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


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


### Thesis including published works declaration

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

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<tr>
<td>4</td>
<td>Explaining low rates of sustained use of siphon water filter: evidence from follow-up of a randomised controlled trial in Bangladesh.</td>
<td>Published Tropical Medicine &amp; International Health 2015</td>
<td>80% Study design, literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
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<td>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</td>
<td>Published International Journal of Epidemiology 2017</td>
<td>80% Study design, literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
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<td>6</td>
<td>Inconsistency in diarrhoea measurements when assessing intervention impact in a cluster randomised trial</td>
<td>Published American Journal of Tropical Medicine and Hygiene 2019</td>
<td>80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript</td>
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<tr>
<td>7</td>
<td>Impact of a large-scale hand washing interventions on reported respiratory illness: findings from a cluster randomised control trial</td>
<td>Published American Journal of Tropical Medicine and Hygiene 2019</td>
<td>80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
</tr>
<tr>
<td>8</td>
<td>Risk factors for community-based reports of gastrointestinal, respiratory, and dermal symptoms: findings from a cohort study in Australia.</td>
<td>Published Journal of Epidemiology 2014</td>
<td>80% Literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
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**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.
Acknowledgements

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.

I am deeply indebted to Karin Leder, my principal supervisor for her support and invaluable mentorship. Without her support this accomplishment would not be possible.

I would like to thank the co-authors of the papers for their time and effort that they provided to refine and finalize the papers. I would especially like to thank Dr. Leanne Unicomb for her feedback and guidance on completing this thesis.

I would like to express my gratitude to the Monash University Institute of Graduate Research (MIGR) for the scholarship that has made it possible to complete this thesis. I would also like to thank Dr Elizabeth Douglas, Doctoral Coordinator, School of Public Health & Preventive Medicine of Monash University for her support during the candidature process.

I am indebted to the participants, icddr,b study staff and data management team. The studies included in this thesis were funded by the Blum Center for Developing Economies and the Institute for Research on Labor and Employment at the University of California, Berkeley, SIDA, the P&G Fund of the Greater Cincinnati Foundation and Bill and Melinda Gates Foundation.

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**

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<tr>
<td>Chapter 6</td>
<td>Results: Inconsistency in Diarrhea Measurements when Assessing Intervention Impact in a Non-Blinded Cluster-Randomized Controlled Trial</td>
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<td>Results: Risk Factors for Community-Based Reports of Gastrointestinal, Respiratory, and Dermal Symptoms: Findings From a Cohort Study in Australia</td>
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<td>Discussion and Conclusion</td>
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**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 remain 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 undernutrition 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).

![Diagram](image)

**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/colliform 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).
In a laboratory environment, this silver-impregnated filter removes $\log_{10} 4.4 - 5.5$ of \textit{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.
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 6.** Cholera hospitalization rate at the *icddr,b* hospital, from different wards in Mirpur, Dhaka (2008-2010)

**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.
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)

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

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.

![Hand-washing station](image)

**Figure 11**: Hand-washing station (includes bucket with tap, bowl, and soapy water bottle)
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 ¾ 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.

**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.
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.
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 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 H$_2$S 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.

![Study timeline](image)

**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 $\alpha$ level of significance with power $1 - \beta$, where $\hat{P}_1$ and $\hat{P}_2$ were estimated by $\hat{P}_1$ and $\hat{P}_2$, respectively, where these estimates were computed over all individuals in each group. Let $Z\alpha$, $Z\beta$ denoted the critical values of the standard normal distribution corresponding to the error rates $\alpha$ and $\beta$, respectively. Then the required number of subjects per intervention group was given approximately by

$$n = \frac{(Z_{\alpha} + Z_{\beta})^2 [P_1(1 - P_1) + P_2(1 - P_2)][1 + (m - 1)\rho]}{(P_1 - P_2)^2},$$

where $\rho$ 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


Declaration by candidate

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

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study design, literature review, statistical analysis and interpretation of results, and writing the manuscript.</td>
<td>80%</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaila Arman</td>
<td>Contributed to study design, analysis of qualitative data, editing of the manuscript</td>
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<tr>
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<td>Extent of contribution (%) for student co-authors only</td>
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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.

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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 $10^{-4.4}$–$10^{-5.5}$ 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$_2$S test [29, 30]. The H$_2$S 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$_2$S 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
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
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
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 1 Descriptive results for individual questionnaire items on attitude by filter user groups during the 3-month follow-up survey, Dhaka, Bangladesh*

<table>
<thead>
<tr>
<th>Multi-item measurement of attitude towards using the filter</th>
<th>Score direction</th>
<th>Regular users</th>
<th>Irregular users</th>
<th>P-value of difference in means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use the water filter makes me feel ‘I am a person who takes good care of her children’</td>
<td>Positive</td>
<td>4.98 ± 0.14</td>
<td>4.66 ± 0.81</td>
<td>0.01</td>
</tr>
<tr>
<td>Use the water filter makes me feel ‘I am a modern person who does not drink untreated water’</td>
<td>Positive</td>
<td>4.96 ± 0.20</td>
<td>4.55 ± 0.87</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Use the water filter makes me feel ‘I am treating water like a rich person’</td>
<td>Positive</td>
<td>4.10 ± 1.47</td>
<td>3.78 ± 1.51</td>
<td>0.22</td>
</tr>
<tr>
<td>Use 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’</td>
<td>Positive</td>
<td>4.40 ± 1.11</td>
<td>4.27 ± 1.07</td>
<td>0.49</td>
</tr>
<tr>
<td>Use the water filter makes me feel ‘I am improving my health’</td>
<td>Positive</td>
<td>4.94 ± 0.24</td>
<td>4.57 ± 0.79</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Use the filter to treat water is an effective way of preventing diarrhoea</td>
<td>Positive</td>
<td>4.96 ± 0.20</td>
<td>4.71 ± 0.86</td>
<td>0.04</td>
</tr>
<tr>
<td>I am proud that I own a water filter that I use to treat my drinking water</td>
<td>Positive</td>
<td>4.78 ± 0.46</td>
<td>4.48 ± 0.73</td>
<td>0.01</td>
</tr>
<tr>
<td>I am satisfied with using the filter</td>
<td>Positive</td>
<td>4.82 ± 0.39</td>
<td>4.52 ± 0.68</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Use the filter is easy</td>
<td>Positive</td>
<td>4.92 ± 0.27</td>
<td>4.12 ± 1.12</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>I am happy that I purchased or received the filter</td>
<td>Positive</td>
<td>4.78 ± 0.42</td>
<td>4.50 ± 0.65</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Use the filter to clean drinking water makes the water taste bad</td>
<td>Negative</td>
<td>4.80 ± 0.81</td>
<td>4.79 ± 0.75</td>
<td>0.95</td>
</tr>
<tr>
<td>Use the filter to clean drinking water makes the water smell bad</td>
<td>Negative</td>
<td>4.78 ± 0.82</td>
<td>4.73 ± 0.84</td>
<td>0.72</td>
</tr>
</tbody>
</table>

*Higher numbers indicate more positive attitudes towards using the filters.
†SD (Standard Deviation).
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 envelop price in the auction. There were no statistically significant differences in regular filter use between people who received it free of charge.

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).
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: 1.0, 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 time 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 Bihar 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)

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

*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. Another commonly reported barrier in the surveys included long wait times for obtaining the filtered water, which is consistent with findings from other studies.

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. 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. 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. 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, sometimes follow behaviour, and sometimes have a reciprocal relationship with behaviours. 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.

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. Before receiving the filter over a quarter of the participants reported, they boiled their water. 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.

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. 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 benefited 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.

Acknowledgements
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. ICDDR,B acknowledges with gratitude the commitment of the funders to the Centre’s research efforts. We are grateful to Fazul Kader Chowdhury, Md. Al Mamun, Smriti Roy, Tahmina Parvin, Fatema Tuj-johra, Rita Begum, Halima Hawa, Kathika Rani Biswas, Abdul Karim, Shahnaj Aktar for collecting these data; Peter Winch for his suggestions on qualitative data collection and both qualitative and quantitative data analysis. The authors particularly appreciate the suggestions made by Dorothy Southern on the manuscript.

References
Sustained use of siphon filters

N. Najnin et al.


19 Anstiss RG, Ahmed M. A conceptual model to be used for community-based drinking-water improvements. *J Health Popul Nutr* 2006; 24: 262.


N. Najnin et al.  Sustained use of siphon filters


Appendix 1

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

<table>
<thead>
<tr>
<th>Predictors</th>
<th>3-month follow-up</th>
<th>6-month follow-up</th>
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<tbody>
<tr>
<td></td>
<td>Univariate logistic regression</td>
<td>Multiple logistic regression</td>
</tr>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Willingness to pay (taka)†</td>
<td>1.004 (1.001, 1.008)</td>
<td>1.005 (1.001, 1.010)</td>
</tr>
<tr>
<td>Attitude towards using the filter (at 3-month follow-up)‡</td>
<td>3.2 (1.6, 6.5)</td>
<td>4.3 (1.9, 9.8)</td>
</tr>
<tr>
<td>Boil drinking water (self-report at baseline)</td>
<td>2.4 (1.2, 4.9)</td>
<td>2.8 (1.3, 6.2)</td>
</tr>
<tr>
<td>Ethnicity (Bihari)</td>
<td>0.5 (0.2, 0.8)</td>
<td>0.6 (0.2, 1.6)</td>
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</tbody>
</table>

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

Corresponding Author Nusrat Najnin, Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia. E-mail: nusrat.najnin@monash.edu
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


Declaration by candidate

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

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
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<tr>
<td>Literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
<td>80%</td>
</tr>
</tbody>
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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:

