয় সেখানে যেতে বলবে এবং পায়খানার পর কিভাবে হাত ধোয় তা দেখাতে বলবে। যদি এরকম দুজনের একজনকেও না পায় সেক্ষেত্রে মার্কস্মী ১৭ বছর বা তার চেয়ে বেশি বয়সের পুরুষকে পায়খানার পর সাধারণত যেখানে হাত ধোয় সেখানে যেতে বলবে এবং পায়খানার পর কিভাবে হাত ধোয় তা দেখাতে বলবে। নোট করবে---

If there is a child <5years at home, the field worker will ask the mother of the child to go to the usual place where they wash hands after defecation and demonstrate how they usually wash their hands after defecation. If there is no such child at home, then the field worker will ask an adult female (≥17years) to go to the usual place where they wash hands after defecation and demonstrate washing hands. In absence of both such persons, the FRA will ask an adult male (≥17years) to go to the usual place where they wash hands after defecation and demonstrate washing hands. The field worker will note

1139. যে ব্যক্তিটি হাত ধুয়ে দেখাবেসে the person who will demonstrate washing hands was. ...

1. ৫ বছরের নীচের বাচ্চার পরিচর্যাকারী Care giver of <5years

2. অন্য কোন প্রাপ্তবয়স্ক মহিলা Another adult female
3. একজন প্রাপ্তবয়স্ক পুরুষ An adult male

1140. ব্যক্তিটির লিঙ্গ (যে সাক্ষাৎকার গ্রহণকারীর সামনে হাত ধুয়ে দেখাতে রাজী হয়েছে)?

What is the sex of that person (who agreed to demonstrate to wash hands in front of the interviewer?)

- 1 পুরুষ (Male)
2. নারী (Female)

1141. উত্তরদাতা/ব্যক্তি কী তার হাত ধুয়েছিল? Did the respondent wash his/her hand?

1. হ্যাঁ Yes
2. না(1147aনং প্রশ্নে যান) No (Skips to 1147a)
3. যেব্যক্তি হাত ধুয়েছে সে উত্তরদাতা ছিল না (Someone else other than the respondent demonstrated washing hands)

1142. উত্তরদাতা/ব্যক্তি কী দুই হাত ধুয়েছিল? (Did he/she wash both the hands?)

1. হ্যাঁ Yes
2. না No

1142a. ব্যক্তিটি কোথায় হাত ধুয়েছিল? Where (the place) did the person demonstrate washing his/her hands?

- 1.প্রধান হাত ধোয়ার স্থানে_ In the primary handwashing station
- 2.দ্বিতীয় প্রধান হাত ধোয়ার স্থানে_ In the secondary handwashing station
3. পায়খানার ভিতরে In the latrine
- 4.রান্নাঘরের ভিতরে In the kitchen
- 5.ঘরের ভিতরে inside his/her room
- 7.অন্যান্য নির্দিষ্ট করুন Other (specify)

1143. উত্তরদাতা/ব্যক্তি তার হাত ধোয়ার জন্য কী ব্যবহার করেছিল?(একাধিক উত্তর গ্রহণযোগ্য) (What did he/she use to wash his/her hands)(Multiple answers allowed)

1. সাবান (Bar Soap)

a. Body/hand soap গোসলের/হাত ধোয়ার সাবান

b. Laundry bar কাপড় ধোয়ার সাবান

c. Dish washing soap থালাবাসন ধোয়ার সাবান

d. তরল সাবান Liquid soap

2. সাবান পানি (Soapy water)

3. ছাই Ash

4. সাবান অথবা ছাই ছাড়া অন্য উপাদান; নির্দিষ্ট করুন (Material other than soap or ash; specify)

5. শুধু পানি Only water

6. দেয়ালের সাবান (Pasted soap on the wall)

7. মাটি/বালু (Mud/Sand)

8. বালতি (Bucket)

9. বেসিন (Basin)

10. ট্যাপ/টিউবওয়েল (Tubewell)

11. কলসহ লাল বালতি (ICDDRБ কতক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)

12. কলসি Kolshi or other containers)

13. গুঁড়া সাবান Detergent powder

1144. সাবানের ফেনা কি অবস্থায় ছিল? To what extent lather was formed?

1. অনেক ফেনা A lot of lather

2. অল্প ফেনা A little lather

3. ফেনা দেখা যায়নি No visible lather

8. প্রযোজ্য নয় Not applicable (Those who did not use soap for washing hands)

1145. কত সময় ধরে হাত ধুয়েছিল? (স্টপ ওয়াচের সাহায্যে গণনা করুন) _____ সেকেন্ড

The total time to spend for washing hands (timed with a stop watch) _____sec

1145a. ব্যক্তিটি কোথা থেকে পানি নিয়েছিল? From where did he/she use water to wash her hands?

1. সরাসরি মিউনিসিপাল কল/হ্যান্ড পাম্প/টিউবওয়েল থেকে Directly from the municipal tap/hand (skip to 1145f)
2. লাল বালতির সংরক্ষিত পানি দিয়ে Water stored in Red Bucket
3. ঘরে সংরক্ষিত পানি দিয়ে water stored within household(skip to 1145f)
4. মিউনিসিপাল লাইনের সংরক্ষিত পানি দিয়ে Water stored from municipal line(skip to 1145f)
7. অন্যান্য নির্দিষ্ট করুন Other (specify)_____ (skip to 1145f)

1145b. ব্যক্তিটি কি আইসিডিডিআরবি থেকে দেয়া কলসহ লাল বালতির কল থেকে পানি ঢেলেছিল? Did he/she use-pour water through the tap of the red icddr bucket?

1. হ্যাঁ Yes

2. না No

1145c. ব্যক্তিটি কি বালতির উপর থেকে পানি নিয়েছিল? Did he/she take water from the top of the red bucket?

1. হ্যাঁ Yes

2. না No

1145d. ব্যক্তিটি কি চলমান পানির নীচে হাত ধুয়েছিল? Did he/she wash hand(s) under running water?

1. হ্যাঁ Yes

2. না No

1145e. ব্যক্তিটি কি আইসিডিডিআরবির দেয়া হাত ধোয়ার বেসিনে হাত ডুবিয়ে ধুয়েছিল? Did he/she wash hand(s) by dipping in washbasin?

1. Yes

2. No

1145f. ব্যক্তিটি হাত ধোয়ার জন্য যে উপাদানগুলি ব্যবহার করেছিল সেগুলি কোথায় ছিল? একাধিক উত্তর গ্রহণযোগ্য Where were the materials that he/she used for HW? (Check all that apply)

1. প্রধান হাত ধোয়ার স্থানে_At the primary handwashing station spot checked earlier
2. দ্বিতীয় প্রধান হাত ধোয়ার স্থানে_At the secondary handwashing station spot checked earlier
3. পর্যবেক্ষণকৃত হাত ধোয়ার স্থানগুলো ব্যতীত অন্য কোন হাত ধোয়ার স্থানে At another handwashing station not spot checked earlier
4. পায়খানার ভিতরে In the latrine
5. রান্নাঘরের ভিতরে In the kitchen
6. ঘরের ভিতরে inside his/her room
7. অন্যান্য নির্দিষ্ট করুন Other (specify)

1146. কিভাবে হাত শুকিয়েছিল? (How were hands dried?)

- 1) সাক্ষাৎকার প্রদানকারীর/ব্যক্তির পরিধেয় কাপড়ব্যতীত অন্য কোন কাপড়ে Cloth other than respondent's/his/her own clothing
- 2) সাক্ষাৎকার প্রদানকারীর/ব্যক্তির পরিধেয় কাপড়ে Respondent's/his/her own clothing
- 3) বাতাসে শুকিয়েছে(অন্য কাজে যাওয়ার আগে বা অন্যকিছু করবার আগে ইচ্ছাকৃতভাবে হাতটি শুকিয়েছে) Air dry (reflects intentional drying before moving on to other activities or touching anything else)
- 4) অন্য কাজ করবার আগে বা অন্য কিছু ধরবার আগে হাত শুকায়নি Did not dry hands before moving on to other activities or touching anything else

এফআরএর জন্য নির্দেশনা: কম্পাউন্ডে/খানায় যদি সাবানপানি থাকে তাহলে সাক্ষাৎকার শেষে এফআরএ হাত ধোয়ার জন্য সাবানপানি আনতে বলবে। যদি খানার এবং কম্পাউন্ডের সকলের ব্যবহারের জন্য সাবানপানি থাকে তাহলে এফআরএ কম্পাউন্ডের সকলের ব্যবহারের সাবানপানি দিয়ে হাত ধুবে এবং নিম্নলিখিত তথ্যগুলি নিবে। Instruction for the FRA: At the end of handwashing behavior uptake, if soapy water is present in the household/compound, the FRA will ask for soapy water to wash his/her hands. If soapy water is present at both respondents' household and at compound level, the FRA will use the soapy water prepared for the communal use. The FRA will note the following information:

1147a. কম্পাউন্ডে/খানায় কি সাবানপানি আছে? Is soapy water present in the compound/household?

1. হ্যাঁ Yes
2. না No (skip to 1004)

1147. সাবানের ফেনা কি অবস্থায় ছিল? To what extent lather was formed?

1. অনেক ফেনা A lot of lather
2. অল্প ফেনা A little lather
3. ফেনা দেখা যায়নি No visible lather

1148. কত ঢাকনা গুঁড়া সাবান মিশানো হয়েছে? (জানিনা=৯৯৯) Ask the respondent or the person who prepared the soapy water how much of detergent powder was added? _____ caps (Don't know=999)

1149. গুঁড়া সাবান কি পরিমাণ পানিতে মিশানো হয়েছিল? (জানিনা=৯৯৯) Ask the respondent or the person who prepared the soapy water to what amount water the detergent powder was added? _____ ml মিলি (Don't know=999)

1150. সাবানপানি তৈরীতে কোন ব্র্যান্ডের গুঁড়া সাবান ব্যবহার করা হয়েছে? Which brand of detergent powder was used to prepare this soapy water?

1. হুইল Wheel
2. কেয়া Keya
3. সারফ এক্সেল Surf excel
4. জেট Jet
5. নির্দিষ্ট কোন ব্র্যান্ড নেই No specific brand
6. অন্যান্য Other _____
7. রিন Rin
9. জানিনা Don't know

1151. এফআরএ অনুগ্রহপূর্বক আপনার ব্যক্তিগত মতামত দিবেন যে সাবানপানি সঠিকভাবে মিশ্রিত, খুবই পাতলা, খুবই বেশি সাবানের মত ছিল কিনা। এই সাবানপানিটির ক্ষেত্রে আপনার স্কের নীচের স্কেলটিতে দিন যেখানে ০= খুবই পাতলা, ১=অল্প পাতলা, ২= সঠিকভাবে মিশ্রিত, ৩=অল্প সাবানের মত এবং ৪= খুব বেশি সাবানের মত। FRA, please give your personal assessment here as to whether the soapy water had the correct consistency, was too diluted, or was too soapy. On a scale from 0 to 4, with 0 = too diluted, 1 = mild diluted, 2=perfect mix, 3 = mild soapy and 4 = too soapy, what is your score of this soapy water preparation? 0 1 2 3 4 (circle the best score)

8/4 _____

৩/3 _____

২/2 _____

১/1 _____

০ _____

Section I: Handwashing Station recognition and reported usage

FRA এফআরএসকল ইন্টারভেনশন পণ্যসহ একটি ফ্লিপ চার্ট বহন করবে (FRA will carry a flip chart with all the intervention products.)

FRA এফআরএউত্তরদাতাকে সাবান পানি এবং সাবান পানিসহ লাল বাগতি এর ছবি দেখাবে এবং নিচের প্রশ্নগুলো করবে:

FRAএফআরএ will show the respondent the picture of soapy water bottle and red bucket with tap and stool and basin and will ask the following question, pointing to the bottle:

1004. আপনি কি এটা চিনতে পারছেন (সাবান পানির বোতল)? [Do you know what this is? (Bottle with soapy water)]

1. হ্যাঁ (Yes)
2. না (No)

1004a. আপনি/আপনার কম্পাউন্ড কি আইসিডিডিআরবি থেকে দেয়া সাবানপানি গ্রহণ করেছিলেন? Did you/r compound receive **BOTTLE** for making soapy water from ICDDR, B/DSK?

1. হ্যাঁ Yes
2. না No

1004b. আপনি কোন কম্পাউন্ডে এটি গ্রহণ করেছিলেন? [Where did you receive this bottle for soapy water?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)
1004c. আপনি বর্তমানে যে কম্পাউন্ডে আছেন সেখানে কি একটি আছে অথবা আগে যে কম্পাউন্ডে থাকতেন সেখানে কি ছিল? [Is there one (or was there one) in the compound you are currently living or in the compound you were living previously?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)

1004d. 1013. আপনি কি কখনও এটি ব্যবহার করেছেন? (Did you ever use it?)

1. হ্যাঁ (Yes)
2. না (No) (skip to 1005)

1005a. আপনি সাবানপানি কি কাজে ব্যবহার করেন For what purpose do you use soapy water? উত্তরগুলি পড়ে শোনান “হ্যাঁ” এর জন্য নিম্নের বক্সে “1” লিখুন এবং না দেখলে “না” এর জন্য নিম্নের বক্সে “0” লিখুন) (Interviewer, ask for each one below and write “1” for “yes” in the box below. , write “0” for “no” in the box below)

1. কাপড় ধোয়ার কাজে For washing clothes -- ☐
2. থালাবাসন ধোয়ার কাজে For washing utensils ☐
3. গোসল করার কাজে For bathing ☐
4. শ্যাম্পু হিসেবে As a shampoo ☐

5. হাত ধোয়ার কাজে for handwashing--□

1005b. আপনি/আপনার পরিবারের অন্য কেউ শেষ কবে এটি ব্যবহার করেছিলেন? (সাক্ষাৎকার প্রদানকারী নিজে) When did you or someone in your household use soapy water for handwashing last?