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<th>Name</th>
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<tr>
<td>Karin Leder</td>
<td>interpreted results and provided critical comments</td>
<td>N/A</td>
</tr>
<tr>
<td>Firdausi Qadri</td>
<td>designed the study, served as principal investigators, interpreted results; critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Name</td>
<td>Nature of contribution</td>
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<tr>
<td>Andrew Forbes</td>
<td>analysed and interpreted data; reviewed the manuscript, drafted or critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Leanne Unicomb</td>
<td>oversaw data collection, supervised behavioural intervention implementation; critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Peter J. Winch</td>
<td>designed behaviour interventions, provided input on data collection instruments; critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Pavani K. Ram</td>
<td>designed behaviour interventions, provided input on data collection instruments; critically revised the paper</td>
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</tr>
<tr>
<td>Elli Leontsini</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
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<tr>
<td>Fosiul A. Nazame</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
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<tr>
<td>Shaila Arman</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Farzana Begum</td>
<td>supervised implementation of behavioural interventions; reviewed the manuscript, critically revised the paper</td>
<td>N/A</td>
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<tr>
<td>Shwapon K. Biswas</td>
<td>supervised data collection; reviewed the manuscript, drafted or critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>John D. Clemens</td>
<td>interpreted results and provided critical comments</td>
<td>N/A</td>
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<tr>
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<tr>
<td>Mohammad Ali</td>
<td>interpreted results and provided critical comments</td>
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</tr>
<tr>
<td>Alejandro Cravioto</td>
<td>interpreted results and provided critical comments</td>
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</tr>
<tr>
<td>Stephen P. Luby</td>
<td>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</td>
<td>N/A</td>
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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.

<table>
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<th>Main Supervisor’s Signature</th>
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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

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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
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. 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). 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, and it was approved for research purposes in this study. Details of vaccine transportation, storage and administration have been reported. 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. 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.
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. 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. The water treatment hardware consisted of a chlorine dispenser containing liquid sodium hypochlorite (Figure 2b). 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 h) 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.

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

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)].
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.

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

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Vaccine-only area (n = 109700) %</th>
<th>Vaccine-plus-behaviour-change area (n = 107134) %</th>
<th>Control area (n = 97914) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, SD)</td>
<td>23.3 (15.6)</td>
<td>23.4 (15.5)</td>
<td>23.4 (15.7)</td>
</tr>
<tr>
<td>≤ 5 years</td>
<td>13.1</td>
<td>13.2</td>
<td>13.3</td>
</tr>
<tr>
<td>&gt; 5–15 years</td>
<td>19.6</td>
<td>19.2</td>
<td>19.9</td>
</tr>
<tr>
<td>&gt; 15–50 years</td>
<td>61.9</td>
<td>62.2</td>
<td>61.1</td>
</tr>
<tr>
<td>&gt; 50 years</td>
<td>5.5</td>
<td>5.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>48.2</td>
<td>48.7</td>
<td>48.7</td>
</tr>
<tr>
<td>Educational status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education (includes children &lt; 5 years)</td>
<td>43.8</td>
<td>41.4</td>
<td>43.9</td>
</tr>
<tr>
<td>Below primary</td>
<td>17.4</td>
<td>17.5</td>
<td>17.6</td>
</tr>
<tr>
<td>Primary and some secondary</td>
<td>30.8</td>
<td>31.7</td>
<td>30.0</td>
</tr>
<tr>
<td>Above secondary</td>
<td>8.0</td>
<td>9.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Number of people in a family (median, interquartile range)</td>
<td>5 (2)</td>
<td>5 (2)</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Number of months living in this house (median, interquartile range)</td>
<td>12 (57)</td>
<td>12 (57)</td>
<td>12 (56)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of households</th>
<th>Vaccine area (n = 27341) %</th>
<th>Vaccine-plus-behaviour-change area (n = 26794) %</th>
<th>Control area (n = 24393) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of drinking water (WASA supply water)</td>
<td>99.9</td>
<td>99.7</td>
<td>99.9</td>
</tr>
<tr>
<td>Treat drinking water (yes)</td>
<td>52.6</td>
<td>58.7</td>
<td>54.6</td>
</tr>
<tr>
<td>Boil water</td>
<td>51.5</td>
<td>56.4</td>
<td>53.1</td>
</tr>
<tr>
<td>Filter water</td>
<td>0.7</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Chemical treatment</td>
<td>0.4</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Distance from source of drinking water to the kitchen in centimeters (median, interquartile range)</td>
<td>457 (457)</td>
<td>457 (457)</td>
<td>457 (457)</td>
</tr>
<tr>
<td>Shared kitchen (yes)</td>
<td>89.6</td>
<td>93.0</td>
<td>87.6</td>
</tr>
<tr>
<td>Shared toilet (yes)</td>
<td>96.7</td>
<td>96.0</td>
<td>95.8</td>
</tr>
<tr>
<td>Type of toilet (direct observation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitary latrine with or without flush</td>
<td>70.5</td>
<td>81.3</td>
<td>78.5</td>
</tr>
<tr>
<td>Non-sanitary</td>
<td>28.5</td>
<td>17.9</td>
<td>21.3</td>
</tr>
<tr>
<td>Use open space</td>
<td>1.0</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Waste disposal (fixed place)</td>
<td>81.8</td>
<td>84.7</td>
<td>79.3</td>
</tr>
<tr>
<td>House construction material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrugated iron</td>
<td>87.1</td>
<td>84.5</td>
<td>83.2</td>
</tr>
<tr>
<td>Brick/concrete</td>
<td>12.8</td>
<td>15.4</td>
<td>16.7</td>
</tr>
<tr>
<td>Bamboo/wood/other</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brick/concrete</td>
<td>90.3</td>
<td>90.4</td>
<td>91.5</td>
</tr>
<tr>
<td>Bamboo/wood/other</td>
<td>9.7</td>
<td>9.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrugated iron</td>
<td>28.2</td>
<td>23.9</td>
<td>26.0</td>
</tr>
<tr>
<td>Brick/concrete</td>
<td>68.4</td>
<td>73.9</td>
<td>70.1</td>
</tr>
<tr>
<td>Bamboo/wood/other</td>
<td>3.4</td>
<td>2.2</td>
<td>3.9</td>
</tr>
<tr>
<td>Number of rooms in the house (mean, SD)</td>
<td>1.1 (0.4)</td>
<td>1.2 (0.5)</td>
<td>1.2 (0.5)</td>
</tr>
<tr>
<td>Monthly rent paid (median, interquartile range) (US$)</td>
<td>25.8 (12.9)</td>
<td>25.8 (12.9)</td>
<td>25.8 (12.2)</td>
</tr>
<tr>
<td>Monthly household expenditure (median, interquartile range) (US$)</td>
<td>103.0 (51.3)</td>
<td>105.6 (52.2)</td>
<td>104.3 (49.6)</td>
</tr>
<tr>
<td>Monthly average savings (median, interquartile range) (US$)</td>
<td>0 (3.8)</td>
<td>0 (2.6)</td>
<td>0 (3.1)</td>
</tr>
</tbody>
</table>

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

a Unique person identification (ID); some categories do not sum to 100% because of rounding.

b Pre-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.

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

d 1 USD = 77.7 BDT (average exchange rate during 2012).
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% ($n = 22,665$ people both in and out migrated during outcome-monitoring time period) 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 $\leq 5$ 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 $\geq 1$ 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: 8.3–10.6); vaccine-plus-behaviour-change 9.0/1000 person-years (95% CI: 7.6–10.6); control 9.7/1000 person-years (95% CI: 8.6–11.0).
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 diarrheal 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 did not, but we could not link the intervention uptake data that was collected from only a small fraction of the study population.

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

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Hospitalizations/1000 person-years Before outcome-monitoring start date</th>
<th>Hazard ratio</th>
<th>95% CI</th>
<th>Hazard ratio</th>
<th>95% CI</th>
<th>Hazard ratio</th>
<th>95% CI</th>
<th>Hazard ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All study areas combined</td>
<td>2.4 12.7</td>
<td>24/09/2010 to 23/09/2011</td>
<td>12.8</td>
<td>9.6 10.2 7.6 11.0</td>
<td>0.99 (0.7–1.2) 0.99 (0.7–1.4) 0.97 (0.7–1.4)</td>
<td>0.95 (0.7–1.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.2 13.7</td>
<td>24/09/2010 to 23/09/2011</td>
<td>12.7</td>
<td>9.8 10.3 7.9 11.2</td>
<td>1.0 1.0 1.0 1.0</td>
<td>1.0 1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccine-only</td>
<td>3.2 12.5</td>
<td>24/09/2010 to 23/09/2011</td>
<td>12.1</td>
<td>8.8 10.1 7.8 10.9</td>
<td>0.99 (0.7–1.4) 0.97 (0.7–1.4) 0.97 (0.7–1.4)</td>
<td>0.97 (0.7–1.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaccine-plus-behaviour-change</td>
<td>2.8 12.1</td>
<td>24/09/2010 to 23/09/2011</td>
<td>12.1</td>
<td>10.2 10.4 7.1 10.7</td>
<td>1.0 1.0 0.90 (0.6–1.3) 0.95 (0.7–1.3)</td>
<td>0.95 (0.7–1.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Results are cluster-adjusted.
\(^b\)Results 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).

Cholera vaccine was delivered during this period.
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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We are grateful to the study participants; to Dushtha-Shasthya-Kendra (DSK) for intervention implementation; to the field and data management staff for providing incredible effort to make the study successful; to Dushtha-Shasthya-Kendra (DSK) for intervention implementation; to the field and data management staff for providing incredible effort to make the study successful; and to the people who provided valuable input in this study.

Conflict of interest: None declared.

References


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

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

*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)*

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

* 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)

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

*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


Declaration by candidate

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

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designing data collection instruments; contributed in designing behavioural interventions; literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
<td>80%</td>
</tr>
</tbody>
</table>

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:

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

<table>
<thead>
<tr>
<th>Candidate’s Signature</th>
<th>15/07/2019</th>
</tr>
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<tr>
<td>Main Supervisor’s Signature</td>
<td>22/07/2019</td>
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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 (~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. 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 behavioral 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 Biotechs-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 handwashing 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. 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, 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.38 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.38 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
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 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. Depending on random selection of households sometimes we had to visit the same compound twice in a week for interviewing different households.

### Table 1

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

* 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.
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

---

**Table 2**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Diarrhea prevalence from census, % (n/N) (95% CI)</th>
<th>Interventions vs. control groups in prevalence, % of difference in prevalence; 95% CI; P-value</th>
<th>Diarrhea prevalence from monthly surveys, % (n/N) (95% CI)</th>
<th>Interventions vs. control groups in prevalence, % of difference in prevalence; 95% CI; P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All study groups combined</td>
<td>2.43 (6,081/250,514)</td>
<td>2.87 (171/5,949)</td>
<td>2.43 (6,081/250,514)</td>
<td>2.87 (171/5,949)</td>
</tr>
<tr>
<td>Vaccine-only group</td>
<td>2.32 (1,981/85,484) (1.91, 2.81)</td>
<td>3.39 (63/1,564)</td>
<td>2.60 (3.65)</td>
<td>Prevalence is 0.4% lower in vaccine-only group than control; −0.0080, 0.0039; 0.49</td>
</tr>
<tr>
<td>Vaccine-plus-behavior-change group</td>
<td>2.44 (2,028/83,075) (2.03, 2.94)</td>
<td>2.08 (59/2,832)</td>
<td>1.39 (3.12)</td>
<td>Prevalence is 1.7% lower in vaccine-plus-behavior change group compared to control; −0.0068, 0.0051; 0.78</td>
</tr>
<tr>
<td>Control group</td>
<td>2.53 (2,072/81,955) (2.12, 3.01)</td>
<td>3.80 (69/1,553)</td>
<td>2.53 (2,072/81,955)</td>
<td>3.80 (69/1,553)</td>
</tr>
</tbody>
</table>

*Results are adjusted for cluster-randomized design.*

---

**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.ajtogh.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 behavioral 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.

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 others 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. 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, Hawthorne effect, or courtesy bias.

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 WHO and has been adopted in many other studies. 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. 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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CONSISTENCY IN DIARRHEA MEASUREMENT IN NON-BLINDED TRIAL

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REFERENCES


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

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

*Results adjusted for cluster randomized design
### Supplementary table 2: Age stratified distribution of participants in the census survey*

<table>
<thead>
<tr>
<th>Age</th>
<th>Vaccine-only&lt;br&gt; N=142,879</th>
<th>Vaccine plus behavior change&lt;br&gt; N=140,202</th>
<th>Control&lt;br&gt; N=137,451</th>
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</thead>
<tbody>
<tr>
<td>≤1 year</td>
<td>7.0%</td>
<td>7.2%</td>
<td>7.2%</td>
</tr>
<tr>
<td>&gt;1 to ≤2 years</td>
<td>1.9%</td>
<td>1.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>&gt;2 to ≤3 years</td>
<td>2.0%</td>
<td>1.9%</td>
<td>2.0%</td>
</tr>
<tr>
<td>&gt;3 to ≤4 years</td>
<td>1.9%</td>
<td>1.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>&gt;4 to ≤5 years</td>
<td>1.9%</td>
<td>1.8%</td>
<td>1.8%</td>
</tr>
<tr>
<td>&gt;5 years</td>
<td>85.3%</td>
<td>85.3%</td>
<td>85.2%</td>
</tr>
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</table>

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

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

<table>
<thead>
<tr>
<th>Age</th>
<th>Vaccine-only&lt;br&gt; N=13,914</th>
<th>Vaccine plus behavior change&lt;br&gt; N=27,059</th>
<th>Control&lt;br&gt; N=14,236</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 year</td>
<td>3.5%</td>
<td>3.7%</td>
<td>3.3%</td>
</tr>
<tr>
<td>&gt;1 to ≤2 years</td>
<td>2.0%</td>
<td>1.6%</td>
<td>2.1%</td>
</tr>
<tr>
<td>&gt;2 to ≤3 years</td>
<td>1.9%</td>
<td>1.8%</td>
<td>1.9%</td>
</tr>
<tr>
<td>&gt;3 to ≤4 years</td>
<td>2.2%</td>
<td>1.9%</td>
<td>2.1%</td>
</tr>
<tr>
<td>&gt;4 to ≤5 years</td>
<td>1.7%</td>
<td>1.6%</td>
<td>1.7%</td>
</tr>
<tr>
<td>&gt;5 years</td>
<td>88.6%</td>
<td>89.4%</td>
<td>89.0%</td>
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* 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


Declaration by candidate

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

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review, statistical analysis and interpretation of results, development and writing the manuscript.</td>
<td>80%</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karin Leder</td>
<td>interpreted results and provided critical comments</td>
<td>N/A</td>
</tr>
<tr>
<td>Andrew Forbes</td>
<td>analysed and interpreted data; reviewed the manuscript, drafted or critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Leanne Unicomb</td>
<td>oversaw data collection, supervised behavioural intervention implementation; critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Peter J Winch</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Name</td>
<td>Nature of contribution</td>
<td>Extent of contribution (%) for student co-authors only</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Pavani K. Ram</td>
<td>designed behaviour interventions, provided input on data collection instruments; critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Fosiul A. Nizame</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Shaila Arman</td>
<td>designed behaviour interventions, provided input on data collection instruments; reviewed the manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Farzana Begum</td>
<td>supervised implementation of behavioural interventions; reviewed the manuscript, critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Shwapon Biswas</td>
<td>supervised data collection; reviewed the manuscript, drafted or critically revised the paper</td>
<td>N/A</td>
</tr>
<tr>
<td>Alejandro Cravioto</td>
<td>interpreted results and provided critical comments</td>
<td>N/A</td>
</tr>
<tr>
<td>Stephen P. Luby</td>
<td>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</td>
<td>N/A</td>
</tr>
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</table>
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.

<table>
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<tr>
<th>Candidate’s Signature</th>
<th>15/07/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Supervisor’s Signature</td>
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</table>
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 ratioadjusted: 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
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. 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. Details about the interventions and how these were delivered in the study community have been reported elsewhere. In short, handwashing intervention hardware included a bucket with a tap, soapy water bottle, and a bowl to collect rinse water after washing hands (Figure 1). 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. 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. Details of vaccine transportation, storage, and administration to the study population have been previously reported.

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.

**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.

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
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. 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.

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. 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. 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. We used the first factor from the principal component analysis, as this has been reported to best capture economic status. Based on their wealth score, we divided households into quintiles and adjusted for wealth quintile in the log-binomial regression models.

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). 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.
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.

Intervention uptake. Uptake of behavior-change interventions was modest as previously reported. 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; RRadjusted = 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) (RRadjusted = 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
who had soap/soapy water plus water present at their hand-washing 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. 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, the handwashing intervention uptake was not much higher in our study compared with those of other large-scale interventions. 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. 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%). 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%. Neither SHEWA-B nor the Peru national handwashing program were externally funded programmatic interventions targeting millions of people.

### Table 1

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

<table>
<thead>
<tr>
<th>Characteristics of individuals</th>
<th>Vaccine-only group (n = 13,148)</th>
<th>Vaccine-plus-behavior-change group (n = 25,566)</th>
<th>Control group (n = 13,523)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, SD) (years)</td>
<td>24 (15.9)</td>
<td>25 (15.9)</td>
<td>24 (16.0)</td>
</tr>
<tr>
<td>≤ 5</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>&gt; 5 to 15</td>
<td>21</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>&gt; 15 to 50</td>
<td>62</td>
<td>63</td>
<td>61</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of households</th>
<th>Vaccine-only group (n = 1,965)</th>
<th>Vaccine-plus-behavior-change group (n = 3,886)</th>
<th>Control group (n = 1,991)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender of the respondent (female)</td>
<td>82</td>
<td>84</td>
<td>85</td>
</tr>
<tr>
<td>Educational status of respondent</td>
<td>No formal education</td>
<td>37</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Below primary</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Primary and some secondary</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Above secondary</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Source of drinking water (WASA supply water)†</td>
<td>80</td>
<td>82</td>
<td>85</td>
</tr>
<tr>
<td>Toilet shared among families</td>
<td>91</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>House construction material</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corrugated iron</td>
<td>85</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Brick/concrete</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Bamboo/wood/other</td>
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<td>0.2</td>
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<tr>
<td>Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brick/concrete</td>
<td>92</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Bamboo/wood/mud/sand/other</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brick/concrete</td>
<td>71</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Bamboo/wood/corrugated iron/</td>
<td>29</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of fuel used for cooking</td>
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<tr>
<td></td>
<td>Natural gas</td>
<td>72</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Wood/husk/charcoal/kerosene</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Other (electric heater)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Monthly income (median, interquartile range) (US$)‡</td>
<td>141 (97)</td>
<td>155 (90)</td>
<td>141 (90)</td>
</tr>
</tbody>
</table>

* 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).
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
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. 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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REFERENCES


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


Declaration by candidate

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

<table>
<thead>
<tr>
<th>Nature of contribution</th>
<th>Extent of contribution (%)</th>
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<tbody>
<tr>
<td>Literature review, statistical analysis and interpretation of results, and writing the manuscript.</td>
<td>80%</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Nature of contribution</th>
<th>Extent of contribution (%) for student co-authors only</th>
</tr>
</thead>
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<tr>
<td>Andrew Forbes</td>
<td>Data analysis, critically reviewed and edited manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Martha Sinclaire</td>
<td>Contributed to the study design and critically reviewed and edited manuscript</td>
<td>N/A</td>
</tr>
<tr>
<td>Karin Leder</td>
<td>Contributed to the study design, provided suggestion on analysis and critically reviewed and edited manuscript</td>
<td>N/A</td>
</tr>
</tbody>
</table>
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.