1. আজই (Today)
2. গতকাল (Yesterday)
3. এক সপ্তাহের মধ্যে (Within one week)
4. এক মাসের মধ্যে (Within one month)
5. 1 – 6 মাস (1 – 6 months)
6. ছয় মাস আগে (More than six months ago)

99. মনে নাই (Don't remember)

যদি গতকাল হয় তাহলে নীচের প্রশ্নটি করুন নাহলে 1005 এ চলে যান or yesterday then ask 1005c otherwise skip to 1005

1005c. আপনি গতকাল সাবানপানি দিয়ে কতবার হাত ধুয়েছেন? How many times did you, yourself use soapy water for handwashing yesterday? -----বার times

1005d. আপনি বা আপনার পরিবারের কোন সদস্য কি কখনও সাবান পানি তৈরী করেছেন? Have you or any of your family member ever made soapy water?

1. হ্যাঁ Yes
2. না No
3. জানিনা Dont know.
8. প্রযোজ্য নয় Not applicable.

1005. গত দুসপ্তাহে আপনি অথবা আপনার পরিবারের কোন সদস্য কি বাড়িতে আপনার পরিবারের ব্যবহারের জন্য সাবানপানি তৈরী করেছেন? Within last 2 weeks did you or any of your family members ever make soapy water at home for your family?

1. হ্যাঁ Yes
2. না (1008নং প্রশ্নে চলে যান)No(skip to 1008)
9. জানিনা (1008 নং প্রশ্নে চলে যান) Don't know (skip to 1008)

1006. গত দুসপ্তাহে আপনি অথবা আপনার পরিবারের কোন সদস্য কতবার নিজেরা আপনাদের পরিবারের জন্য সাবানপানি তৈরী করেছেন(প্রযোজ্য নয়=৮৮৮) (নির্দিষ্ট করুন)Within last 2 weeks how many times did you/your family members

make soapy water at home for your family? _____ times [Put 999 if 'cannot remember';
put 888 if 'not applicable'(specify):_____]

1006 a. আপনি কি সাবানপানির তৈরীর পদ্ধতি জানেন? Do you know the recipe of making soapy water?

1. হ্যাঁ Yes

2. না (skip to 1008)

1006b. কত ঢাকনা গুঁড়া সাবান মিশানো হয়? (জানিনা=৯৯৯) Ask the respondent how much of detergent powder is added for making soapy water? _____ caps (Don't know=999)

1006c. গুঁড়া সাবান কি পরিমাণ পানিতে মিশানো হয়? (জানিনা=৯৯৯) Ask the respondent to what amount water the detergent powder is added? _____ ml মিলি (Don't know=999)

1008. আপনি কি আমাকে সাবান পানি দেখাতে পারেন? (Can you show me the soapy water bottle?)

1. হ্যাঁ (Yes)= (বোতল এবং সাবানপানি) bottle plus soapy water

2. না, বোতল খালি ছিল (No, bottle was empty) () []

3. না (No) (১০০৯a নং প্রশ্নে চলে যান) [(skip to 1009a)] = কোন বোতল ছিল না no bottle

1009. সাবান পানি দেখাতে কতক্ষণ সময় লেগেছিল?----- (সেকেন্ড)

1009aa1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষণ করুন Please observe the status of the cap on the soapy water bottle.

m) কার্যত ব্যবহার উপযোগী ঢাকনা, ছিদ্র নেই Functional usable cap, not leaking

n) ঢাকনা আছে কিন্তু ছিদ্র হয়ে গেছে Cap is present, but leaking

o) ঢাকনা ভেঙ্গে গেছে/হারিয়ে গেছে Cap is broken/missing

p) কোন সাবানপানির বোতল নেই No soapy water bottle is present

1009aa2. সাবানপানির বোতল কেমন পরিষ্কার আছে তা পর্যবেক্ষণ করুন এবং লিপিবদ্ধ করুন Please observe and record how clean is the soapy water bottle?

a) খুব পরিষ্কার Very clean (0)

b) পরিষ্কার Clean (1)

c) পরিষ্কার ও না অপরিষ্কারও না Neither clean nor dirty (2)

d) অপরিষ্কার Dirty (3)

e) খুব অপরিষ্কার Very dirty (4)

[How many seconds did it take to show the soapy water? _____ (sec)]

1009a1. আপনি /আপনার পরিবার কি সাবান পানি তৈরী করার জন্য ডিটারজেন্ট পাউডার কিনেছেন? Have you/household bought detergent powder for making soapy water?

1. হ্যাঁ Yes
2. না No
3. জানিনা Dont know.
8. প্রযোজ্য নয় Not applicable

1009a. আপনি কী গত দুই সপ্তাহের মধ্যে সাবানপানি তৈরীর জন্য গুঁড়া সাবান কিনেছেন? (Did you purchase detergent powder for making soapy water in the last two weeks?)

1. হ্যাঁ (Yes)
2. না [No]
8. প্রযোজ্য নয় Not applicable
9. জানিনা [Don't know]

1010. এই কম্পাউন্ডে কি এমন কোন ঘর আছে যে ঘরের সদস্যরা নিজেরা গত দুসপ্তাহে তাদের ব্যবহারের জন্য সাবান পানি তৈরী করেছে?

Is there any other household within this compound who prepared soapy water by themselves for their use within last 2 weeks?

1. হ্যাঁ Yes
2. না No
9. জানিনা Don't know

1011. আপনার প্রতিবেশী/কম্পাউন্ডের কেউ কি আছে যে গত দুসপ্তাহে সকলের ব্যবহারের জন্য সাবান পানি তৈরী করেছে? (একাধিক উত্তর গ্রহণযোগ্য)

Did you or anyone from the neighbourhood/compound prepare soapy water for communal use within last 2 weeks? (>1 answers allowed)

1. আমি /আমার পরিবার করেছে I/my family did it
2. কেয়ারটেকার/কমিউনিটি ভলান্টিয়ার/কম্পাউন্ড ম্যানেজার করেছে caretaker/manager/community volunteer did it
3. কম্পাউন্ডের বিভিন্ন পরিবার এটি পর্যায়ক্রমে করেছে several families within the compound did it by rotation

4. একটি পরিবার ইচ্ছাকৃতভাবে দায়িত্ব নিয়ে এটি করেছে A family volunteered to do that
5. অন্যান্য Other
6. কেউ করেনি No one did it
9. জানিনা Don't know

1011a. আপনার কম্পাউন্ডে সাবান পানির পূর্ণ বোতল শেষ হতে কত সময় লাগে? [Instruction for PDA team maximum 30 weeks]

দিন-----সপ্তাহ (লিখুন ৮৮৮=প্রযোজ্য নয়, ৯৯৯=জানিনা) How long does a full bottle of soapy water last in your compound? _____Hours_ - _____Day_____weeks [write 888 if 'not applicable' & '999' if 'don't know']

1011b. সাবান পানির বোতল আমার এবং আমার পরিবারের হাত ধোয়াকে- The soapy water bottle makes handwashing for me and my household

1. আগের চেয়ে সহজ করেছে easier than before
2. আগের চেয়ে কঠিন করেছে harder than before
3. প্রায় একই রেখেছে about the same
8. প্রযোজ্য নয় Not applicable

1012. আপনি কি এটি চিনতে পারছেন (কলসহ লাল বালতি,টুল এবং গামলা)?[Do you know what this is? (Red bucket with tap and stool and basin supplied by ICDDR,B)]

1. হ্যাঁ(Yes)
2. না(No)

1013a. আপনি/আপনার কম্পাউন্ড কি আইসিডিডিআরবি থেকে দেয়া ট্যাপসহ লাল বালতি,টুল এবং গামলা গ্রহণ করেছিলেন?Did you/your compound receive Red bucket with tap,stool and basin from ICDDR,B?

1. হ্যাঁ Yes
2. না No

1013b. আপনি কোন কম্পাউন্ডে এটি গ্রহণ করেছিলেন ? [Where did you receive the red bucket with tap,stool and basin from ICDDR,B?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)
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1013c. আপনি বর্তমানে যে কম্পাউন্ডে আছেন সেখানে কি এটি আছে অথবা আগে যে কম্পাউন্ডে থাকতেন সেখানে কি এটি ছিল? [Is there in the compound you are currently living or in the compound you were living previously?]	1. বর্তমান (Current compound) 2. পূর্ববর্তী (Previous compound) 3. উভয় (Both) 4. কোনটি নয় (Neither)
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1013. আপনি কি কখনও এটি ব্যবহার করেছেন?(Did you ever use it?)

1. হ্যাঁ(Yes)

2. না(No)(skip to 1014)

1013d For what purpose do you use the red bucket? আপনি এটি কি কাজে ব্যবহার করেন? উত্তরগুলি পড়ে শোনান“ হ্যাঁ ” এর জন্য নিম্নের বক্সে “1” লিখুন এবং না দেখলে “ না ” এর জন্য নিম্নের বক্সে “0” লিখুন) (Interviewer, ask for each one below and write “1” for “yes” in the box below. , write “0” for “no” in the box below)

1. কাপড় ধোয়ার কাজে For washing clothes --□

2. থালাবাসন ধোয়ার কাজে For washing utensils--□

3. গোসল করার কাজে For bathing□

4.পাণি সংরক্ষণ করবার কাজে To store water--□

5. হাত ধোয়ার কাজে for handwashing--□

6.শাকসবজি ধোয়ার কাজে To wash vegetables--□

7.অন্যান্য নির্দিষ্ট করুন----□---others specify-----

1014d. আপনি শেষ কবে এটি ব্যবহার করেছিলেন? (সাক্ষাৎকার প্রদানকারী নিজে) When did you or your household use red bucket with tap for handwashing last?

1.আজই (Today)

2. গতকাল (Yesterday)

3. এক সপ্তাহের মধ্যে (Within one week)

4. এক মাসের মধ্যে (Within one month)

5. 1 – 6 মাস (1 – 6 months)

6. ছয় মাস আগে (More than six months ago)

7. কখনও না Never

99. মনে নাই (Don't remember)

যদি গতকাল হয় তাহলে নীচের প্রশ্নটি করুন নাহলে **1014c** এ চলে যান **or yesterday then ask 1014b otherwise skip to 1014**

1014b. আপনি গতকাল কলসহ লাল বালতি দিয়ে কতবার হাত ধুয়েছেন? How many times did you, yourself use red bucket with tap for handwashing yesterday? -----বার times

1014c. গত দুই সপ্তাহের মধ্যে আপনি কত ঘন ঘন হাত ধোয়ার জন্য লাল বালতিটি ব্যবহার করেছেন? In the last 2 weeks, how often have you used the red bucket for handwashing?

1. দিনে কয়েকবার several times a day
2. দিনে একবার once a day
3. সপ্তাহে একবার once a week
4. একবারও না Not once in these two weeks

1014d. লাল বালতির এক বালতি পানি কত সময় ধরে থাকে? How long does the water in the bucket last? -Hour---ঘন্টা
----Dayদিন (জানি না=৯৯৯) (Don't know=999)

1014e.. কম্পাউন্ড ম্যানেজার কি হাত ধোয়ার স্টেশনটিকে(বালতি এবং সাবার পানি) এমন কোন জায়গায় রাখে যেখান থেকে সবাই হাত ধোয়ার জন্য এটা ব্যবহার করতে পারে? Does the compound manager put the hand washing station (bucket and soapy water) in a place where everyone can use it to wash hands?

- a) হ্যাঁ, তিনি এটা সবসময় খোলা রাখেন Yes, he always puts it out in the open
- b) হ্যাঁ, তিনি এটা কখনও কখনও খোলা রাখেন এবং কখনও কখনও তালাবদ্ধ রাখেন Yes Yes, he sometimes puts it out in the open , and sometimes keeps it locked up
- c) না, তিনি এটা সবসময় তালাবদ্ধ রাখেন No, he always keeps it locked up
- d) এটা সাবার ব্যবহার উপযোগী জায়গায় আছে It is in common place
- e.) প্রযোজ্য নয় Not applicable নির্দিষ্ট করে লিখুন) _____

1014f. .. হাত ধোয়ার স্টেশনটি(বালতি এবং সাবার পানি) যিনি রক্ষণাবেক্ষণ করেন তিনি কি কম্পাউন্ডের অন্যান্যদেরকে হাত ধোয়ার জন্য এটি ব্যবহার করতে দেন? Do the Person who maintain the hand washing station (bucket and soapy water) allow others in the compound to use it to wash hands?

- a) হ্যাঁ, সবসময় Yes, always
- b) হ্যাঁ, কখনও কখনও Yes, sometimes
- c) না No
- d) জানি না Don't know
- e) প্রযোজ্য নয় Not applicable নির্দিষ্ট করে লিখুন) _____

1014g) টুল এবং বেসিনসহ বালতিটি আমার এবং আমার পরিবারের হাত ধোয়াকে- The bucket with stool and basin makes handwashing for me and my household

1. আগের চেয়ে সহজ করেছে easier than before
2. আগের চেয়ে কঠিন করেছে harder than before
3. প্রায় একই রেখেছে about the same
8. প্রযোজ্য নয় Not applicable নির্দিষ্ট করে লিখুন) _____

1014. আপনার ঘরে এখন হাত ধোয়ার কোন সাবান (সাবান পানি ছাড়া) আছে কি?

Right now, do you have any soap (other than soapy water) in the house that you use for handwashing?

1. হ্যাঁ (Yes)
2. না (1018 নং প্রশ্নে চলে যান) [No (Skips to 1018)]
9. জানিনা (1018নং প্রশ্নে চলে যান) Don't know (Skips to 1018)

1015. আপনি কী আমাকে সাবানটি দেখাবেন (পর্যবেক্ষণ করুন) Can you show me the soap? (Observe)

1. হ্যাঁ (Yes)
2. না, সাবান দেখা যাচ্ছে না (অন্য কোথাও ব্যবহৃত হচ্ছে, ঘরে সাবান নেই, ইত্যাদি) [১০১৮ নং প্রশ্নে চলে যান] No, soap unobservable (in use elsewhere, none in the house, etc.) (Skips to 1018)

1016. সাবানটি দেখাতে কতক্ষণ সময় নিয়েছে? _____ সেকেন্ড

(How long did it take to show the soap? _____ second)

1017. এটা কোন ধরনের সাবান? (পর্যবেক্ষণের পর পূরণ করুন। হ্যাঁ = 1 এবং না = 0) What kind of soap is it? (Fill in based on observation. Put 1= Yes and 0=No)

- | _____ | 1. কাপড় ধোয়ার সাবান (laundry bar soap)
- | _____ | 2. ডিটারজেন্ট পাউডার (detergent powder)
- | _____ | 3. হাড়ি-পাতিল ধোয়ার সাবান (dish soap)
- | _____ | 4. গোসল/হাত ধোয়ার সাবান (body/hand soap)
- | _____ | 5. তরল সাবান (Liquid soap)
- | _____ | 7. অন্যান্য (নির্দিষ্ট করে লিখুন) _____ (Other _____)

1018. আপনার খানাতে অতিরিক্ত কোন অব্যবহৃত সাবান আছে কি? (এখনও খোলা হয়নি এমন বার/প্যাকেট) Do you have any spare unused soap in the house? (a second bar/package that is unopened)

1. হ্যাঁ (Yes)
2. না [1024 নং প্রশ্নে চলে যান] [No (Skips to 1022)]
9. জানিনা [1024 নং প্রশ্নে চলে যান] [Don't know (Skips to 1022)]

1019. আপনি কী আমাকে সাবানটি দেখাবেন (পর্যবেক্ষণ করুন) Can you show me the soap? (observe)

1. হ্যাঁ (Yes)
2. না [নং প্রশ্নে চলে যান] [No (Skips to 1022)]

1020. সাবানটি দেখাতে কতক্ষণ সময় নিয়েছে? _____ সেকেন্ড

(How long did it take to show the soap? _____ seconds)

1021. এটা কোন ধরনের সাবান? (পর্যবেক্ষণের পর পূরণ করুন। হ্যাঁ = 1 এবং না = 0) What kind of soap is it? (Fill in based on observation. Put 1= Yes and 0=No)

- | _____ | 1. কাপড় ধোয়ার সাবান (Laundry bar soap)
- | _____ | 2. ডিটারজেন্ট পাউডার (detergent powder)
- | _____ | 3. হাড়ি-পাতিল ধোয়ার সাবান (Dish soap)
- | _____ | 4. গোসল/হাত ধোয়ার সাবান (body/hand soap)
- | _____ | 5. তরল সাবান (Liquid soap)
- | _____ | 7. অন্যান্য (নির্দিষ্ট করে লিখুন) _____ [Other _____]

1022. সাক্ষাৎকার প্রদানকারী যদি ১০১৭ অথবা ১০২১ এ বার সাবানগুলো দেখায় তাহলে প্রতিটি সাইজের কতগুলো হাত ধোয়ার/গোসলের বার সাবান আপনাকে দেখিয়েছে? If the respondent showed bar soap(s) in q 1017 or 1021, how many bars of each size hand/ body soap did he/she show you?

1. ছোট _____ (small)
2. মাঝারি _____ (medium)
3. বড় _____ (large)

1023. সাক্ষাৎকার প্রদানকারী যদি ১০১৭ অথবা ১০২১ এ গুঁড়াসাবানের প্যাকেটগুলো দেখায়তাহলে প্রতিটি সাইজের কতগুলো গুঁড়া সাবানের প্যাকেট আপনাকে দেখিয়েছে? If the respondent showed detergent packet(s) in q. 1017 or 1021, how many of each size detergent packet(s) did he/she show you?

1. ছোট _____ (small)
2. মাঝারি _____ (medium)
3. বড় _____ (large)

1024. আপনি কী গত দুই সপ্তাহের মধ্যে কাপড় ধোয়ার বার সাবান কিনেছেন? (Did you purchase laundry bar soap in the last two weeks?)

1. হ্যাঁ (Yes)
2. না [1026 নং প্রশ্নে চলে যান] No (skip to 1026)
9. জানিনা [1026নং প্রশ্নে চলে যান] [Don't know (skip to 1026)]

1025. গত দুই সপ্তাহের মধ্যে কাপড় ধোয়ার বার সাবান কিনার জন্য কত টাকা খরচ করেছেন? _____ টাকা(জানিনা=৯৯৯)

[How much money did you spend on laundry soap in the last two weeks? _____ (taka)(don't know=999)]

1025.1. আপনি /আপনার পরিবার কী কখনও হাত ধোয়ার জন্য বার সাবান কিনেছেন? Have you/your household ever bought bar soap for handwashing?

1. হ্যাঁ Yes.
2. না No
3. মনে করতে পারছেন না Cant remeber
4. প্রযোজ্য নয় Not applicable

1025.2. আপনি /আপনার পরিবার কী কখনও হাত ধোয়ার জন্য ডিটারজেন্ট পাউডার কিনেছেন? Have you/your household ever bought detergent for handwashing?

1. হ্যাঁ Yes.
2. না No
3. মনে করতে পারছেন না Cant remeber
4. প্রযোজ্য নয় Not applicable

1026. আপনি কী গত দুই সপ্তাহের মধ্যে হাত ধোয়ার/ গোসল করার সাবান কিনেছেন? (Did you purchase hand/ body soap in the last two weeks?)

1. হ্যাঁ (Yes)

2. না [1028 নং প্রশ্নে চলে যান] [No]

9. জানিনা [1028 নং প্রশ্নে চলে যান] [Don't know ()]

1027. গত দুই সপ্তাহের মধ্যে হাত ধোয়ার/ গোসল করার সাবান কিনার জন্য কত টাকা খরচ করেছেন? _____ টাকা (জানিনা=৯৯৯)
(How much money did you spend on hand/ body soap in the last 2 weeks? _____ (taka) (don't know=999))

1028. গত ১ মাসের মধ্যে হাত ধোয়ার/ গোসল করার জন্য কতগুলো বার সাবান কিনেছেন? _____

(How many bars of each size hand/ body soap did you buy in the last one month? _____)

1. ছোট _____ (small)

2. মাঝারি _____ (medium)

3. বড় _____ (large)

1029. এই বাড়িতে কি এমনকোন জায়গা আছে যেখানে সাবান দেয়ালের সাথে আটকানো অবস্থায় আছে?
(Is there any place within this compound where soap has been attached to the wall?)

1. হ্যাঁ Yes

2. না (১০০১ নং প্রশ্নে চলে যান) No (skip to 1001)

9. জানিনা (১০০১ নং প্রশ্নে চলে যান) Don't know (skip to 1001)

1031. আপনি কী আমাকে সাবানটি/দেয়ালে আটকানো সাবানগুলো দেখাবেন (পর্যবেক্ষণ করুন)(একাধিক উত্তর গ্রহণযোগ্য) Can you show me the soap/soaps attached to the wall? (observation) (>1 response allowed)

1. পায়খানার মধ্যে It is in the latrine

2. রান্নাঘরের মধ্যে It is in the kitchen

3. হাত ধোয়ার জায়গায় In the handwashing station

4. কোন সাবান দেখা যায়নি No soap could be observed

7. অন্যান্য (নির্দিষ্ট করে লিখুন) _____ Other place (specify) _____

Section J: উত্তরদাতার হাত ধোয়ার অভ্যাস সম্পর্কিত তথ্য (Respondent's reported hand washing practice :)

1001. আমি এখন আপনাকে যে পণ্যগুলির নাম বলব আপনি কত ঘনঘন এগুলো দিয়ে হাত ধোন? [নীচের তালিকাটি পড়ে শোনান এবং জিজ্ঞাসা করুন তারা এটি 'সবসময়', 'বেশিরভাগ সময়', 'কখনও কখনও' এবং 'কখনই না' কিভাবে চর্চা করে; প্রযোজ্য নয়=৮৮৮] How frequently do you wash your hands with the materials that I am going to mention to you now? [Ask about each of the options and ask them if they practice this 'always', 'most of the time', 'sometimes' and 'never'; if not applicable, write '888']

হাত ধোয়ার পণ্যসামগ্রীর নাম Name of the handwashing agents	1. সবসময় Always	2. বেশিরভাগ সময় Most of the time	3. কখনও কখনও sometimes	4. Never কখনই না
a. body/hand soap গোসলের /হাত ধোয়ার সাবান				
b. dish soap থালাবাসন ধোয়ার সাবান				
c. laundry soap কাপড় ধোয়ার সাবান				
d. ash ছাই				
e. Soapy water সাবানপানি				
f. only water শুধু পানি				
g. mud মাটি				
h. powdered detergent গুঁড়া সাবান				
i. Soap pasted on the wall দেয়ালের সাবান				

1002. আমি এখন আপনাকে যে কাজগুলির কথা বলব আপনি কত ঘনঘন এই কাজগুলির ক্ষেত্রে শুধু পানি দিয়ে হাত ধোঁন? [নীচের তালিকাটি পড়ে শোনান এবং জিজ্ঞাসা করুন তারা এটি 'সবসময়', 'বেশিরভাগ সময়', 'কখনও বখনও' এবং 'কখনই না' কিভাবে চর্চা করে; প্রযোজ্য নয়=৮৮৮] How frequently do you wash your hands with water alone at each of the times I am going to mention now? [Ask about each of the options and ask them if they practice this 'always', 'most of the time', 'sometimes' and 'never'; if not applicable, write '888']

হাত ধোয়ার সময় Time to wash hands	1. সবসময় Always	2. বেশিরভাগ সময় Most of the time	3. কখনও কখনওsometimes	4. কখনই নাnever	৪. প্রযোজ্য নয়(নির্দিষ্ট করুন)  not applicable(specify):_
a. খাওয়ার পূর্বে Before eating					
b. খাওয়ার পর After eating					
c. বাচ্চাকে খাওয়ানোর আগে Before feeding a child					
d. বাচ্চাকে সৌচানোর পর After cleaning the child's anus					
e. মাছ/মাংস কাটার পর After cutting fish or meat					
f. পায়খানার পর After					

defecation					
g. শাকসবজি কাটার আগে, Before cutting vegetables, ,					
g 1.before cutting fruit ফল কাটার আগে					
g 2.before cutting salad সালাদ কাটার আগে					
g 3.before mashing any food কোন ভর্তা করার আগে					
h. রান্না করা খাবার ছোঁয়ার পূর্বে Before touching cooked food					
i. রান্না করা খাবার ছোঁয়ার পর After touching cooked food					

1003. আমি এখন আপনাকে যে কাজগুলির কথা বলব আপনি কত ঘনঘন এই কাজগুলির ক্ষেত্রে সাবান/সাবানপানি দিয়ে হাত ধোঁন? [নীচের তালিকাটি পড়ে শোনান এবং জিজ্ঞাসা করুন তারা এটি 'সবসময়', 'বেশিরভাগ সময়', 'কখনও বখনও' এবং 'কখনই না' কিভাবে চর্চা করে; প্রযোজ্য নয়=৮৮৮] How frequently do you wash your hands with soap/soapy water at each of the times I am going to mention now? [Ask about each of the options and ask them if they practice this 'always', 'most of the time', 'sometimes' and 'Never'; if not applicable, write '888']

Time to wash hands	1. সবসময় Always	2. বেশিরভাগ সময় Most of the time	3. কখনও কখনওsometimes	4. কখনই না Never	৪. প্রযোজ্য নয়(নির্দিষ্ট করুন)  not applicable(specify):_____
a. খাওয়ার পূর্বে Before eating					
b. খাওয়ার পর After eating					

c. বাচ্চাকে খাওয়ানোর আগে Before feeding a child					
d. বাচ্চাকে সৌচানোর পর After cleaning the child's anus					
e. মাছ/মাংস কাটার পর After cutting fish or meat					
f. পায়খানার পর After defecation					
g. শাকসবজি কাটার আগে Before cutting vegetables,					
g 1.before cutting fruit ফল কাটার আগে					
g 2.before cutting salad সালাদ কাটার আগে					
g 3.before mashing any foodকোন ভর্তা করার আগে					
h. রান্না করা খাবার ছোঁয়ার পূর্বে Before touching cooked food					
i. রান্না করা খাবার ছোঁয়ার পর After					

touching cooked food					
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Section K: পানি এবং হাত ধোয়া বিষয়ক জ্ঞান Knowledge about water and hand hygiene

এখন আমি আপনাকে বিভিন্ন উক্তি পড়ে শুনাব। প্রত্যেক উক্তির ক্ষেত্রে, আমি জানতে চাইব আপনি এই উক্তির সাথে কতটা একমত বা দ্বিমত পোষণ করেন। এখানে কোন ভুল বা ঠিক উত্তর বলে কিছু নাই-আমি শুধু আশা করব যে আপনি এই উক্তিটির উপর সত্যনিষ্ঠ মতামত দিবেন। কারণ এটা আগের প্রশ্ন গুলোর মত নয় যে গুলো আপনি উত্তর করেছেন, আমি একটা উদাহরণ দিচ্ছি : (Now I am going to read you a variety of statements. For each statement, I would like to know how much you agree or disagree with the statement. There are no right or wrong answers – I only ask that you tell me your honest opinion on these statements. Because this may not be like previous questions you have answered, I would like to do an example:)

ভাত রান্না করা সহজ, আপনি কি এই মতের সাথে একমত না দ্বিমত? (Cooking rice is easy. Do you agree or disagree with this statement?)

যদি একমত হন: ঠিক আছে- আপনি একমত যে ভাত রান্না করা সহজ। এখন, আমি জানতে চাইব আপনি এই উক্তির সাথে কত বেশী একমত। আপনি কি বলবেন যে আপনি এই উক্তির সাথে কিছুটা একমত যে, ভাত রান্না করা সহজ নাকি আপনি বলবেন যে সম্পূর্ণ একমত এই উক্তির সাথে যে ভাত রান্না করা সহজ? (If Agree: Okay – you agree that cooking rice is easy. Now, I would like to know how strong you agree with the statement. Would you say that you slightly agree with the statement that cooking rice is easy or would you say that you that you strongly agree with the statement that cooking rice is easy?).