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<td><strong>Main Supervisor’s</strong></td>
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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. 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. For respiratory infections, factors such as air pollution and smoking are also important. 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
number of households initially approached) to collect health data during a 12-month period. The details of the participant recruitment process are available elsewhere. 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. 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), 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.

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. 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 swim 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 non-swimmers, 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 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) (n = 1237)

<table>
<thead>
<tr>
<th>Attending institution outside home</th>
<th>Unadjusted</th>
<th>Adjusted(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk ratio</td>
<td>95% CI</td>
</tr>
<tr>
<td>GI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attending child care/kindergarten(^c)</td>
<td>2.51</td>
<td>2.02, 3.12</td>
</tr>
<tr>
<td>Having a pet at home(^d)</td>
<td>0.98</td>
<td>0.68, 1.41</td>
</tr>
<tr>
<td>Swimming in any setting</td>
<td>1.24</td>
<td>0.98, 1.56</td>
</tr>
<tr>
<td>Swimming in public pool/spa(^e)</td>
<td>1.5</td>
<td>1.15, 2.04</td>
</tr>
<tr>
<td>Swimming in private pool/spa(^e)</td>
<td>0.75</td>
<td>0.56, 1.03</td>
</tr>
<tr>
<td>Swimming in ocean and/or river(^a)</td>
<td>0.94</td>
<td>0.68, 1.31</td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attending child care/kindergarten(^c)</td>
<td>2.52</td>
<td>2.09, 3.03</td>
</tr>
<tr>
<td>Having a pet at home(^d)</td>
<td>1.11</td>
<td>0.83, 1.47</td>
</tr>
<tr>
<td>Swimming in any setting</td>
<td>1.06</td>
<td>0.92, 1.22</td>
</tr>
<tr>
<td>Swimming in public pool/spa(^e)</td>
<td>1.34</td>
<td>1.13, 1.58</td>
</tr>
<tr>
<td>Swimming in private pool/spa(^e)</td>
<td>0.71</td>
<td>0.58, 0.87</td>
</tr>
<tr>
<td>Swimming in ocean and/or river(^a)</td>
<td>0.77</td>
<td>0.62, 0.95</td>
</tr>
<tr>
<td>Dermal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attending child care/kindergarten(^c)</td>
<td>2.74</td>
<td>1.71, 4.39</td>
</tr>
<tr>
<td>Having a pet at home(^d)</td>
<td>1.45</td>
<td>0.81, 2.60</td>
</tr>
<tr>
<td>Swimming in any setting</td>
<td>1.82</td>
<td>1.43, 2.33</td>
</tr>
<tr>
<td>Swimming in public pool/spa(^e)</td>
<td>2.07</td>
<td>1.50, 2.87</td>
</tr>
<tr>
<td>Swimming in private pool/spa(^e)</td>
<td>1.16</td>
<td>0.74, 1.80</td>
</tr>
<tr>
<td>Swimming in ocean and/or river(^a)</td>
<td>1.08</td>
<td>0.76, 1.52</td>
</tr>
</tbody>
</table>

Abbreviation: GI, gastrointestinal.
\(^a\)All analysis accounted for clustering by household.
\(^b\)Risk ratios adjusted for age, sex, season, and household clustering.
\(^c\)Comparator group: Attending primary school or a higher educational institution or not attending any educational institute.
\(^d\)Adjusted 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) (n = 1235)

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

Abbreviation: GI, gastrointestinal.

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

\(^b\)Risk 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.
Attending childcare or kindergarten was previously reported as a risk factor for GI and respiratory symptoms. 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.

Recreational swimming is another recognized risk factor for GI, respiratory, and dermal symptoms, 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 identified as a 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, 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, the impact of any disinfection procedures (eg, chlorine, ultraviolet light, and ultrasonic air sparging), and the effectiveness of these disinfection methods. Table 4 and Table 5 present demographic data for individuals with and without respiratory and dermal symptoms, respectively.

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

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

aData Cluster 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) (n = 1235)

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

aData Cluster 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.
chlorination) on pathogen concentration, 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. 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, 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 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. 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.

ACKNOWLEDGMENTS

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Author contributions: NN analyzed and interpreted the data and prepared the draft manuscript; MS contributed to the conception and design of the study and revised the manuscript critically for important intellectual content; AF contributed to the conception and design of the study, analyzed and interpreted the data, and revised the manuscript critically for important intellectual content; KL contributed to the conception and design of the study, interpreted the data, and revised the manuscript for important intellectual content, and gave final approval of the version submitted to the journal.

Conflicts of interest: None declared.
REFERENCES


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 (SGD) #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 SGD 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 $\leq 5$ 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 suggestes 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 a 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 \( \leq 5 \) 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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Appendices

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Appendix 1.1: Microbiological Evaluation of the Efficacy of Soapy Water to Clean Hands: A Randomized, Non-Inferiority Field trial

Appendix 1.2: Reliability and Validity of Measures for Investigating the Determinants of Health Behaviors Among Women With a History of Gestational Diabetes

Appendix 1.3: Effectiveness of a large-scale handwashing promotion intervention on handwashing behaviour in Dhaka, Bangladesh
Microbiological Evaluation of the Efficacy of Soapy Water to Clean Hands: A Randomized, Non-Inferiority Field Trial


International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Dhaka, Bangladesh; Stanford University, Stanford, California; University at Buffalo, Buffalo, New York; Centers for Disease Control and Prevention, Atlanta, Georgia

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 log10 reduction = 0.7 colony-forming units [CFU], P < 0.001 for soapy water; mean log10 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 log10 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. Handwashing with soap after defecation and handling feces and before preparing and eating food can reduce the risk of diarrhoea. In both rural and urban communities of Bangladesh, people rarely wash their hands with soap at recommended times. 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.

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. A study from 68 subdistricts 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. 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 [ORad] = 1.4, 95% CI = 1.1–1.7). A number of research studies from Bangladesh have shown that the cost of soap is a barrier to its use. 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. Soapy water is currently being piloted in low-income rural and urban communities in Bangladesh 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. 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.

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. 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. 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.)
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 a 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, 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. 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. 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, Dhaka and the observed average hand scrubbing time of 14 seconds found in the United Kingdom. Thirty seconds of scrubbing was the maximum scrubbing time observed after receiving the soap intervention in the Kamalapur study. 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).

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), unclean (no dirt is visible on the hand, but part of the hand appears unclean), 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 soap. Fieldworkers used a stopwatch to record the time of hand rinsing.23 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 to 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 collected 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*.22 Thermotolerant coliforms are commonly used as indicators of fecal contamination in handwashing evaluations.20–27 *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).25 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. 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, unclean, 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 participants’ 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 hand(s) contact with feces (self or child’s) within last 1 hour | Soapy water (N = 108)* n (%) | Bar soap (N = 108)* n (%) | Water alone (N = 84) n (%) | Total (N = 420) n (%) |
| 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 | 5 (4) | 9 (7) | 1 (1.5) | 15 (4) |
| Right hand | 3 (2) | 5 (4) | 1 (1.5) | 9 (2) |
| Left hand | 121 (94) | 114 (89) | 65 (97) | 300 (71) |
| Both hands | 27 (96) | 19 (63) | 13 (100) | 59 (92) |
| Handwashing agent used within the last 1 hour (multiple responses allowed) | 1 (4) | 3 (13) | 0 | 4 (6) |
| After defecation | 0 | 1 (4) | 0 | 1 (2) |
| Any soap and water (soap, soapy water, or detergent) | 6 (14) | 1 (4) | 3 (19) | 10 (12) |
| Water only | 37 (86) | 24 (96) | 13 (81) | 74 (88) |
| After toileting | Any soap and water | 36 (86) | 35 (92) | 17 (100) | 88 (91) |
| Water only | 14 (88) | 9 (90) | 4 (100) | 27 (90) |
| After cleaning child’s anus | Water only | 14 (88) | 9 (90) | 4 (100) | 27 (90) |
| Any soap and water | 36 (86) | 35 (92) | 17 (100) | 88 (91) |
| Water only | 14 (88) | 9 (90) | 4 (100) | 27 (90) |
| During bathing | 27 (96) | 19 (63) | 13 (100) | 59 (92) |
| Water only | 6 (14) | 1 (4) | 3 (19) | 10 (12) |
| Before eating and feeding | 6 (14) | 1 (4) | 3 (19) | 10 (12) |
| Any soap and water | 37 (86) | 24 (96) | 13 (81) | 74 (88) |
| Water only | 14 (88) | 9 (90) | 4 (100) | 27 (90) |
| After household or kitchen works | 14 (88) | 9 (90) | 4 (100) | 27 (90) |
| 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 | 39 (23) | 40 (24) | 17 (20) | 96 (23) |
| No handwashing | 36 (21) | 51 (30) | 31 (37) | 118 (28) |
| One time | 42 (25) | 42 (25) | 18 (22) | 102 (24) |
| Two times | 51 (31) | 35 (21) | 18 (21) | 104 (25) |
| More than two times | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Appearance of right hand: fingernails | 63 (38) | 69 (41) | 25 (30) | 157 (37) |
| Dirty† | 89 (53) | 94 (56) | 51 (61) | 234 (56) |
| Clean§ | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Unclean‡ | 33 (20) | 14 (8) | 7 (8) | 54 (13) |
| Appearance of right hand: palms | 131 (78) | 153 (91) | 76 (91) | 360 (86) |
| Dirty† | 32 (19) | 22 (13) | 9 (11) | 63 (15) |
| Clean§ | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Unclean‡ | 131 (78) | 153 (91) | 76 (91) | 360 (86) |
| Appearance of right hand: fingers | 78 (46) | 72 (43) | 27 (32) | 177 (42) |
| Dirty† | 74 (44) | 87 (52) | 44 (52) | 205 (49) |
| Clean§ | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Unclean‡ | 129 (77) | 152 (90) | 73 (87) | 354 (84) |
| Appearance of left hand: fingernails | 4 (2) | 1 (0.6) | 1 (1) | 6 (1) |
| Dirty† | 4 (2) | 1 (0.6) | 1 (1) | 6 (1) |
| Clean§ | 33 (20) | 14 (8) | 7 (8) | 54 (13) |
| Unclean‡ | 131 (78) | 153 (91) | 76 (91) | 360 (86) |
| Appearance of left hand: palms | 78 (46) | 72 (43) | 27 (32) | 177 (42) |
| Dirty† | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Clean§ | 74 (44) | 87 (52) | 44 (52) | 205 (49) |
| Unclean‡ | 16 (10) | 5 (3) | 8 (10) | 29 (7) |
| Appearance of left hand: fingers | 74 (44) | 87 (52) | 44 (52) | 205 (49) |