যদি দ্বিমত হন: ঠিক আছে - আপনি এই উক্তির সাথে দ্বিমত যে ভাত রান্না করা সহজ। এখন আমি জানতে চাইব আপনি এই উক্তির সাথে কত বেশী দ্বিমত। আপনি কি এই উক্তির সাথে কিছুটা দ্বিমত নাকি আপনি সম্পূর্ণ দ্বিমত? (If Disagree: Okay – you disagree with the statement that cooking rice is easy. Now I would like to know how strong you disagree with the statement. Do you slightly disagree with the statement or do you strongly disagree with the statement?)

Ok – Would you like to do one more practice session?

Rickshaws are the best way to travel.

301A	ডায়রিয়া প্রতিরোধের উত্তম পন্থা হচ্ছে খাবার পানি ফুটিয়ে নেয়া। (Boiling drinking water is the best way to protect against diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301B	যে পানি দেখতে পরিষ্কার তা খাবার জন্য নিরাপদ। (Water that looks clear is safe to drink)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)

301L	আমি বিশ্বাস করি যে পানিতে অদ্ভুত স্বাদ না থাকলেই পানিটা পরিষ্কার I believe water is clean if it does not have a funny taste	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301M	আমি বিশ্বাস করি যে পানি তখনই পরিষ্কার হয় যদি তা ফুটিয়ে বা ক্লোরিন দ্বারা বিশুদ্ধ করা হয় I believe water is clean if it has been treated with chlorine or boiled	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301C	পানি বিশুদ্ধ করে ডায়রিয়া প্রতিরোধ করা যাবে (Treating drinking water will protect against diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301D	টয়লেট ব্যবহারের পর, পানি দিয়ে হাত ধুলেই যথেষ্ট। (After using the toilet, it is okay to just rinse hand with water)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301E	খাবার পর সাবান দিয়ে হাত ধোয়া ডায়রিয়া প্রতিরোধের একটা গুরুত্বপূর্ণ উপায় (Washing hands with soap after eating food is an important way to protect against diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301F	বাচ্চাকে শৌচ করানোর পর, যদি আপনার হাতে পায়খানা লেগে থাকে, শুধু তখনই হাত ধোয়া উচিত (After cleaning a child's bottom, it is only important to wash hands if you can see feces on your hands)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301G	পঁচা খাবার খেলে ডায়রিয়া হবে (Eating spoiled foods will cause diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301H	ফল ও শাক-শজি ধরার আগে হাত ধোয়া জরুরী নয় (It is not important to wash hands before touching fruits and vegetables)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301I	কলেরা ভ্যাকসিন নিয়ে ডায়রিয়ার মত রোগ প্রতিরোধ করা সম্ভব নয় (Taking cholera vaccine will not protect against cholera and diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
301J	খাবার পরিবেশনের আগে হাত ধোয়া জরুরী (It is important to wash hands before touching food that is to be served)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)

301K	পানি দিয়ে হাত ধুয়ে ডায়রিয়া প্রতিরোধ করা সম্ভব (Rinsing hands with water will protect against diarrhea)	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
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(সাক্ষাৎকার প্রদানকারীকে পড়ে শোনানোর জন্য): আপনি জানেন যে, আমরা লোকজনের সাথে কথা বলছি যে কিভাবে তাদের খাবার পানি পানের জন্য নিরাপদ করা নিশ্চিত করবেন। প্রত্যেকেই তার নিজস্ব উপায়ে খাবার পানি পানের জন্য নিরাপদ করা নিশ্চিত করে। এখন আমি আপনাকে পানি বিশুদ্ধ করার কিছু উপায় সম্পর্কে জিজ্ঞেস করবো-প্রত্যেকটির জন্য, আমি জানতে চাইব, আপনি কি পানি বিশুদ্ধ করণের এই পদ্ধতি সম্পর্কে শুনেছেন, আপনি কি কখনো এটা ব্যবহার করেছেন, এবং পানি বিশুদ্ধ করার জন্য এটা কতটা কার্যকর বলে আপনি মনে করেন?

(Preamble (To be read to the survey respondent): As you know, we have been talking to people about how to make sure their drinking water is safe to drink. Each person has her or his own way of making sure that drinking water is safe to drink. I am going to read you a list of things that people do to keep their drinking water safe. – for each of these, I would like to know if you have heard of this method, if you have ever used it, and how effective you think it is at purifying water.)

	আপনি কি শুনেছেন যে লোকেরা...খাবার জন্য পানি নিরাপদ করে (Have you heard of people...to make water safe for drinking?)	আপনার খাবার পানি নিরাপদ করার জন্য আপনি কি কখনো এটা ব্যবহার করেছেন? (Have you ever used this to make your drinking water safe?)	খাবার পানি বিশুদ্ধ করার জন্য এটা কতটা কার্যকর বলে আপনি মনে করেন: 1. কার্যকর নয় 2. কিছুটা কার্যকর 3. অত্যন্ত কার্যকর (How effective do you think this is for purifying drinking water: not effective, somewhat effective, or very effective)
A. ফুটিয়ে (Boiling)	302A1 1. হ্যাঁ (Yes) 2. না(No) -> 302B1 9. জানি না (Don't know) -> 302B1	302A2 কোন SKIP CODES নাই (PLEASE NOTE – NO SKIP CODES ON THESE) 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302A3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
B. কাপড় দিয়ে ছেঁকে (Filtering with a cloth)	302B1 1. হ্যাঁ (Yes) 2. না(No) -> 302C1 9. জানি না (Don't know) -> 302C1	302B2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302B3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
C. তলানি ফেলে (Sedimentation)	302C1 1. হ্যাঁ (Yes) 2. না(No) -> 302D1 9. জানি না (Don't know) -> 302D1	302C2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302C3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)

D. ফিটকারি [Aluminum sulphate (fitkiri)]	302D1 1. হ্যাঁ (Yes) 2. না(No) -> 302I1 9. জানি না (Don't know) -> 302E1	302D2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302D3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
I. চায়ের দোকানে পান করার জন্য পানি কেনা Buying water to drink at the tea stalls	302I1 1. হ্যাঁ (Yes) 2. না(No) -> 302J1 9. জানি না (Don't know) -> 302E1	302I2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302I3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
J. কেবল চা বা অন্য গরম তরল পান করা Only drinking tea or other hot liquid	302J1 1. হ্যাঁ (Yes) 2. না(No) -> 302E1 9. জানি না (Don't know) -> 302E1	302J2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302J3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
E. ক্লোরিন ট্যাবলেট (Chlorine tablets)	302E1 1. হ্যাঁ (Yes) 2. না(No) -> 302F1 9. জানি না (Don't know) -> 302F1	302E2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302E3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
F. ক্লোরিন পাউডার (Chlorine powder)	302F1 1. হ্যাঁ (Yes) 2. না(No) -> 302G1 9. জানি না (Don't know) -> 302G1	302F2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302F3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
G. ফিল্টার (Filter)	302G1 1. হ্যাঁ (Yes) 2. না(No) -> 302H1 9. জানি না (Don't know)-> 302H1	302G2 1. হ্যাঁ (Yes) 2. না(No) 9. জানি না (Don't know)	302G3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)
H. ক্লোরিন ডিস্পেন্সার (Chlorine dispenser)	302H1 1. হ্যাঁ (Yes) 2. না(303 নং প্রশ্নে চলে যান)(No)(skip to 303) 9. জানি না (303 নং প্রশ্নে চলে যান)Don't know(skip to 303)	302H2 1. হ্যাঁ (Yes) 2. না(No) (302H3-এর পর 303a-303d skip হবে) (after 302H3 skip 303a-303d) 9. জানি না (Don't know) (302H3-এর পর 303a-303d skip হবে) (after 302H3 skip 303a-303d)	302H3 1. কার্যকর নয় (Not effective) 2. কিছুটা কার্যকর (Somewhat effective) 3. অত্যন্ত কার্যকর (Very effective)

303a	ক্লোরিন দিয়ে পানি বিসুদ্ধ করার পর ২৪ ঘন্টা পর্যন্ত ক্লোরিন পানিতে বিদ্যমান থাকে এই বিষয়টি আমাকে আমার খাবার পানি ক্লোরিন দিয়ে পানি বিসুদ্ধ করতে উদ্বুদ্ধ করেছে The fact that chlorine stays in the water 24 hrs after treatment motivates me to chlorinate my drinking water	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
303b	ক্লোরিনের গন্ধ আমাকে বলে দেয় যে এই পানি খাওয়ার জন্য নিরাপদ The smell of chlorine tells me that the water is safe to drink	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
303e	ক্লোরিন দ্বারা বিসুদ্ধ করা পানির স্বাদ আমি পছন্দ করি। I like the taste of chlorinated water:	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
303f.	ক্লোরিন দ্বারা বিসুদ্ধ করা পানির গন্ধ আমি পছন্দ করি। I like the smell of chlorinated water:	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
303c	পৃথিবীর আধুনিক দেশগুলি সবসময় ক্লোরিন দ্বারা বিসুদ্ধকৃত পানি খায় Modern countries around the world always drink chlorinated water	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)

303d	The smell of chlorine is not as noticeable after getting used to it যখন আমি ক্লোরিন দিয়ে বিশুদ্ধকৃত পানি খেতে অভ্যস্ত হয়ে যাই তখন আর এর গন্ধ সেরকম লাগেনা	1. সম্পূর্ণ দ্বিমত (Strongly disagree) 2. কিছুটা দ্বিমত (Slightly disagree) 3. কিছুটা একমত (Slightly agree) 4. সম্পূর্ণ একমত (Strongly agree)
303	পানি ফুটানোর জন্য আপনার গ্যাস আছে কি? (Do you have access to gas to boil your water?)	1. হ্যাঁ (Yes) 2. না(No)
304	যদি আপনার বাসায় বিশুদ্ধ পানি না থাকে তা হলে আপনি কি করেন? (What do you do if you do not have treated water at home?)	1. সরাসরি উৎস হতে পান করি(Drink directly from source water) 2. ঘরে সংরক্ষণকৃত অবিশুদ্ধ পানি পান করি(Drink untreated stored water) 3. বোতলের পানি কিনে নেই(Buy bottled water) 4. প্রতিবেশীর কাছ থেকে পানি নেই যারা নিজেদের পানি বিশুদ্ধ করে (Take water from the neighbours who are known to treat their water) 5. কখনও অবিশুদ্ধ পানি পান করিনা(Never drink untreated water) 7. অন্যান্য (নির্দিষ্ট করুন)Other (specify)_____
304a	যদি আপনার বাসায় বিশুদ্ধ পানি না থাকে তা হলে আপনি আর কি করেন? আমি একটি তালিকা পড়ে শোনাব (এবং অন্য অপশনটি সংগ্রহ করব) what else do you do if you do not have treated water at home- I will read a list (and collect any further options)	1. সরাসরি উৎস হতে পান করি(Drink directly from source water) 2. ঘরে সংরক্ষণকৃত অবিশুদ্ধ পানি পান করি(Drink untreated stored water) 3. বোতলের পানি কিনে নেই(Buy bottled water) 4. প্রতিবেশীর কাছ থেকে পানি নেই যারা নিজেদের পানি বিশুদ্ধ করে (Take water from the neighbours who are known to treat their water) 5. কখনও অবিশুদ্ধ পানি পান করিনা(Never drink untreated water) 6. অন্য কিছু করিনা Nothing else 7. অন্যান্য (নির্দিষ্ট করুন)Other (specify)_____

Section L: Exposure to the ICVB Behavior Change Intervention by icddr/dsk CHPs –Ask all arms

1032a. আপনি কি কখনও আপনার খাওয়ার পানি ক্লোরিন দ্বারা বিশুদ্ধকরণ এবং নিরাপদ সংরক্ষণ বিষয়ে কোন আলোচনায় অংশ নিয়েছিলেন অথবা কারও কাছ থেকে শুনেছিলেন কিনা? Have you ever had any discussion or received any information about treating your drinking water with chlorine and safe storage, ?

1. হ্যাঁ Yes
2. না (1032c নং প্রশ্নে চলে যান) No(skip to 1032c)

1032b. আপনি কার সাথে আলোচনা করতেন অথবা কার কাছ থেকে তথ্য পেতেন? উত্তরগুলি পড়ে শোনান(একাধিক উত্তর গ্রহণযোগ্য)

Who have you discussed with or received information from? Read options. >1 options allowed

1. বন্ধু Friend
2. পরিবারের সদস্য Family member
3. আইসিডিডিআরবি/ ডিএসকে সিএইচপি Icdrr,b/DSK CHPs
4. অন্য কোন এনজিওর সিএইচ পি Other NGO CHPs
5. চিকিৎসাসেবীদের কাছ থেকে Medical practitioner
6. স্কুল থেকে School based interaction
7. মসজিদ থেকে Mosque based interaction
8. প্রতিবেশী Neighbor
9. অন্যান্য(নির্দিষ্টকরুন)Other (Specify):-----

1032b1. তারা আপনাকে কি কি দেখিয়েছে? What materials did they show you?

1. ফ্লিপচার্ট/বই Flipchart/Book
2. পানি বিশুদ্ধকরণ মেশিনটি ব্যবহারকরীয়ক কিউকার্ড Cue card on how to use dispenser
3. ফ্ল্যাশকার্ড Flash card
4. পোস্টার Poster
5. স্টিকার Sticker
৬. কিছুই দেখায়নি Nothing
7. অন্যান্য other

1032c. আপনি কি কখনও সাবান অথবা সাবানপানি দিয়ে হাত ধোয়া বিষয়ক কোন আলোচনায় অংশ নিয়েছিলেন অথবা এই বিষয়ক কোন তথ্য পেয়েছেন? Have you ever had any discussion or received any information about handwashing with soap/soapy water ?... .

1. হ্যাঁ Yes
2. না (1032c নং প্রশ্নে চলে যান) No (skip to 1032e)

1032d. আপনি কার সাথে আলোচনা করতেন অথবা কার কাছ থেকে তথ্য পেতেন?(একাধিক উত্তর গ্রহণযোগ্য) Who have you discussed with or received information from? (Multiple responses allowed)

1. বন্ধু Friend
2. পরিবারের সদস্য Family member

3. আইসিডিডিআরবি/ ডিএসকে সিএইচপি Icddr,b/DSK CHPs
4. অন্য কোন এনজিওর সিএইচপি Other NGO CHPs
5. চিকিৎসাসেবীদের কাছ থেকে Medical practitioner
6. স্কুল থেকে School based interaction
7. মসজিদ থেকে Mosque based interaction
8. প্রতিবেশী Neighbor
9. অন্যান্য(নির্দিষ্টকরুন)Other (Specify):-----

1032d1. তারা আপনাকে কি কি দেখিয়েছে? What materials did they show you?

1. ফ্লিপচার্ট/বই Flipchart/Book
2. হাত ধোয়া বিষয়ক কিউকার্ড Cue card on how to wash hands
3. ফ্ল্যাশকার্ড Flash card
4. পোস্টার Poster
5. স্টিকার Sticker
6. কিছুই দেখায়নি Nothing
7. অন্যান্য নির্দিষ্ট করুন other(Specify):-----

1032d2. ডিএসকের সিএইচপি কি কখনও হাত ধোয়ার কোন নির্দেশনা দিয়েছে? Has DSK CHP ever provided instruction on handwashing?

1. হ্যাঁ Yes
2. না No
3. জানি না Dont know

1032d3. . ডিএসকের সিএইচপি কি কখনও হাত ধোয়ার স্টেশন এর ব্যবহার সম্পর্কে কোন নির্দেশনা দিয়েছে? Has DSK CHP ever provided instruction on using the handwashing station?

1. . হ্যাঁ Yes
2. না No
3. . জানি না Dont know

1032 d4. . ডিএসকের সিএইচপি কি কখনও ক্লোরিন দ্বারা পানি বিশুদ্ধকরার কোন নির্দেশনা দিয়েছে? Has DSK CHP ever provided instruction on water chlorination?

1. হ্যাঁ Yes
2. না No
3. . জানি না Dont know

1032d5. ডিএসকের সিএইচপি কি কখনও ক্লোরিন ডিসপেনসার ব্যবহারের কোন নির্দেশনা দিয়েছে? Has DSK CHP ever provided instruction on using the Chlorine Dispensar?

1. হ্যাঁ Yes
2. না No
3. জানি না Dont know.

1032e.. আইসিডিডিআরবির এবং ডিএসকের কিছু কমিউনিটি স্বাস্থ্য কর্মী যারা তাদের আইডি কার্ডে লোগো ব্যবহার করে এবং তারা কিছু প্রতিবেশীকে পণ্য সরবরাহ করে এবং অন্যদেরকে করে না । আপনি কি আপনার প্রতিবেশীর ঘরে তাদেরকে দেখেছেন? There are community health promoters sponsored by an organization known as DSK and by icddr – they carry those logos on their IDs, who do promotion in some neighborhoods and not in others. Have you seen them in your neighbourhood?

1. হ্যাঁ Yes

2. না No

q1032f. আপনার পরিবারে/কম্পাউন্ডে গত জুন'২০১১ থেকে এখন পর্যন্ত আইসিডিডিআরবির/ ডিএসকের কোন সিএইচপি কি পরিদর্শনে এসেছিল? Have your household/compound received any visit by any icddr,b/DSK CHP from June 2011 to until today?

1. . হ্যাঁ Yes

2. না No

3. জানিনা Dont know

1032. গত একমাসে আপনার কম্পাউন্ডে কতবার কমিউনিটি স্বাস্থ্য কর্মী এসেছে?-----বার (মনে করতে পারছি না=999)(প্রযোজ্য নয়=888)(যদি '888' হয় তাহলে পরের সেকশনে চলে যান)How many times did an icddr/b/dsk CHP visit your compound within last 1 month? _____times [put 999 if don't remember] (Not applicable=888)

1034a. আইসিডিডিআরবির/ ডিএসকের যে সিএইচপি আপনার বাড়িতে আসে তার নাম কি? _____ (প্রযোজ্য নয়=888) (জানিনা =৯৯৯) What is the name of the icddr/b/dsk CHP who comes to your home/compound? _____ (Not applicable=888)(Don't know=999)

1034b. উত্তরদাতা কি সিএইচপির নাম বলেছিল?Did the respondent mention the name of the CHP?

1.হ্যাঁ Yes

2. না no

1034c . গত এক মাসের মধ্যে আপনি অথবা আপনার পরিবারের কোন সদস্য কতবার হাত ধোয়া অথবা পানি বিশুদ্ধকরণ বিষয়ক চায়ের দোকানের আলোচনায় অংশগ্রহণ করেছেন?) ?-----বার (প্রযোজ্য নয়=888)In last one month how many times have you or members of your household attended a promotion of handwashing or water treatment at a teastall? _____times(Not applicable=888)

1034d. গত এক মাসের মধ্যে আপনার বাচ্চারা কতবার আইসিডিডিআরবির/ ডিএসকের বাচ্চাদের হাত ধোয়া অথবা পানি বিশুদ্ধকরণ বিষয়ক আলোচনায় অংশগ্রহণ করেছে?-----বার (প্রযোজ্য নয়=888) In last one month how many times did your children attend a meeting with other children organized by the DSK CHP on handwashing or water treatment? _____times(Not applicable=888)

1034d1. আইসিডিডিআরবির/ ডিএসকের সিএইচপি কি আপনার এবং আপনার কম্পাউন্ডের সদস্যদের সাথে পানি বিশুদ্ধ করার মেশিনটি বসানোর পূর্বে মেশিনটি অথবা হাত ধোয়ার লাল বালতিটি বসানোর আগে লাল বালতিটি কোথায় বসানো হবে সে বিষয়ে আপনাদের মতামত নিয়েছিল?Did the icddr/b/dsk CHP ask the people's opinion on where to install any technologies/hardware?

1. খুবই ভালোভাবে Very well
2. কিছুটা করেছিল Somewhat
3. করেনি did not ask
8. প্রযোজ্য নয় Not applicable

1034e. আপনি কি মনে করতে পারেন ফ্লিপচার্ট/বইটার ছবিগুলো দেখে আপনি শিখেছিলেন ---- Regarding the materials such as flipcharts/books etc, do you remember learning from looking at them,

1. অনেক A lot
2. কিছুটা Some
3. একদম না None
8. প্রযোজ্য নয় Not applicable

1034f. খাওয়ার পানি বিশুদ্ধকরণ বিষয়ে আপনি কি বলতে পারেন যে আইসিডিডিআরবি/ডিএসকের সিএইচ পিদের কাছ থেকে আপনি শিখেছেন--- Regarding drinking water treatment, would you say that you learned from the icddr/dsk CHP...

1. নতুন অনেক কিছু Many new things
2. নতুন কিছু Some new things
3. নতুন কিছুই না Nothing new
8. প্রযোজ্য নয় Not applicable

1034g. পানি বিশুদ্ধকরণ মেশিন এবং পন্য বিষয়ে আপনি কি মনে করেন এগুলো--- Regarding the water treatment machine and agent/material, do you find it

1. খুবই কার্যকর Very useful
2. কিছুটা কার্যকর Somewhat useful
3. কার্যকর নয় Not useful
8. প্রযোজ্য নয় Not applicable

1034g1. আপনার কি এখনও পানি বিশুদ্ধ করার জন্য ক্লোরিন ডিসপেনসারের কাছে লাগানো পানি বিশুদ্ধকরণ কিউকার্ডটি দেখার প্রয়োজন হয় ? Do you still need to look at the given instruction in the cue card placed by chlorine dispenser to treat water?

1. সবসময় always
2. কখনও কখনও some times
3. কখনই না never
8. প্রযোজ্য নয় নির্দিষ্ট করুন:-----Not applicable specify: -----

1034h. হাত ধোয়া চর্চা বিষয়ে আপনি কি বলতে পারেন যে আইসিডিডিআরবি/ডিএসকের সিএইচ পিদের কাছ থেকে থেকে আপনি শিখেছেন---- Regarding handwashing practice, would you say that you learned from the icddr/dsk CHP

1. নতুন অনেক কিছু Many new things
2. নতুন কিছু Some new things
3. নতুন কিছুই না Nothing new
8. প্রযোজ্য নয় Not applicable

1034i. হাত ধোয়ার হার্ডওয়্যার বিষয়ে আপনি কি মনে করেন এগুলো--- Regarding the handwashing technologies/hardware, do you find them

1. খুবই কার্যকর Very useful
2. কিছুটা কার্যকর Somewhat useful
2. কার্যকর নয় Not useful
8. প্রযোজ্য নয় Not applicable

1034j. আপনার কি এখনও পানি বিশুদ্ধ করার জন্য লাল বালতির কাছে লাগানো হাত ধোয়া বিষয়ক কিউকার্ডটি দেখার প্রয়োজন হয়? Do you still need to look at the given instruction in the cue card placed by hand washing station?

1. সবসময় always
2. কখনও কখনও some times
3. কখনই না never
8. প্রযোজ্য নয় নির্দিষ্ট করুন----- Not applicable specify-----

1035. আপনি কি খাওয়ার পানি সম্পর্কিত আপনার কোন সমস্যার কথা কমিউনিটি স্বাস্থ্য কর্মীকে বলেছেন? Did you share any of your concerns related to drinking water treatment with the CHP?

1. হ্যাঁ
2. না (1037নং প্রশ্নে চলে যান)
3. আমার এব্যাপারে কোন আতঙ্ক নেই I did not have any concerns (1037 নং প্রশ্নে চলে যান)
8. প্রযোজ্য নয় Not applicable (1037 নং প্রশ্নে চলে যান)
9. জানিনা Don't know(1037 নং প্রশ্নে চলে যান)

1036. কমিউনিটি স্বাস্থ্য কর্মীরা কি আপনাকে কোন সমাধান দিয়েছিল? Did the CHP help you find a solution?

1. হ্যাঁ, আংশিকভাবে Yes, partly
2. হ্যাঁ, পরিপূর্ণভাবে Yes, complete solution
3. না No

1037. আপনার কি পানি বিশুদ্ধকরণ নিয়ে এখনও সমস্যা আছে? Do you have problem now with water treatment?

1. হ্যাঁ Yes
2. না No (skip to 1038)
3. 8. প্রযোজ্য নয় Not applicable (skip to 1038)

1037a. যদি হ্যাঁ হয় তাহলে জিজ্ঞাসা করুন সমস্যাটির কারণে কি আপনার পানি বিশুদ্ধকরণ চর্চায় ব্যাঘাত ঘটছে? If yes, has the problem prevented you from practicing water treatment?

1. হ্যাঁ খুবই A lot
2. কিছুটা Somewhat
3. একেবারেই না Not at all

1038. আপনি কি হাত ধোয়া সম্পর্কিত আপনার কোন সমস্যার কথা কমিউনিটি স্বাস্থ্য কর্মীকে বলেছিলেন? you share any of your concerns related to handwashing with the CHP?

1. Yes হ্যাঁ
2. No না (skip to 1040)
3. Did not have any concerns (skip to 1040)
8. প্রযোজ্য নয় **Not applicable**(skip to 1040)
9. Don't know জানিনা (skip 1040)

1039. কমিউনিটি স্বাস্থ্য কর্মীরা কি আপনাকে কোন সমাধান দিয়েছিল? Did the CHP help you find a solution?

1.
হ্যাঁ, আংশিকভাবে Yes, partly
2. হ্যাঁ, পরিপূর্ণভাবে Yes, complete solution
3. না No

1040. আপনার কি এখনও হাত ধোয়া বিষয়ে সেই সমস্যা আছে? Do you have problem now with handwashing?

1. Yes হ্যাঁ
2. No না
8. প্রযোজ্য নয় **Not applicable**

1040a. যদি হ্যাঁ হয় তাহলে জিজ্ঞাসা করুন সমস্যাটির কারণে কি আপনার হাত ধোয়ার চর্চায় ব্যাঘাত ঘটছে? If yes, has the problem prevented you from practicing handwashing?

1. হ্যাঁ খুবই A lot
2. কিছুটা Somewhat
3. একেবারেই না Not at all

1041. আপনি কি আমাকে বলবেন যে কমিউনিটি স্বাস্থ্য কর্মী আপনার বাড়িতে আসে তার ব্যবহার কতটা বন্ধুসূলভ? Would you say that the CHP who visits you is very courteous, somewhat courteous, or not at all?

1. হ্যাঁ খুবই very courteous
2. কিছুটা somewhat courteous
3. একেবারেই না Not at all
8. প্রযোজ্য নয় Not applicable

1041a. আপনি কি বলবেন যে ,যেই কমিউনিটি স্বাস্থ্য কর্মী আপনার বাড়িতে/ কম্পাউন্ডে আসে সে Would you say that the CHP who visits you :

1. হাত ধোয়ার ব্যাপারে বেশী কথা বলেছে Talked more about handwashing
2. ক্লোরিন দ্বারা পানি বিপ্লব করার ব্যাপারে বেশী কথা বলেছে Talked more about water chlorination
3. ক্লোরিন দ্বারা পানি বিপ্লব করা এবং হাত ধোয়া উভয় ব্যাপারে সমানভাবে কথা বলেছে Talked equally about both handwashing and water chlorination
4. দুটোর কোনটার ব্যাপারেই কিছু বলে নাই none of these are mentioned
8. প্রযোজ্য নয় নির্দিষ্ট করুন..... Not applicable specify.....