*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

<table>
<thead>
<tr>
<th>Scrubbing time and indicator organisms</th>
<th>Soapy water group</th>
<th>Bar soap group</th>
<th>Water alone group</th>
<th>Difference in differences between groups (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-wash (N = 168)</td>
<td>Post-wash (N = 168)</td>
<td>Difference within group</td>
<td>Pre-wash (N = 168)</td>
</tr>
<tr>
<td>15 seconds of scrubbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermotolerant coliforms</td>
<td>2.5</td>
<td>1.8</td>
<td>0.7 (0.44–0.92)</td>
<td>2.7</td>
</tr>
<tr>
<td><em>C. perfringens</em></td>
<td>1.2</td>
<td>0.4</td>
<td>0.8 (0.65–1.0)</td>
<td>1.2</td>
</tr>
<tr>
<td>30 seconds of scrubbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermotolerant coliforms</td>
<td>2.7</td>
<td>2.0</td>
<td>0.7 (0.46–0.96)</td>
<td>NA</td>
</tr>
<tr>
<td><em>C. perfringens</em></td>
<td>1.0</td>
<td>0.3</td>
<td>0.7 (0.52–0.91)</td>
<td>1.2</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Indicator organisms in hand rinse samples</th>
<th>Visibly dirty hands* (N = 140)</th>
<th>Visibly clean hands† (N = 196)</th>
<th>Difference</th>
<th>Visibly dirty hands* (N = 168)</th>
<th>Visibly clean hands† (N = 168)</th>
<th>Difference</th>
<th>Visibly dirty hands* (N = 34)</th>
<th>Visibly clean hands† (N = 94)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermotolerant coliforms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-wash</td>
<td>2.6</td>
<td>2.5</td>
<td>-0.1</td>
<td>2.7</td>
<td>2.7</td>
<td>0</td>
<td>2.4</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Post-wash</td>
<td>2.0</td>
<td>1.7</td>
<td>-0.3</td>
<td>2.2</td>
<td>2.1</td>
<td>0.1</td>
<td>2.2</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Differences</td>
<td>(-0.87 to -0.37)</td>
<td>(-1.1 to -0.54)</td>
<td>(-0.18 to -0.55)</td>
<td>(-0.87 to -0.22)</td>
<td>(-0.83 to -0.25)</td>
<td>(-0.42 to -0.04)</td>
<td>(-0.64 to -0.14)</td>
<td>(-0.76 to -0.09)</td>
<td>(-0.49 to -0.06)</td>
</tr>
<tr>
<td>C. perfringens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-wash</td>
<td>1.1</td>
<td>1.2</td>
<td>-0.1</td>
<td>1.2</td>
<td>1.3</td>
<td>0.1</td>
<td>1.2</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Post-wash</td>
<td>0.4</td>
<td>0.4</td>
<td>0</td>
<td>0.4</td>
<td>0.4</td>
<td>0</td>
<td>0.7</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Differences</td>
<td>(-0.92 to -0.56)</td>
<td>(-1.0 to -0.6)</td>
<td>(-0.19 to -0.33)</td>
<td>(-0.98 to -0.63)</td>
<td>(-1.1 to -0.76)</td>
<td>(-0.13 to -0.4)</td>
<td>(-0.67 to -0.21)</td>
<td>(-1.2 to -0.72)</td>
<td>(0.19 to 0.87)</td>
</tr>
</tbody>
</table>

*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 harder 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 month and US$0.09 for each subsequent 1 month. This cost provides a savings of US$0.90 in the first 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.1,38

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 (log10 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.39 Other evaluations suggest that washing hands with water alone can reduce the amount of bacteria18,26,35,36 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 (log10 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.5,37 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.21,22,34 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.22 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 log10, whereas washing hands with plain soap and water for 30 seconds reduced counts by 1.8–2.8 log10.36 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 duration22,23,39–41 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.23

There are important limitations to this study. First, we used supervised handwashing regimens with pre-specified hand scrubbing times and hand lathering motions. 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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REFERENCES


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), perceived barriers (α = .75), encouragement (α = .76) and self-efficacy (α = .82), weight control attitudes (α = .90), and diabetes-related fear (α = .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 κ = 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.
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, Grzegzulkia, & 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, & ApeIqvist, 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, Martin-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 background (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, Niura, & 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 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/m\(^2\), 25.1-30 kg/m\(^2\), or >30 kg/m\(^2\)), 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 (\(\rho\)) was used to assess agreement on the ordinal scale score and weighted kappa (\(\kappa\)) 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 \(\alpha\) ≥.70. The PCA identified six items for physical activity outcome expectancies with loadings ≥.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 \(\rho\) ranged from 0.62 for physical activity self-efficacy to 0.91 for weight loss attitudes. The weighted \(\kappa\) showed that the tertile classification of respondent self-efficacy had fair reliability; the classification of 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 \(\text{AOR} = 3.51, p < .01\)). 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 (\(\text{AOR} = 2.71, p < .05\)) and high tertiles (\(\text{AOR} = 7.84, p < .01\)) 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 (\(\text{AOR} = 3.37, p < .01\)) 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.

<table>
<thead>
<tr>
<th>Scales and item</th>
<th>Factor loading</th>
<th>Stage 1 internal reliability (N = 160), Cronbach’s α</th>
<th>Stage 2 retest reliability (N = 93)</th>
<th>Spearman’s ρ</th>
<th>Weighted κ^g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity outcome expectations³</td>
<td></td>
<td>.82</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Help control weight</td>
<td>0.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve fitness</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve self-esteem</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve health</td>
<td>0.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce diabetes risk</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase energy</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barriers to physical activity⁴</td>
<td></td>
<td>.75</td>
<td>0.70</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Lack of time</td>
<td>0.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work demands</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family demands</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of help with child care</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putting needs of others in the family first</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not having your family nearby to help</td>
<td>0.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouragement to be active²</td>
<td></td>
<td>.76</td>
<td>0.78</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Receive encouragement</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friends encourage</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partner encourages</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other family members encourage</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity self-efficacy¹</td>
<td></td>
<td>.82</td>
<td>0.62</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>When feeling tired</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When lack time</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When feeling stressed</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dealing with demands of parenting</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dealing with other demands at home</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When have household chores to do</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When feeling alone</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When feeling lazy</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When feeling depressed</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight loss attitudes</td>
<td></td>
<td>.90</td>
<td>0.91</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>Feel more optimistic</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel more attractive</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have more self-respect</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family would be proud</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less self-conscious</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More respect form others</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear nicer clothes</td>
<td>0.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would accomplish more</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Should lose weight</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes-related fear</td>
<td></td>
<td>.70</td>
<td>0.75</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Afraid of developing type 2 diabetes</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afraid of effect of GDM on child</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afraid of effect of GDM on own health</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDM had severe impact on life</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. GDM = gestational diabetes mellitus.

³Excluded items: improved mood, enjoyment, meeting new people, lower stress, more time for self, being positive role model for children. ⁴Excluded items: lack of motivation, insufficient energy, not having activity partner, poor weather, poor health, lack of convenient locations, being overweight, lack of money. ⁵Excluded items: accompanied by family or friends, assistance with child care, assistance with household chores, encouragement from health care professionals, encouragement from complementary health providers. ⁶Excluded item: poor weather. ⁷Excluded item: able to eat preferred foods. ⁸Excluded items: perception of harm, level of risk of disease, effect of family history, can reduce risk by personal action, can prevent diabetes by medications. ⁹Agreement 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.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Total physical activity</th>
<th>Fruit and vegetable intake</th>
<th>Unhealthy food intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β coefficient</td>
<td>≥150 minutes/week, adjusted</td>
<td>Serves/day, adjusted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>odds ratio</td>
<td>odds ratio</td>
</tr>
<tr>
<td>Barriers to physical activity</td>
<td>-0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate versus low</td>
<td>0.37*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High versus low</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encouragement to be active</td>
<td>0.14</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>Moderate versus low</td>
<td></td>
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<tr>
<td>High versus low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity self-efficacy</td>
<td>0.27**</td>
<td>2.71*</td>
<td></td>
</tr>
<tr>
<td>Moderate versus low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High versus low</td>
<td></td>
<td>7.84**</td>
<td></td>
</tr>
<tr>
<td>Weight loss attitudes</td>
<td>-0.07</td>
<td>0.79</td>
<td>2.41</td>
</tr>
<tr>
<td>Moderate versus low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High versus low</td>
<td></td>
<td>1.21</td>
<td>3.37**</td>
</tr>
<tr>
<td>Diabetes-related fear</td>
<td>0.02</td>
<td>0.02</td>
<td>0.08</td>
</tr>
<tr>
<td>Moderate versus low</td>
<td></td>
<td>1.19</td>
<td>1.24</td>
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<tr>
<td>High versus low</td>
<td></td>
<td>1.36</td>
<td>0.80</td>
</tr>
</tbody>
</table>

*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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References