Section La: Perceived Water Quality

STATEMENTS		Strong-ly dis-agree	Slight-ly dis-agree	Slight-ly agree	Strong-ly agree
La1.	ওয়াসার সরবরাহকৃত পানি পানের জন্য খুব নিরাপদ The water supplied by WASA is very safe to drink	1	2	4	5
La2.	ওয়াসার সরবরাহকৃত পানির একটা ভাল স্বাদ আছে The water supplied by WASA has a good taste				
La3.	(যারা ১০৬ নং প্রশ্নে শ্যালো টিউবওয়েল বা ডিপ টিউবওয়েল উত্তর দিয়েছেন তাদের জন্য) আমার টিউবওয়েলের সরবরাহকৃত পানি পানের জন্য খুবই নিরাপদ [For those who answered shallow tube well or deep tube well in question 106]The water supplied by my tube well is very safe to drink				

La4.	(যারা ১০৬ নং প্রশ্নে শ্যালো টিউবওয়েল বা ডিপ টিউবওয়েল উত্তর দিয়েছেন তাদের জন্য) আমার টিউবওয়েলের সরবরাহকৃত পানির একটা ভাল স্বাদ আছে [For those who answered shallow tube well or deep tube well in question 106] The water supplied by my tube well has a good taste				
La5.	ট্যাপ/হ্যান্ড পাম্পের সরবরাহকৃত সাপাটাইর পানি সরাসরি পান করলে অসুস্থ হওয়া সহজ It is easy to get sick from drinking the supply water directly from the tap/hand pump				
La6.	ট্যাপ/হ্যান্ড পাম্পের সরবরাহকৃত পানি সরাসরি শিশুদের দেয়া নিরাপদ The water coming direct from the tap/hand pump is safe to give to young children				
La7.	ট্যাপ/হ্যান্ড পাম্পের সরাসরি সরবরাহকৃত পানির গুণগত মান খুব ভাল The water coming direct from the tap/hand pump is of high quality				
La8.	ট্যাপ/হ্যান্ড পাম্পের সরবরাহকৃত পানি সরাসরি পান করলে আমার কলেরা হবার সম্ভাবনা আছে। I am likely to get cholera if I drink water directly from the tap/hand pump				
La9.	ট্যাপ/হ্যান্ড পাম্পের সরবরাহকৃত পানি সরাসরি পান করলে আমার আমাশয় হবার সম্ভাবনা আছে। I am likely to get dysentery if I drink water directly from the tap/hand pump				
La10.	ট্যাপ/হ্যান্ড পাম্পের সরবরাহকৃত পানি সরাসরি পান করলে আমার জন্ডিস হবার সম্ভাবনা আছে। I am likely to get jaundice if I drink water directly from the tap/hand pump				
La11.	আমি খুবই উদ্দিগ্ন যে, আমার অথবা আমার পরিবারের কারো কলেরা হতে পারে এবং এটা একটা বিপদজনক রোগ। I am very concerned that I or someone in my family will get cholera, and it is a dangerous disease				
La12.	আমি খুবই উদ্দিগ্ন যে, আমার অথবা আমার পরিবারের কারো আমাশয় হতে পারে এবং এটা একটা বিপদজনক রোগ। I am very concerned that I or someone in my family will get dysentery, and it is a dangerous disease				
La13.	আমি খুবই উদ্দিগ্ন যে, আমার অথবা আমার পরিবারের কারো জন্ডিস হতে পারে এবং এটা একটা বিপদজনক রোগ। I am very concerned that I or someone in my family will get jaundice, and it is a dangerous disease				

If 506 is 5 then

Section Lb : Practice of alternative behavior : Boiling water

STATEMENTS		Strong-ly disagree	Slightly disagree	Slightly agree	Strong-ly agree
Lb1.	. আমি আমার পানি ফুটিয়ে নিই কারণ এটা পানিকে অধিকতর পরিষ্কার করে। I boil my water because it makes it cleaner	1	2	4	5
Lb2.	. আমি আমার পানি ফুটিয়ে নিই কারণ এটা ব্যাকটেরিয়াকে মেরে ফেলে যা আমাদেরকে অসুস্থ করতে পারে। I boil my water because it kills bacteria that can make us sick				
Lb3.	. আমি আমার পানি ফুটিয়ে নিই কারণ আমি আগে থেকেই পানি গরম করি। I boil my water because I am already cooking/heating water				
Lb4.	. আমি আমার পানি ফুটিয়ে নিই কারণ এটা আমার জন্য করা সহজ। I boil my water because it is easy for me to do				
Lb5.	. আমি আমার পানি ফুটিয়ে নিই কারণ আমার প্রতিবেশী এটা করে। I boil my water because my neighbor does it				
Lb6.	. আমি আমার পানি ফুটিয়ে নিই কারণ সিএইচপি আমাকে তা করতে বলেছে। I boil my water because the CHP told me to do				
Lb7.	আমি আমার পানি ফুটাইনা কারণ আমি মনে করি যে এটা পানিকে নেরাপদ করার জন্য কিছুই করেনা। I do not boil my water because I think it does nothing to make the water safe				
Lb8.	আমি আমার পানি ফুটাইনা কারণ এতে সময় এবং জ্বালানীর অপচয় হয়। I do not boil my water because it is a waste of time and fuel				
Lb9.	আমি আমার পানি ফুটাইনা কারণ আমার পানি ফুটানোর মত টাকা/অর্থ বা জায়গা নেই। I do not boil my water because I do not have the money or space to boil water				
Lb10.	আমি আমার পানি ফুটাইনা কারণ যে কোন স্থানে রেখে দিলে এটা পুণরায় দূষিত হয়ে যাবে। I do not boil my water because The water will be				

	recontaminated if left sitting anyways				
Lb11.	আমি আমার পানি ফুটাইনা কারণ আমার পরিবার গরম পানি পছন্দ করেনা। I do not boil my water because My family does not like hot water				

Section N: আর্থসামাজিক অবস্থা (Socio economic status))

601. সাক্ষাৎকার প্রদানকারী কি পড়তে/লিখতে জানে? (Can the respondent read newspaper and/or write?)

1. পড়তে ও লিখতে জানেন না (Cannot read or write)
2. পড়তে জানে তবে লিখতে জানে না (Can read but cannot write)
3. পড়তে ও লিখতে জানেন (Can read and write)

602. সাক্ষাৎকার প্রদানকারী সর্বোচ্চ কতদূর পর্যন্ত পড়াশোনা করেছে?
(What is the highest level of education of the respondent? _____years of education)

603. খানার ঘরটিতে কতগুলো কক্ষ আছে? (রান্নাঘর ও বাথরুম বাদে) _____
[How many rooms do you have in your house? (Excluding kitchen and bathroom)_____]

604. আপনার পরিবার বর্তমানে যে বাড়িতে বসবাস করছে তার মালিকানা কোন ধরনের? (What is the ownership status of the house where your household is currently living?)

1. নিজস্ব বাড়ি (Self owned)
2. ভাড়া বাড়ি (Rental)
3. সরকারি জমি (Government land)
4. অন্যের বাড়িতে ভাড়া না দিয়ে থাকে (Living in someone's house without giving rent)
7. অন্যান্য (নির্দিষ্ট করুন)----- (Other (specify)_____)

605. আপনার খানা সদস্যদের কি কোন বসতভূমি আছে? (Does your household own any homestead land?)

1. হ্যাঁ (Yes)
2. না (No)
8. বলতে রাজি হয়নি (Refused to say)
9. জানি না (Don't know)

606. আপনার খানা সদস্যদের কি বসতভূমি ছাড়া অন্য কোন জমি আছে? (Does your household own any land other than homestead land?)

1. হ্যাঁ (Yes)
2. না (No)
8. বলতে রাজি হয়নি (Refused to say)

9. জানি না (Don't know)

607. আপনার খানাতে নিম্নের কোন জিনিসগুলো আছে? (হ্যাঁ=1, না=2 লিখুন) [Does your household/family own any of the followings? (WRITE 1=yes and 2=No)]

- |____| (A) সাইকেল (খেলনা সাইকেল নয়) Bicycle
- |____| (B) মটর সাইকেল Motor cycle
- |____| (C) বেবীটেক্সি/সিএন জি Baby taxi/CNG
- |____| (D) রিকশা/ভ্যান Rickshaw/van
- |____| (E) রেডিও/ক্যসেট প্লেয়ার/সিডি প্লেয়ার Working radio/Cassette Player/CD player
- |____| (F) টেলিভিশন/ভিসিডি Working television/VCD
- |____| (G) কম্পিউটার Working computer
- |____| (H) মোবাইল ফোন (Working mobile Phone)
- |____| (I) রেফ্রিজারেটর (Working refrigerator)
- |____| (J) খাট/চকি (Bed/chouki)
- |____| (K) সোফা সেট (Sofa set)
- |____| (L) সেলাই মেশিন (Working sewing machine)
- |____| (M) আলনা [locally made holder for clothings]
- |____| (N) কম্বল / লেপ (Blanket)
- |____| (O) আলমারী/ওয়ার্ড্রব (কাঠ/স্টীল) [Almira/wardrobe (wooden/steel)]
- |____| (P) বিদ্যুৎ (Electricity connection)

608. আমাদের গবেষণার সুবিধার্থে আপনি কি বলবেন আপনার পরিবারের মোট মাসিক আয় কত টাকা? (মোট মাসিক আয় হিসাব করার সময় আয়ের সকল ক্ষেত্র বিবেচনা করবেন যেমন- বেতন, বাড়ী ভাড়া, কৃষি ইত্যাদি, 'জানি না' হলে 999 লিখুন) _____ টাকা
(For the purpose of our research, would you please tell us your total monthly household income? (Please sum up your income from all sources like wage, rent, agriculture etc.) _____ taka)

609. আপনার খানায় রান্নার জন্য প্রধানত কি ধরনের জ্বালানী ব্যবহার করা হয়? (What kind of fuel do you use for cooking?)

১. কাঠ/ কাঠ কয়লা (Wood/ charcoal)
২. কেরোসিন (Kerosene)
৩. প্রাকৃতিক গ্যাস (Natural gas)
৪. বিদ্যুৎ (বৈদ্যুতিক হীটার) [Electricity (Electric heater)]
৫. ভুষ্টি (Husk/ Dust of Wood)
৭. অন্যান্য _____ (Other _____)

610.. আপনার খানার তিন বছরের নীচের বাচ্চারা প্রধানত কোন ধরনের পায়খানা ব্যবহার করে? (জিজ্ঞেস করুন এবং পর্যবেক্ষণ করুন) (>1 উত্তর গ্রহণযোগ্য) (What kind of toilet facility do the children less than three years old in your household use?) (ask and observe) (>1 answers allowed)

1. ঘরের ভিতরে পানি নিরোধক পায়খানা (Water sealed latrine in the home) (skip to 611)
2. ঘরের বাইরেপানি নিরোধক পায়খানা (skip to 611)
(Water sealed latrine outside the home)
3. ঘরের ভিতরে পিট-টয়লেট (Pit latrine in the home) (skip to 611)
4. ঘরের বাহিরে পিট-টয়লেট (skip to 611)
(Pit latrine outside of the home)
5. শিশুদের মলমূত্র ত্যাগ করার পাত্রে/ পট (Potties)
6. ঝুলন্ত পায়খানা (Hanging latrine) (skip to 611)
7. নির্দিষ্ট কোন স্থান নেই (No fixed place) (skip to 611)
77. অন্যান্য (নির্দিষ্ট করে লিখুন)_____ (Other___) (skip to 611)
8. প্রযোজ্য নয় (যদি বাচ্চা না থাকে) [Not applicable (if there is no such children at home)] (skip to 611)
10. ঘরের ভিতরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal in the home) (skip to 611)
11. ঘরের বাইরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal shared by multiple households) (skip to 611)

610a. পাত্রটি কোথায় খালি করা হয়? Where are potties emptied?

1. ঘরের ভিতরে পানি নিরোধক পায়খানা (Water sealed latrine in the home)
2. ঘরের বাইরেপানি নিরোধক পায়খানা
(Water sealed latrine outside the home)
3. ঘরের ভিতরে পিট-টয়লেট (Pit latrine in the home)
4. ঘরের বাহিরে পিট-টয়লেট যা
(Pit latrine outside of the home)
5. ঝুলন্ত পায়খানা (Hanging latrine)
6. নির্দিষ্ট কোন স্থান নেই (No fixed place)
7. ঘরের ভিতরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal in the home)
8. ঘরের বাইরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal outside the home)
77. অন্যান্য (নির্দিষ্ট করে লিখুন)_____ (Other___)

611. আপনার বাড়ির বড়রা কি ধরনের পায়খানা ব্যবহার করে [What kind of toilet facility do the adults in your household use? (ask and Observe)]

1. ঘরের ভিতরে পানি নিরোধক পায়খানা (Water sealed latrine in the home)
2. ঘরের বাইরেপানি নিরোধক পায়খানা(Water sealed latrine outside the home)
3. ঘরের ভিতরে পিট-টয়লেট (Pit latrine in the home)
4. ঘরের বাহিরে পিট-টয়লেট (Pit latrine outside of the home)
5. ঝুলন্ত পায়খানা (Hanging latrine)
6. নির্দিষ্ট কোন স্থান নেই (No fixed place)
7. অন্যান্য (নির্দিষ্ট করে লিখুন)Other _____
10. ঘরের ভিতরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal in the home)

11. ঘরের বাইরে কিন্তু পানি নিরোধক নয় (Latrine Without Water seal outside the home)

611a: Toilet facility (Observation)

FRAs will not ask this question (to the respondents). They will just observe it and check the options এফআরএ উত্তরদাতাকে এই প্রশ্নটি করবে না। তারা কেবল পর্যবেক্ষণ করবে এবং অপশনগুলো মিলিয়ে নিবে।

উন্নত পায়খানা Improved sanitation facilities

ফ্লাশ টয়লেট অথবা পানি ঢেলে ফ্লাশ করা টয়লেট [Flush or pour flush toilet flushed to:]

- 01 পয়ঃনিষ্কাশন পাইপের সাথে সংযোগ করে দেয়া (Piped sewer system)
- 02 সেপটিক ট্যাংক বসানো আছে (Septic tank)
- 03 সেপটিক ট্যাংক নেই কিন্তু ফ্লাশ করে বা পানি ঢেলে পায়খানা দূরে পিটের মধ্যে সরিয়ে দেয়া যায় (Flush to pit latrine (Off set))
- 04 পিট টয়লেট (স্ল্যাব এবং ওয়াটার সীল আছে) [Pit latrine with slab & water seal]
- 05 পিট টয়লেট (স্ল্যাব আছে কিন্তু ওয়াটার সীল নেই তবে ঢাকনা দেয়ার ব্যবস্থা আছে) [Pit latrine with slab & no water seal but with a lid]
- 06 বায়ু চলাচলের উপযোগী উন্নত টয়লেট [Ventilated Improved Pit Latrine (VIP)]
- 07 পিট টয়লেট যার স্ল্যাব আছে কিন্তু ভেন্টিলেশনের ব্যবস্থা এবং ওয়াটার সীল নেই [Pit Latrine with slab but without ventilation and no water seal]
- 08 কমপোজিং টয়লেট (পায়খানা এবং প্রস্রাব করার জন্য আলাদা আলাদা ঘর এবং সাথে আলাদা কোথাও পানির ব্যবস্থা আছে) [Composting toilet, (Composting toilet ensure separation of urine, water and excreta)]
- 09 পিট টয়লেট যার দুটি গর্ত আছে (Dual Pit Latrine)

অনুন্নত পায়খানা Unimproved sanitation facilities

- 10 ফ্লাশ টয়লেট অথবা পানি ঢেলে ফ্লাশ করা টয়লেট যা কোন খাল, ড্রেন, নদী ইত্যাদির সাথে সংযোজন করা [Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]
- 11 পিট/গর্ত পায়খানা যার স্ল্যাব নেই (এবং মশা/মাছি যাওয়া আসা করতে পারে এবং দূর্গন্ধ ছড়ায়) [Pit latrine without slab / Open pit]
- 12 বালতিসহ পায়খানা (Bucket)
- 13 ঝুলন্ত পায়খানা (Hanging toilet)

উন্মুক্ত পায়খানা Open defecation

- 14 কোন পায়খানা নেই/বোপ-বাড়ি/খোলা জায়গায় (No facility / bush / field)

612. একাধিক পরিবার এই একই পায়খানা ব্যবহার করে কিনা?(Does more than one household share the same toilet?)

1. হ্যাঁ (Yes)
2. না (৭০১ নং প্রশ্নে চলে যান)(No (Skips to q701)

613. এই কম্পাউন্ডে কতগুলো খানা আছে (উত্তরদাতার ঘরসহ)? _____

[How many households (including the respondent's household) are there within this compound?__]

614. এই কম্পাউন্ডে কতগুলো পায়খানা আছে? _____

(How many toilets are there within this compound? _____)

701. পোশাক পরিচ্ছদের অবস্থা [-----] (Observe the condition of the clothing carefully (without asking anything) and record)

1. কোনো ছেঁড়া/ ফাঁটা নেই (No holes/tears)
2. সামান্য ছেঁড়া/ ফাঁটা (A few holes/tears)
3. অনেক জায়গায় ছেঁড়া/ ফাঁটা (Many holes/tears)

702. বাড়ির আশেপাশে কোন বাচ্চার মল দৃশ্যমান রয়েছে? (নির্ধারিত জায়গা ছাড়া) [-----] (Are there child faeces visible in the compound (other than in a designated pile)?)

1. হ্যাঁ (Yes)
2. না (No)

703. কম্পাউন্ডের ভিতরে কি পশুর মল দেখা যাচ্ছে? (কোন নির্দিষ্ট স্তম্ভ ছাড়া) [Are there animal feces visible in the compound (other than in a designated pile)?]

1. হ্যাঁ (Yes)
2. না (No)

704. গৃহের দেয়ালের নির্মাণ উপকরণ: [-----] (MAIN EXTERIOR Construction materials of the walls)

1. মাটি/ কাঠি/ নলখাগড়া/বাম্বুর বেড়া (Mud/sticks/reeds/branches)
2. ঢেউ টিন/টিন(Corrugated iron/tin)
3. আগুনে পোড়ানো ইট (Fired bricks)
4. কাঠ (Wood)
5. সিমেন্ট/ কংক্রিট (Cement/concrete)
7. অন্যান্য (OTHER (SPECIFY):)_____

705. মেঝের নির্মাণ উপকরণ: [-----](Construction material of the floor)

1. মাটি/গোবর/বালু (Earth/mud/dung/sand)

2. সিমেন্ট/ কংক্রিট (Cement/concrete)
3. কাঠ (Wood)
7. অন্যান্য (Other (specify):)_____

706. ছাদের নির্মাণ উপকরণ: [-----](Construction material of the roof)

1. মাটি/বাম্বের বেড়া (Mud, branches)
2. কাঠ (Wood)
3. ডেউটিন (Corrugated iron/tin)
4. সিমেন্ট/ কংক্রিট (Cement/concrete)
7. অন্যান্য (নির্দিষ্ট করুন) Other (specify):_____

707. আপনার পরিবার আবর্জনা প্রধানত কোথায় ফেলে? (পর্যবেক্ষণ করে লিখুন) (How does your household dispose of most of its wastes? (ask and Observe))

1. নির্দিষ্ট জায়গায় (THROW IN A SPECIFIED PLACE)
 - a. কম্পাউন্ডের মধ্যে স্তুপ করে রাখা Designated pile in the compound
 - b. ময়লা ফেলার নির্দিষ্ট ডাস্টবিন/গর্ত/গাদা Designated Garbage dump
 - c. ময়লা এসে নিয়ে যায় Collection service
 - d. অন্যান্য others (specify)
2. নদী/খাল/ড্রেনে (THROW IN DRAINS/ LAKES/ STREAMS)
3. যে কোন খালি জায়গায় (No specific place to dispose the wastes)
7. অন্যান্য (নির্দিষ্ট করুন):_____ OTHER (SPECIFY)_____

708. এই বাড়ির আর্থ সামাজিক অবস্থান কোন পর্যায়ে পড়ে? (সাক্ষাৎকার গ্রহণকারী তার নিজস্ব পর্যবেক্ষণ এবং মূল্যায়নের উপর ভিত্তি করে একটিতে গোল চিহ্ন দিবেন) [In which category the socioeconomic status of this household fit? (Interviewer will circle an option based on his/her own observation and assessment)]

1. বিত্তহীন (Very poor)
2. নিম্ন মধ্যবিত্ত (Somewhat poor)
3. মধ্যবিত্ত (Neither poor nor rich)
4. উচ্চ মধ্যবিত্ত (Somewhat rich)
5. বিত্তশালী (Very rich)

709. এই বাড়ি যেখানে অবস্থিত সেই এলাকা বা এর আশপাশের অবস্থা : Type of area/neighborhood the household is located :

- a) সাধারণ এলাকা General area
- b) ক্যাম্প এলাকা Camp area
- c) ঝুলন্ত বস্তি এলাকা Hanging slum

Section P: H₂S and E. coli water test results

820. ২৪ ঘন্টা পরে সংরক্ষিত পানির H₂S পরীক্ষার ফলাফল কী ছিল? (What was the H₂S test result of household stored water after 24 hours?)

1. পানি দূষিত ছিল (Water was found to be contaminated)
2. পানি দূষিত ছিল না (water was uncontaminated)
৪. প্রযোজ্য নয়(নির্দিষ্ট করুন)(Not applicable)(specify):_____

821. ৪৮ ঘন্টা পরে সংরক্ষিত পানির H₂S পরীক্ষার ফলাফল কী ছিল?(What was the H₂S test result of household stored water after 48 hours?)

1. পানি দূষিত ছিল (Water was found to be contaminated)
2. পানি দূষিত ছিল না (Water was uncontaminated)
৪. প্রযোজ্য নয়(নির্দিষ্ট করুন)(Not applicable)(specify):_____

822. ২৪ ঘন্টা পরে উৎস পানির H₂S পরীক্ষার ফলাফল কী ছিল? (What was the H₂S test result of source water after 24 hours?)

1. পানি দূষিত ছিল (Water was found to be contaminated)
2. পানি দূষিত ছিল না (water was uncontaminated)
৪. প্রযোজ্য নয় (নির্দিষ্ট করুন)(Not applicable)(specify):_____

823. ৪৮ ঘন্টা পরে উৎস পানির H₂S পরীক্ষার ফলাফল কী ছিল?(What was the H₂S test result of source water after 48 hours?)

1. পানি দূষিত ছিল (Water was found to be contaminated)
2. পানি দূষিত ছিল না (Water was uncontaminated)
৪. প্রযোজ্য নয়(নির্দিষ্ট করুন)(Not applicable)(specify):_____

824. খাবার পানিতে ই. কলাই *E. Coli*-এর(কলোনী) সংখ্যা (প্রযোজ্য নয় হলে ‘‘৪৪৪’’লিখুন) _____
(*E. Coli* count in the stored drinking water ____/100ml) [Put ‘888’ if not applicable.]

825. উৎস পানিতে ই. কলাই *E. Coli*-এর(কলোনী) সংখ্যা (প্রযোজ্য নয় হলে ‘‘৪৪৪’’লিখুন) _____
(*E. Coli* count in the source water ____/100ml) [Put ‘888’ if not applicable.]

Appendix 2.3: Data collection tool used for collecting data for research objective 5

Appendix 2.3.1: Rainwater enrolment form.....	329
Appendix 2.3.2: Rainwater health diary.....	331

The Adelaide Rainwater Study Enrolment Questionnaire

Screening No.

Details	Participant Number					
	1	2	3	4	5	6
1 Participant first/given name						
2 Participant surname						
3 Gender	☐ Male ☐ Female	☐ Male ☐ Female	☐ Male ☐ Female	☐ Male ☐ Female	☐ Male ☐ Female	☐ Male ☐ Female
4 Date of birth (day/month/year)	 DD - MM - YYYY	 DD - MM - YYYY	 DD - MM - YYYY	 DD - MM - YYYY	 DD - MM - YYYY	 DD - MM - YYYY
5 Relationship with Participant 1 1 = Spouse / Partner 4 = Grandparent 2 = Child / Stepchild 5 = Brother / Sister 3 = Parent 6 = Other / Unrelated						
6 Country of birth 1 = Australia 5 = Italy 2 = New Zealand 6 = Other 3 = United Kingdom 4 = Yugoslavia (including Serbia, Croatia, Bosnia)	 Code	 Code	 Code	 Code	 Code	 Code
7 Main language spoken at home 1 = English 3 = Greek 2 = Italian 4 = Other	 Code	 Code	 Code	 Code	 Code	 Code
8 Does the person have any long term current skin problems such as psoriasis or eczema?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
9 Does the person have current respiratory problems such as asthma or bronchitis?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
10 Is the person attending childcare, school or any other education institution?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

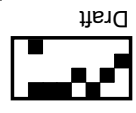


Print

The Adelaide Rainwater Study Enrolment Questionnaire

Screening No.

Details	Participant Number					
	1	2	3	4	5	6
11 If YES to question 10, what type of institution? 1 = Childcare 2 = Preschool 3 = Primary school 4 = Secondary school 5 = Tertiary institution	 Code	 Code	 Code	 Code	 Code	 Code
12 If NO to question 10, what is the highest level of education completed? 1 = Did not attend school 2 = Primary 3 = Secondary / Commercial / Technical 4 = Trade qualification 5 = University / College	 Code	 Code	 Code	 Code	 Code	 Code
13 Current work status for person over 18 1 = F/T paid work 2 = P/T paid work 3 = F/T home duties 4 = Unemployed 5 = Retired	 Code	 Code	 Code	 Code	 Code	 Code
14 For which other activities do you use rainwater?	☐ Gardening	☐ Toilet flushing	☐ Washing clothes/laundry	☐ Washing car	☐ Showering/bathing	☐ All
15 Apart from rainwater, what other sources of water are available to you?	☐ Mains water	☐ Bore water	☐ River/creek/dam water			
16 Does your household have any of the following pets ?	Cat ☐ Yes ☐ No	Dog ☐ Yes ☐ No	Fish ☐ Yes ☐ No	Bird ☐ Yes ☐ No		
17 Are you willing and eligible to take part in the water sampling program?	☐ Yes ☐ No					
18 Is there an accessible outdoor rainwater tap for water collection by study personnel?	☐ Yes ☐ No					
19 If NOT, is the householder willing to take an indoor sample?	☐ Yes ☐ No					



Water Treatment unit assigned

Starting Week No:

Household ID:

Health Diary for:

Instructions:

Use **black or blue biro only.**

Please mark like this:

Not like this:

Section 1.

Beginning Monday:

1.1a Has the person been away from home overnight during the week?

If YES 1.1b Mark the day(s) away from home: Overseas
Within Australia

STOP at this point if the person has been away from home every day of a week.

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

☐ Yes ☐ No

1.2a Has the person been swimming during the week?