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-trend <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 ≤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 cholerae* 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 washes 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 spillover 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 mothers 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].
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

<table>
<thead>
<tr>
<th>Title of activity</th>
<th>Intended audience</th>
<th>Details of the activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household visits</td>
<td>Household members, residence of urban compound/clusters</td>
<td>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</td>
</tr>
<tr>
<td>Initial household visit: 1st round</td>
<td></td>
<td>Installation of hardware and orientation about proper use and maintenance</td>
</tr>
<tr>
<td>Initial household visit: 2nd round</td>
<td></td>
<td>Ask about problems related to hardware</td>
</tr>
<tr>
<td>Initial household visit: 3rd round</td>
<td></td>
<td>Counsel household members and motivate them to wash hands at critical times, with handwashing demonstration</td>
</tr>
<tr>
<td>Successive visit: 1st round</td>
<td></td>
<td>Observe household members' handwashing practice, discuss hardware-related problem, talk with handwashing station caretakers and monitor her or his performance</td>
</tr>
<tr>
<td>Successive visit: 2nd round</td>
<td></td>
<td>Use game and fun, train the mother of under-five children on teaching handwashing to the child</td>
</tr>
<tr>
<td>Successive visit: 3rd round</td>
<td></td>
<td>Communicate to motivate handwashing and handwashing device use, when caring for the new child for early habit formation</td>
</tr>
<tr>
<td>Follow-up visits</td>
<td>Household members, residence of urban compound/clusters</td>
<td>Follow-up on skills in handwashing station use and maintenance, identify and solve hardware-related problem, caretaker schedule and performance</td>
</tr>
<tr>
<td>Follow-up visits</td>
<td>Pregnant women</td>
<td>Train caretakers on hardware maintenance (clean up handwashing station, refill soapy water bottle)</td>
</tr>
<tr>
<td>Follow-up visits</td>
<td>Handwashing station caretakers</td>
<td></td>
</tr>
<tr>
<td>Community activities</td>
<td>Women’s groups</td>
<td>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</td>
</tr>
<tr>
<td>Courtyard/compound activity sessions</td>
<td>Pre-school children (age 2–5 years)</td>
<td>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</td>
</tr>
<tr>
<td>Courtyard/compound-based fun activities</td>
<td>Children’s group (age 6–13 years)</td>
<td>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)</td>
</tr>
<tr>
<td>Tea stall and club-based activities (confined within cluster)</td>
<td>Tea stall owners</td>
<td>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.</td>
</tr>
<tr>
<td>Tea stall and club-based activities (confined within cluster)</td>
<td>Men’s group</td>
<td>Group discussion to promote handwashing behaviours, motivate participation in handwashing promotion, discuss resistance that may arise from men</td>
</tr>
<tr>
<td>Intensive Programme (confined within clusters)</td>
<td>Community</td>
<td>Handwashing promotion activities during holidays or special events, for example Global Handwashing Day, World Water Day, such as demonstrations, poster making and information dissemination</td>
</tr>
</tbody>
</table>

Outcomes

Table 1 Components of the behaviour change intervention, ICVB Study, Dhaka, Bangladesh, 2012–13
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 household members 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 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 months 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 variable 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: V = 0.01 for VBC arm, V = 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: V = 0.297 for VBC arm, V = 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

### 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.
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 VBC 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.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Study arm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VBC (n = 4265)</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
</tr>
<tr>
<td>Sex of the respondent (% female)</td>
<td>3607 (85%)</td>
</tr>
<tr>
<td>Age of the respondent (median (1st quartile, 3rd Quartile))</td>
<td>29 (23, 38)</td>
</tr>
<tr>
<td>Language spoken at home</td>
<td></td>
</tr>
<tr>
<td>Bengali</td>
<td>4002 (94%)</td>
</tr>
<tr>
<td>Bengali and Urdu</td>
<td>173 (4%)</td>
</tr>
<tr>
<td>Urdu or other languages only</td>
<td>90 (2%)</td>
</tr>
<tr>
<td>Socioeconomic Status (SES)*</td>
<td></td>
</tr>
<tr>
<td>Lowest tertile</td>
<td>704 (33%)</td>
</tr>
<tr>
<td>Medium tertile</td>
<td>1124 (52%)</td>
</tr>
<tr>
<td>Highest tertile</td>
<td>317 (15%)</td>
</tr>
</tbody>
</table>

*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.

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

<table>
<thead>
<tr>
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<tr>
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<tr>
<td>Highest tertile</td>
<td>317 (15%)</td>
</tr>
</tbody>
</table>

VBC, Vaccine-and-behaviour-change arm; V, Vaccine-only arm.

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, 81% of

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W.Wichaidit et al. Handwashing promotion effectiveness in Bangladesh
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 spill-over 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
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 item 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

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.

Remark:
*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.
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)

<table>
<thead>
<tr>
<th>Description of events from structured observations</th>
<th>Number of observed events (n = 3028)</th>
<th>VBC (n = 1449)</th>
<th>V (n = 768)</th>
<th>Control (n = 811)</th>
<th>PR (95%CI)†</th>
<th>PR (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of events observed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VBC vs. V</td>
<td>VBC vs. Control</td>
</tr>
<tr>
<td>Toileting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other faecal contact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Food related</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Respiratory fluid contact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Before breastfeeding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Other‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Handwashing behaviour at all events of possible pathogen transmission</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not wash</td>
<td>(n = 1449)</td>
<td>757 (52%)</td>
<td>415 (54%)</td>
<td>433 (53%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Washed with water only</td>
<td></td>
<td>532 (37%)</td>
<td>285 (37%)</td>
<td>297 (37%)</td>
<td>1.02 (0.76, 1.37)</td>
<td>1.02 (0.74, 1.42)</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td></td>
<td>44 (3%)</td>
<td>14 (2%)</td>
<td>18 (2%)</td>
<td>1.72 (0.89, 3.35)</td>
<td>1.40 (0.68, 2.89)</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td></td>
<td>116 (8%)</td>
<td>54 (7%)</td>
<td>63 (8%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Handwashing behaviour at toileting events</td>
<td>(n = 98)</td>
<td>32 (33%)</td>
<td>13 (12%)</td>
<td>9 (22%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Did not wash</td>
<td></td>
<td>12 (12%)</td>
<td>9 (17%)</td>
<td>12 (29%)</td>
<td>0.67 (0.31, 1.42)</td>
<td>0.48 (0.27, 0.84)</td>
</tr>
<tr>
<td>Washed with water only</td>
<td></td>
<td>17 (17%)</td>
<td>4 (8%)</td>
<td>1 (2%)</td>
<td>1.47 (0.58, 3.75)</td>
<td>3.47 (0.48, 25.33)</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td></td>
<td>37 (38%)</td>
<td>26 (50%)</td>
<td>19 (46%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td></td>
<td>(n = 8)</td>
<td>(n = 8)</td>
<td>(n = 8)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Handwashing behaviour at other faecal contact events§</td>
<td>(n = 12)</td>
<td>4 (33%)</td>
<td>6 (75%)</td>
<td>4 (50%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Did not wash</td>
<td></td>
<td>1 (8%)</td>
<td>2 (25%)</td>
<td>4 (50%)</td>
<td>0.8 (0.09, 7.48)</td>
<td>0.4 (0.06, 2.55)</td>
</tr>
<tr>
<td>Washed with water only</td>
<td></td>
<td>6 (50%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td></td>
<td>1 (8%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td>(n = 232)</td>
<td>156 (67%)</td>
<td>72 (71%)</td>
<td>85 (75%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Handwashing behaviour at food preparation events</td>
<td>(n = 102)</td>
<td>4 (33%)</td>
<td>28 (28%)</td>
<td>24 (21%)</td>
<td>1.14 (0.62, 2.08)</td>
<td>1.57 (0.86, 2.85)</td>
</tr>
<tr>
<td>Did not wash</td>
<td></td>
<td>69 (30%)</td>
<td>28 (28%)</td>
<td>24 (21%)</td>
<td>1.62 (0.29, 9.03)</td>
<td>1.91 (0.35, 10.32)</td>
</tr>
<tr>
<td>Washed with water only</td>
<td></td>
<td>7 (3%)</td>
<td>2 (2%)</td>
<td>2 (2%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td></td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (2%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td>(n = 313)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2 (2%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Handwashing behaviour at food contact events other than preparation</td>
<td>(n = 552)</td>
<td>337 (61%)</td>
<td>172 (61%)</td>
<td>182 (58%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Did not wash</td>
<td></td>
<td>172 (61%)</td>
<td>107 (38%)</td>
<td>119 (38%)</td>
<td>0.95 (0.65, 1.39)</td>
<td>0.91 (0.63, 1.31)</td>
</tr>
<tr>
<td>Washed with water only</td>
<td></td>
<td>200 (36%)</td>
<td>107 (38%)</td>
<td>119 (38%)</td>
<td>0.95 (0.65, 1.39)</td>
<td>0.91 (0.63, 1.31)</td>
</tr>
</tbody>
</table>
Table 3  (Continued)

<table>
<thead>
<tr>
<th>Description of events from structured observations</th>
<th>Number of observed events ( (n = 3028) )</th>
<th>PR (95% CI)†</th>
<th>PR (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VBC ( (n = 1449) ) V Control ( (n = 811) )</td>
<td>VBC vs. V (Ref.)</td>
<td>VBC vs. Control (Ref.)</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td>6 (1%) 2 (1%) 6 (2%)</td>
<td>1.53 (0.30, 7.86)</td>
<td>0.54 (0.14, 2.03)</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td>9 (2%) 3 (1%) 6 (2%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Handwashing behaviour at respiratory fluid contact events</td>
<td>(n = 26)</td>
<td>(n = 12) (n = 7)</td>
<td>(n = 30)</td>
</tr>
<tr>
<td>Did not wash</td>
<td>52 (90%) 56 (98%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Washed with water only</td>
<td>5 (9%) 1 (2%)</td>
<td>5.38 (0.53, 54.79)</td>
<td>2.06 (0.31, 13.56)</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td>0 (0%) 0 (0%) 0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td>1 (2%) 0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Handwashing behaviour at Breastfeeding events</td>
<td>(n = 26)</td>
<td>(n = 12) (n = 7)</td>
<td>(n = 30) (n = 13) (n = 7)</td>
</tr>
<tr>
<td>Did not wash</td>
<td>26 (100%) 11 (92%)</td>
<td>Ref.</td>
<td>Ref.</td>
</tr>
<tr>
<td>Washed with water only</td>
<td>0 (0%) 1 (8%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Washed with water and soap</td>
<td>0 (0%) 0 (0%) 0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Couldn’t observe</td>
<td>0 (0%) 0 (0%)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Handwashing behaviour at toileting event, stratified by availability of water and soap at handwashing place during interview \( (n = 2746\) observations from 294 households) 

| Do not wash                                        | N/A | Ref. | Ref. |
| Washed with water only                            | 47 (41%) 50 (38%) | 1.10 (0.81, 1.48) | 1.05 (0.74, 1.48) |
| Washed with water and soap                        | 1 (1%) 4 (3%) | 0.33 (0.04, 2.84) | 0.35 (0.03, 3.71) |
| Couldn’t observe                                   | 13 (11%) 10 (8%) | N/A | N/A |

| Only water or soap observed at handwashing place   | (n = 453) | (n = 391) (n = 308) | (n = 453) | (n = 391) (n = 308) |
| Did not wash                                       | 234 (52%) 210 (54%) | Ref. | Ref. |
| Washed with water only                            | 174 (38%) 145 (37%) | 1.04 (0.88, 1.24) | 0.86 (0.73, 1.01) |
| Washed with water and soap                        | 15 (3%) 6 (2%) | 2.17 (0.86, 5.49) | 0.84 (0.4, 1.78) |
| Couldn’t observe                                   | 30 (7%) 14 (5%) | N/A | N/A |

| Water and soap observed at handwashing place       | (n = 705) | (n = 207) (n = 344) | (n = 705) | (n = 207) (n = 344) |
| Did not wash                                       | 382 (54%) 117 (57%) | Ref. | Ref. |
| Washed with water only                            | 244 (35%) 73 (35%) | 1.01 (0.83, 1.25) | 1.18 (0.98, 1.43) |
| Washed with water and soap                        | 20 (3%) 4 (2%) | 1.5 (0.52, 4.32) | 2.59 (0.9, 7.47) |
| Couldn’t observe                                   | 59 (8%) 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.

References


W. Wichaidit et al. Handwashing promotion effectiveness in Bangladesh


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 (<44.4%), and VBC arm households in neighborhoods (clusters) with higher prevalence of water and soap at handwashing place (>44.4%) (n = 4263).
Appendix 2: Data collection tools used in the study

Appendix 2.1: Data collection tool used for collecting data for research objective 1 ........ 209

Appendix 2.2: Data collection tool used for collecting data for research objective 2-4 ..... 229

Appendix 2.3: Data collection tool used for collecting data for research objective 5........ 328
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. Flash 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')

<table>
<thead>
<tr>
<th></th>
<th>(A) Bicycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(B) Electricity</td>
</tr>
<tr>
<td></td>
<td>(C) Radio/Cassette Player/CD player</td>
</tr>
<tr>
<td></td>
<td>(D) Television/VCD</td>
</tr>
<tr>
<td></td>
<td>(E) Motor Cycle</td>
</tr>
<tr>
<td></td>
<td>(F) Mobile Phone</td>
</tr>
</tbody>
</table>

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

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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 can .............................................................. 7
h. Jug ................................................................. 8
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

Enumerators signature ________________________
Appendix 2.2: Questionnaires used to collect data for objective 2-4

Appendix 2.2.1: ICVB Baseline Census Questionnaire

<table>
<thead>
<tr>
<th>Household visiting status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household ID:</td>
</tr>
<tr>
<td>GIS ID:</td>
</tr>
<tr>
<td>Ward number:</td>
</tr>
<tr>
<td>Area/Para/Bosti name:</td>
</tr>
<tr>
<td>Sec/Block:</td>
</tr>
<tr>
<td>House:</td>
</tr>
<tr>
<td>Road:</td>
</tr>
</tbody>
</table>

3. The household belongs to high risk 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.: 

234
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- Unknown
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

<table>
<thead>
<tr>
<th>Code and event</th>
<th>Date of event</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>For existing members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1= No event</td>
<td>Date of visit (auto filling)</td>
<td>--</td>
</tr>
<tr>
<td>7=Death</td>
<td>Date of death</td>
<td>1=Hospital, 2=Home, 3=Away</td>
</tr>
<tr>
<td>8=Migration-out</td>
<td>Date of migration out</td>
<td>Destination of migration (ward and section number)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>88=Outside</td>
</tr>
<tr>
<td>9=Internal migration-out</td>
<td>Date of internal migration-out</td>
<td>--</td>
</tr>
<tr>
<td>10=Resident’s whereabouts could not be traced in current census</td>
<td>Date of entry of the member (auto filling)</td>
<td>--</td>
</tr>
<tr>
<td>11=Change of marital status</td>
<td>Date of change in the marital status</td>
<td>New marital status</td>
</tr>
<tr>
<td>14=Pregnancy status</td>
<td>Yes=1 NO=2 Not sure=3</td>
<td>For 2 or 3 LMP</td>
</tr>
<tr>
<td>12=Change of relationship to the household head</td>
<td>Date of death/migration-out of the former head</td>
<td>New relationship to head</td>
</tr>
<tr>
<td>13=Diarrhea in last 48 hours</td>
<td>Date of onset of diarrhea</td>
<td>--</td>
</tr>
<tr>
<td>Code and event</td>
<td>Date of event</td>
<td>Info</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>For new entrants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2=Birth</td>
<td>Data of birth</td>
<td>--</td>
</tr>
<tr>
<td>3=Migration-in</td>
<td>Date of migration-in</td>
<td>Origin of migration (codes are same as “destination of migration” given above)</td>
</tr>
<tr>
<td>4=Internal migration-in</td>
<td>Date of internal migration-in</td>
<td>--</td>
</tr>
<tr>
<td>5=Remigration</td>
<td>If a migrated-out individual came back to the study area: date of remigration is the date of event</td>
<td>--</td>
</tr>
<tr>
<td>6=Residents who were missed to register in previous census</td>
<td>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)</td>
<td>--</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Health Facilities for Disease Surveillance</th>
<th>Hospital Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sl. No.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Shishu Hospital</td>
</tr>
<tr>
<td>2</td>
<td>Sarwardy Hospital</td>
</tr>
<tr>
<td>3</td>
<td>Mohakhali Cholera Hospital</td>
</tr>
<tr>
<td>4</td>
<td>Mirpur Treatment Centre</td>
</tr>
<tr>
<td>5</td>
<td>Kalshi Shisu Hospital</td>
</tr>
<tr>
<td>6</td>
<td>Adhunic Hospital Mirpur</td>
</tr>
<tr>
<td>7</td>
<td>Shishu Hospital Mirpur-2</td>
</tr>
<tr>
<td>8</td>
<td>Radda Barnen (Mirpur-10)</td>
</tr>
<tr>
<td>9</td>
<td>UJMC (Ibrahimpur)</td>
</tr>
<tr>
<td>10</td>
<td>The Marks ENT clinic and General Hospital</td>
</tr>
<tr>
<td>11</td>
<td>Waida Hospital (Ibrahimpur)</td>
</tr>
<tr>
<td>12</td>
<td>Al-Helal Hospital</td>
</tr>
</tbody>
</table>
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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<table>
<thead>
<tr>
<th>ID 001a</th>
<th><strong>আর্ম ID (Arm ID)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

| 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 ব্যক্তি 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. কলার হাসপ্তানের লোকের অপনাকে/আপনার পরিবারের কোন সদস্যকে দেখা কার্ড দেয়া থাকে কর্ড আমাকে দেখেন? Can you show me the card given to you/to any of your family member by Cholera hospital people?

1. জ্যা (Yes) 2. না (No)

**ID 001b, 002a এবং 003a-এর তথ্যে তথ্য গ্রহণ করুন।** যদি কার্ড দেখবার যাবত হয়, ID 001b, 002a এবং 003a-কে ‘999’ লিখিন। (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)

<table>
<thead>
<tr>
<th>ID 001b</th>
<th><strong>ক্লাস্টার ID (Cluster ID- as shown in the respondent’s ID card/members ID card)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 001</th>
<th><strong>Cluster ID (as shown in the PDA)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 002a</th>
<th><strong>খানা ID (Household ID- as shown in the respondent’s ID card/members ID card)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 002</th>
<th><strong>Household ID (as shown in the PDA)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 003a</th>
<th><strong>উল্লেখ্য ID (Individual ID-as shown in the respondent’s ID card)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 003</th>
<th><strong>Individual ID-as shown in the PDA</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 004</th>
<th><strong>খানাধারকের নাম (Name of household head)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 005</th>
<th><strong>খানার দপ্তর (খিলাকিন দপ্তর) [Household address (detailed)]</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 006</th>
<th><strong>তথ্য সংগ্রহকারীর নাম (Interviewer name)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 007</th>
<th><strong>তথ্য সংগ্রহকারীর নম্বর (Interviewer Number)</strong></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ID 008</th>
<th><strong>তথ্য সংগ্রহের তারিখ (নি/মাস/বছর) (Date)</strong></th>
</tr>
</thead>
</table>
### Section-B: Demographic information

| FRA: | I would like to begin by collecting a bit of information on you and the people that live in this household. |

| 101 | **Name** (Name of the respondent) |
| 102 | **Language spoken in the home** |
|     | 1. **Bengali** (Bengali only) |
|     | 2. **Urdu** and **Bengali** |
|     | 3. **Urdu** (Urdu only) |
|     | 4. **Other** (Specify): |
| 103 | **Sex of the respondent** (record by observation) |
|     | 1. **Male** |
|     | 2. **Female** |
| 104 | **Your age in years?** (Full Years) |
| 105 | **Marital status** |
|     | 1. **Married** |
|     | 2. **Divorced** / **Separated** |
|     | 3. **Widow(er)** |
|     | 4. **Never married** |
| 105a | **How many pregnant women are in your household?** |
1. What 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)