If YES 1.2b Where did they swim?
(mark the days for each place)

Public pool/spa
Private pool/spa
River/dam/lake
Ocean/beach

[illegible][illegible][illegible]

☐ Yes ☐ No

M	T	W	T	F	S
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐

Section 2 - Gastroenteritis					Household ID:		Individual ID:	
2.1a	Has the person had diarrhoea?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.1b Mark the day(s): 2.1c Mark the maximum number of loose bowel actions in a 24hr period:								
2.2a	Has the person had vomiting?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.2b Mark the day(s): 2.2c Mark the maximum number of times per day vomiting occurred:								
2.3a	Has the person had nausea?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.3b Mark the day(s):								
2.4a	Has the person had abdominal cramps / pains?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.4b Mark the day(s):								
2.5a	Has the person had a fever?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.5b Mark the day(s):								
2.6a	Has the person had chills or sweats?		☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+	☐ Yes ☐ No M T W T F S S ☐ 1 ☐ 2 ☐ 3 ☐ 4+		
If YES 2.6b Mark the day(s):								
If NO to question 2.1a to 2.6a go to Section 3								
2.7a	Has the person consulted a doctor due to this illness?		☐ Yes ☐ No ☐ Yes ☐ No	☐ Yes ☐ No ☐ Yes ☐ No	☐ Yes ☐ No ☐ Yes ☐ No	☐ Yes ☐ No ☐ Yes ☐ No		
If YES 2.7b Was medication prescribed for this person?								
2.8	Has the person been to a hospital due to this illness?		☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No		

Section 2 - Gastroenteritis continuedHousehold ID: Individual ID: **2.9a** Has the person been absent from school/work/childcare or unable to carry out normal duties?**If YES 2.9b** Mark the day(s):☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○**2.10** Has the person stayed in bed for part of the day or more?☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No**2.11a** Has the illness caused another family member to take time off work/school to care for the sick person?**If YES 2.11b** Mark the day(s):☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○**Section 3 - Respiratory symptoms****3.1a** Has the person had any respiratory symptoms or a cold?**If YES 3.1b** Has the person had a sore throat?**3.1c** Has the person had a runny nose?**3.1d** Has the person had a cough?☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No**If NO to question 3.1a go to Section 4****3.2a** Has the person consulted a doctor due to this illness?**If YES 3.2b** Was medication prescribed for the person?☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No**3.3** Has the person been to a hospital due to this illness?☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No**3.4a** Has the person been absent from school/work/childcare or unable to carry out normal duties?**If YES 3.4b** Mark the day(s):☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○**3.5** Has the person stayed in bed for part of the day or more?☐ Yes ☐ No☐ Yes ☐ No☐ Yes ☐ No**3.6a** Has the illness caused another family member to take time off work/school to care for the sick person?**If YES 3.6b** Mark the day(s):☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○☐ Yes ☐ No
M T W T F S S
○ ○ ○ ○ ○ ○ ○

Section 4 - Skin symptoms					Household ID: Individual ID:			
		Week 1	Week 2	Week 3	Week 4			
4.1a	Has the person had any skin symptoms or infections? If YES 4.1b Has the person had a rash? 4.1c Has the person had generalised itching? 4.1d Has the person had a skin infection?	Yes No Yes No Yes No Yes No	Yes No Yes No Yes No Yes No	Yes No Yes No Yes No Yes No	Yes No Yes No Yes No Yes No			
If NO to question 4.1a STOP HERE								
4.2a	Has the person consulted a doctor due to this illness? If YES 4.2b Was medication prescribed for the person?	Yes No Yes No	Yes No Yes No	Yes No Yes No	Yes No Yes No			
4.3	Has the person been to a hospital due to this illness?	Yes No	Yes No	Yes No	Yes No			
4.4a	Has the person been absent from school/work/childcare or unable to carry out normal duties? If YES 4.4b Mark the day(s):	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○			
4.5	Has the person stayed in bed for part of the day or more?	Yes No	Yes No	Yes No	Yes No			
4.6a	Has the illness caused another family member to take time off work/school to care for the sick person? If YES 4.6b Mark the day(s):	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○	Yes No M T W T F S S ○ ○ ○ ○ ○ ○ ○			

Appendix 3: Sample size calculations for the ICVB Project

Introduction of Cholera Vaccine in Bangladesh

International Centre for Diarrhoeal Disease Research, Bangladesh

Sample size calculations for the ICVB Project

We assumed that the number of migration-in cases will be equivalent to the number of migration-out cases, and all migration-in cases are to be non-vaccines

Assumptions	Values
Alpha	0.05
Beta	0.20
CV	0.3
Study area population (6 wards)	247,391
Number of clusters per arm	30
Average cluster size	2,749
Vaccine protective efficacy	0.65
Initial vaccine coverage	0.65
Annual Migration	0.25
Incidence rate	0.0016
Surveillance period (years)	2
Cumulative incidence among control clusters	0.0032
OPE during 1st year surveillance	0.316875
OPE during 2nd year surveillance	0.23765625
OPE at a mid- point of follow-up	0.277265625
Relative Risk	0.722734375
Cumulative incidence among vaccine clusters	0.00231275
Sample size required for individually randomized trial	43,173

Assumptions	Values
ICC	0.0002889246
Inflation factor (IF)	1.79
Sample size required for cluster randomized trial per arm	77,449
Sample size per cluster	2,582
Sample size per arm	77,460
Total sample size for 3 groups	232,380
Total samples required including infants and pregnant women (3%)	239,352

Appendix 4: Ethical Approval Letters

Memorandum

24 August 2008

To: Dr. Stephen P. Luby
Principal Investigators of research protocol # 2008-032
Health Systems and Infectious Diseases Division (HSID)

From: Professor AKM Nurul Anwar
Chairman
Ethical Review Committee (ERC)



Sub: Approval of research protocol # 2008-032

Thank you for your memo dated 17 August 2008 attaching the modified version of your research protocol # 2008-032 entitled **“End-user performances for and use of point-of-use water treatment measures in Bangladesh”** addressing the issues raised by the ERC in its July meeting held on 30th July 2008 on your research protocol to the satisfaction of the Committee. Accordingly, the Committee approved the research protocol. You will be required to observe the following terms and conditions in implementing the research protocol:

1. As Principal Investigator, the ultimate responsibility for scientific, and ethical conduct including the protection of the rights and welfare of study participants vest upon you. You shall also be responsible for ensuring competence, integrity and ethical conduct of other investigators and staff directly involved in this research protocol.
2. You shall conduct the study in accordance with the ERC-approved protocol and shall fully comply with any subsequent determinations by the ERC.
3. You shall obtain prior approval from the Research Review Committee and the ERC for any modification in the approved research protocol and/or approved consent form(s), except in case of emergency to safeguard/eliminate apparent immediate hazards to study participants. Such changes must immediately be reported to the ERC Chairman.
4. You shall recruit/enroll participants for this study strictly adhering to the criteria mentioned in the research protocol.
5. You shall obtain legally effective informed consent (i.e. consent should be free from coercion or undue influence) from the selected study participants or their legally responsible representative, as approved in the protocol, using the approved consent form prior to their enrollment in this study. Before obtaining consent, all prospective study participants must be adequately informed about the purpose(s) of the study, its methods and procedures, and also what would be done if they agree and also if they do not agree to participate in the study. They must be informed that their participation in the study is

voluntary and that they can withdraw their participation any time without any prejudice. Signed consent forms should be preserved for a period of at least five years following official termination of the study.

6. You shall promptly report the occurrence of any Adverse Event or Serious Adverse Event or unanticipated problems of potential risk to study participants or others to the ERC in writing within 24 hours of such occurrences.
7. Any significant new findings, developing during the course of this study that might affect the risks and benefits and thus influence either participation in the study or continuation of participation should be reported in writing to the participants and the ERC.
8. Data and/or samples should be collected and interviews should be conducted, as specified in the ERC-approved protocol, and confidentiality must be maintained. Data/samples must be protected by reasonable security, safeguarding against risks such as their loss or unauthorized access, destructions, used by others, and modification or disclosure of data. Data/samples should not be disclosed, made available to or use for purposes other than those specified in the protocol, and shall be preserved for a period, as specified under Centre's policies/practices.
9. You shall promptly and fully comply with the decision of the ERC to suspend or withdraw its approval for the research protocol.
10. You shall report progress of research to the ERC for continuing review of the implementation of the research protocol as stipulated in the ERC Guidelines. Relevant excerpt of ERC Guidelines and '*Annual/Completion Report for Research Protocol involving Human Subjects*' are attached for your information and guidance.

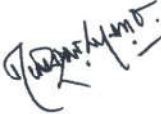
I wish you success in running the above-mentioned study.

Copy: - Acting Director, HSID
- Coordination Manager, RA

Memorandum

17 December 2008

To: Dr. Stephen P. Luby
Principal Investigator of research protocol # 2008-032
Health Systems and Infectious Diseases Division (HSID)

From: Professor AKM Nurul Anwar 
Chairman
Ethical Review Committee (ERC)

Sub: Approval of addendum proposal to research protocol # 2008-032

This has reference to your memo dated 18 November 2008 attaching the modified version of your research protocol # 2008-032 titled "**End-user Preferences for and Use of Point-of-Use Water Treatment Measures in Bangladesh**" addressing the issues raised by the ERC in October meeting held on 29th October 2008 upto the satisfaction of the committee. I have the pleasure to inform you that the addendum proposal to the above research protocol is approved.

Other terms and conditions for implementation of your research protocol, as contained in my memo dated 24 August 2008 according approval of the research protocol shall, however, remain unchanged.

Thank you once again.

Copy: Acting Director, HSID

Memorandum

2 September 2009

To: Dr. Stephen P. Luby
Principal Investigators of research protocol # 2008-032
Health Systems and Infectious Diseases Division (HSID)

From: Professor AKM Nurul Anwar
Chairman
Ethical Review Committee (ERC)



Sub: Research protocol # 2008-032

The ERC considered your addendum proposal to research protocol # 2008-032 titled “**End-user Preferences for and Use of Point-of-Use Water Treatment Measures in Bangladesh**” in its August meeting held on 26th August 2009. I have the pleasure to accord approval of the addendum proposal of the above protocol.

Other terms and conditions for implementation of your research protocol, as contained in our memo dated 24 August 2008 according approval of the research protocol shall, however, remain unchanged.

Thank you once again.

Copy: Acting Director, HSID

Memorandum

24 November 2010

To: Dr Firdausi Qadri
Principal Investigator of research protocol # PR-10061
Laboratory Sciences Division (LSD)

From: Dr Abbas Bhuiya
Chairperson
Research Review Committee (RRC)



Sub: Approval of research protocol # PR-10061

Thank you for your memo dated 22 November 2010 attaching the modified version of your research protocol # PR-10061 entitled "**Introduction of Cholera Vaccine in Bangladesh**" addressing the issues raised by the committee in its meeting held on 9 November 2010 to the satisfaction of the Committee. Accordingly, the Committee approved the research protocol. You will be required to observe the following terms and conditions in implementing the research protocol:

Terms of approval

1. The research protocol is approved as submitted for 60-month period from the date of starting the activities of the protocol. You should, therefore, notify the IRB Secretariat of the start date of the protocol.
2. This approval is only valid whilst you hold a position at ICDDR,B; and in the event of your departure from the Centre, a new Principal Investigator will be designated for the research protocol.
3. This approval shall remain valid for starting the protocol for a period up to 2 years from the date of the approval of the ERC, after two years, you shall have to seek approval (revalidation) of the RRC/ERC before starting the protocol. The RRC/ERC approval shall automatically deemed to be revoked after three years if the protocol is not started.
4. You should notify the RRC and the ERC immediately of any serious or unexpected adverse effects on participants or unforeseen events that might affect continued acceptability of the protocol.
5. Any changes to the research protocol require the submission (in prescribed form) and approval of an amendment/addendum. Substantial variations may require a new protocol.
6. Continued approval of this protocol is dependent on your periodically updating the Centre's database for the protocol to show the progress; and a final

report/completion report should be submitted at the conclusion of the protocol.

7. You shall submit a report for time extension of the protocol (in prescribed form) if you are unable to complete the protocol activities within the time mentioned in the protocol.
8. The RRC should be notified if the protocol is discontinued before the expected date of completion. The report form is available at the IRB Secretariat and on the Centre's intranet.
9. You are responsible for systematic storage and retention of the original data pertaining to the research protocol; and the ownership of data after certain period shall be determined as per Centre's rules and regulations.

I wish you all the success in conducting the research protocol.

Thank you.

Cc: Director, LSD
Coordination Manager, RA

Memorandum

23 December 2010

To: Dr Firdausi Qadri
Principal Investigator of research protocol # PR-10061
Laboratory Sciences Division (LSD)

From: Professor AKM Nurul Anwar
Chairman
Ethical Review Committee (ERC)



Sub: Approval of research protocol # PR-10061

Thank you for your memo dated 20 December 2010 attaching the modified version of your research protocol # PR-10061 entitled "**Introduction of Cholera Vaccine in Bangladesh**" Version No. 1, dated 20 December 2010, and subsequent memo dated 20 December 2010 addressing the issues raised by the committee in its November meeting held on 1 December 2010 to the satisfaction of the Committee. Accordingly, the Committee approved the research protocol. You will be required to observe the following terms and conditions in implementing the above clinical trial research protocol:

1. As Principal Investigator, the ultimate responsibility for scientific and ethical conduct including the protection of the rights and welfare of study participants vest upon you. You shall also be responsible for ensuring competence, integrity and ethical conduct of other investigators and staff directly involved in this research protocol.
2. You shall conduct the study in accordance with the ERC-approved protocol and shall fully comply with any subsequent determinations by the ERC.
3. You shall obtain prior approval from the Research Review Committee and the ERC for any modification in the approved research protocol and/or approved consent form(s), except in case of emergency to safeguard/eliminate apparent immediate hazards to study participants. Such changes must immediately be reported to the ERC Chairman.
4. You shall recruit/enroll participants for this study strictly adhering to the criteria mentioned in the research protocol.
5. You shall obtain legally effective informed consent (i.e. consent should be free from coercion or undue influence) from the selected study participants or their legally responsible representative, as approved in the protocol, using the approved consent form prior to their enrollment in this study.

Before obtaining consent, all prospective study participants must be adequately informed about the purpose(s) of the study, its methods and procedures, and also what would be done if they agree and also if they do not agree to participate in the study. They must be informed that their participation in the study is voluntary and that they can withdraw their participation any time without any prejudice. Signed consent forms should be preserved for a period of at least five years following official termination of the study.

6. You shall promptly report the occurrence of any Adverse Event or Serious Adverse Event or unanticipated problems of potential risk to study participants or others to the ERC in writing within 24 hours of such occurrences.
7. Any significant new findings, developing during the course of this study that might affect the risks and benefits and thus influence either participation in the study or continuation of participation should be reported in writing to the participants and the ERC.
8. Data and/or samples should be collected and interviews should be conducted, as specified in the ERC-approved protocol, and confidentiality must be maintained. Data/samples must be protected by reasonable security, safeguarding against risks such as their loss or unauthorized access, destructions, used by others, and modification or disclosure of data. Data/samples should not be disclosed, made available to or use for purposes other than those specified in the protocol, and shall be preserved for a period, as specified under Centre's policies/practices.
9. You shall promptly and fully comply with the decision of the ERC to suspend or withdraw its approval for the research protocol.
10. The ERC will constitute a Data and Safety Monitoring Board (DSMB) to oversee the implementation of the above study. You are advised to nominate 2-3 names from relevant discipline for membership of the DSMB.
11. You shall report progress of research to the ERC for continuing review of the implementation of the research protocol as stipulated in the ERC Guidelines. Relevant excerpt of ERC Guidelines and '*Annual/Completion Report for Research Protocol involving Human Subjects*' are attached for your information and guidance.

I wish you success in running the above-mentioned study.

Copy: Director, LSD
Coordination Manager, RA