2. Municipal supply for individual household use
3. Common tap/hand pump (Municipal supply) outside the house
4. Shallow well water
5. Deep tube well/Boring water
6. Hand pump
7. Bottled water
8. Municipal water storage in reservoir (Both for underground cistern or overhead tank)

For option 1, the principal source of drinking water for the household is: (Circle one)

- Municipal supply for individual household use
- Common tap/hand pump (Municipal supply) outside the house
- Shallow well water
- Deep tube well/Boring water
- Hand pump
- Bottled water
- Municipal water storage in reservoir (Both for underground cistern or overhead tank)
| 106a (applicable if 106 is 1/2/8) | যদি মিউনিসিপাল এর সরবরাহকৃত পানি ব্যবহার করেন, তবে কত ঘণ্টা পানি থাকে? If you use municipal water supply, how many hours a day do you have water? | a) ১ ঘণ্টার ও কম less than 1 hour  
b) ১-৫ ঘণ্টা 1-5 hours  
c) ৫-১০ ঘণ্টা 5-10 hours  
d) ১০-১৫  ঘণ্টা 10-15 hours  
e) ১৫-২০ ঘণ্টা 15-20 hours  
f) সবসময় পানি থাকে It is available all the time |
| 106b (applicable if 106 is 1/2/8) | যদি মিউনিসিপাল এর সরবরাহকৃত পানি ব্যবহার করেন, তবে ডাঃ যা/হার আপনি দিনে কত কমলী পানি ভরে দিতে পারেন? If you use municipal water supply, how many kolshis could you fill before it runs out? (only for drinking water) | a) ৫ কলশীর ও কম less than 5 kolshis  
b) ৫-১০ কলশী 5-10 kolshis  
c) ১০-১৫ কলশী 10-15 kolshis  
d) ১৫-২০ কলশী 15-20 kolshis  
e) ২০-২৫ কলশী 20-25 kolshis  
f) ২৫ কলশীর বেশি More than 25 kolshis  
g) সবসময় পানি থাকে It is available all the time |
| 107 | আপনি কত দিন যাবৎ এই কমপ্লাউডে বসবাস করেছেন? (For how long have you been living in this compound?) | সপ্তাহ (weeks) মাস ____ (Months)  
ছয় ____ (Years) |
| 108SA | আপনি কি এই কমপ্লাউডে নভেম্বরের প্রথম সপ্তাহ থেকে (২০১১) বাস করেছেন? Have you been living in this compound since the first week of November 2011? | 1. হ্যা Yes  
2. না, কারণ আছে No with card  
3. না, কারণ 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 সংখ্যা (Codes):  
ময়লা প্রতিভায় দেখা যাচ্ছিল (Visible dirt) ............................................................... 1  
ময়লা প্রতিভায় দেখা যাইতে মাটের অপরিষ্কার-পরিচ্ছন্নতা ছিল (No visible dirt but unclean appearance) .... 2  
পরিষ্কার ছিল (Clean) ............................................................................................................. 3  
পর্যবেক্ষণ করা সম্ভব হয়নি/প্রতিবাদ (Observation was not possible/refused). .............................. 4
502. If any child <5 years old is 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.

**Kode Sub** (Codes):
- ময়লা স্পর্শভাবে দেখা যায়েছে (Visible dirt) ................................................. 1
- ময়লা স্পর্শভাবে দেখা না যায় বা অপরিক্ষার ছিল (No visible dirt but unclean appearance) ........ 2
- পরিক্ষার ছিল (Clean)................................................................. 3
- পরিক্ষণ করা সম্ভব হয়নি/প্রত্যাখ্যান (Observation was not possible/refused). ............................ 4
- প্রয়োজন নয় (নিদিষ্ট করন) (Not applicable) (specify) ...................................... 8

a. হাতের নখ (Fingernails) .......................................................... 
b. কলাম (Palms) ................................................................... 
c. আংশের সম্প্রসারণ (Fingerpads) ........................................
Section D: Diarrhoea, respiratory disease and acute hepatitis in the household

এখন আমি আপনাকে এই বাড়িতে বসবাসকারীদের যাত্রা সম্পর্কে জিজ্ঞেস করব। আপনি কি আমাকে কাঁঠি দেখাবেন যা আপনার গ্রামের বাড়ির সদস্যদের মহামারী কলা হাসপাতাল থেকে নেওয়া হয়েছে? (সর্বপ্রথম করে unique card ID (a2) লিখুন। যদি কেহ কার্ড দেখাতে না পারে, ১৯৯ লিখুন unique card ID (a2) পরিবর্তে) (যদি মাইনিটেড হয় তাহলে a1 ৩৩৩ লিখুন) আর্ম ৪ হলে কার্ড না খাকলে a2 ৮৮৮ হবে। a1-এ HHID- এর সাথে ০০ থেকে সদস্য আইডি তোলায় ২৪ ঘণ্টায় তিনবার অথবা তিনদিনের অধিক পাতলা পায়খানা করলে আমরা ভয়হিত 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 1D will be start from HHID+00, We will consider diarrhoea if three or more loose stool pass in 24 hours.
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<tr>
<th>ক্রমিক নং</th>
<th>(Serial number)</th>
<th>a1. ইউনিক কার্ড আইডিএ (Uniqe ID in the PDA)</th>
<th>a2. ইউনিকে আইডিএ (Unique ID in the respondent's ID card)</th>
<th>b. নাম (Name)</th>
<th>c. বয়স (Age) (Years)</th>
<th>d. পত দুই দিনের মধ্যে কাশি হয়েছিল (Fever in the last 2 days)</th>
<th>e. পত দুই দিনের মধ্যে ঝুঁকি হয়েছিল (Diarrhoea in the last 2 days)</th>
<th>f. পত দুই দিনের মধ্যে কাশি পানি পড়েছিল (Fever in the last 2 days)</th>
<th>g. পত দুই দিনের মধ্যে কাশি পানি পড়েছিল (Nasal congestion or a runny nose in the last two days)</th>
<th>h. পত দুই দিনের মধ্যে ক্ষুদ্র আহ্বান পানি পড়েছিল (Breathing difficulties in the last two days)</th>
<th>h1. পত দুই দিনের মধ্যে কি কোন মরাত্মক আঘাত পেয়েছেন? (Any serious injury in the last two days)</th>
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<td>क्रमिक नंं (Serial number)</td>
<td>a1. इतुनक कार्ड आईडी (Unique ID in the PDA)</td>
<td>a2. इतुनक कार्ड आईडी (Unique ID in the PDA)</td>
<td>b. नाम (Name)</td>
<td>c. वयस (Age) दिन (Days) मास (Months) वर्ष (Years)</td>
<td>i. पत दुई मासें में में पत दुई तारीख अर्थात् पात्र क्षमता हिदुद्व हो दिया (Did you have any yellow coloration of eyes and skin in the last two months?)</td>
<td>1. Yes 2. No (skip to c)</td>
<td>j. चाक्रक हुए हो (Did you have yellow coloration of eyes?)</td>
<td>k. जब हुए हो (When was this) 1. In the last 2 weeks 2. 2-4 weeks 3. 5-8 weeks</td>
<td>l. जब हुए हो (Did you have fever at that time?) 1. Yes 2. No</td>
<td>m. देखा करते किस फूल किस (Did you have fever at that time?) 1. Yes 2. No</td>
<td>n. दिनों के बाद तक के परिवार के प्राइवेट साइट बाइकों का फ़र्ज का किना</td>
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</table>
**Section E:** Treatment, storage and handling of drinking water; treated water testing; reported drinking water practice

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. ল্যান্স (Drum) ............................................................... 2
c. কলস (Kalashi) ............................................................... 3
d. হাথি (Hari) ................................................................. 4
e. মেটিকা (Matka) ........................................................... 5
f. ব্যাটল (Bottle) ............................................................ 6
g. জেরি কেন / প্যালন (Jerry can) ................................ 7
h. জুগ (Jug) ................................................................. 8
i. ম্যানেজ টাক (Mini water tank) .............................. 9
j. জেরি কেন চলর (Reservoir with chlorine dispenser) .. 10
k. অন্যান্ত মুখের পাত্র (Other wide-mouthed container) . 11
l. অন্যান্ত ছোট মুখের পাত্র (Other narrow-mouthed container) .................................. 12
m. दुई चेन्योकारी फिल्टर (Double chambered filter) ........................................... 13
n. एक मुहूर्त घर सार्वजनिक पानी ने (No water stored) ........................................... 14
o. बलते और देशाते राजी हसनी (Refused to say & show) ........................................... 98

यदि 503-एर उच्च 14 अथवा 98 है, तोहले 508 नं यंग्ले चले यान
(If 503 is 14 or 98, skip to 508)

504. सर्वेक्षणकृत पानींच्या पातळीच ठाकी येणा आहेक विशिष्ट (एकदिवसीय होणे केले पातळी पर्यावरण करणे)....

Observe stored water’s covering status (if >1 storage containers, then document the status of the largest one)

1. सम्पूर्ण खोला (Completely uncovered)
2. आंशिक ढका (Partially covered)
3. सम्पूर्ण ढका (Completely covered)

504a. पर्यावरण करणे पानींच्या पातळीच सिंच्या एक देखी पानी मापार कोन लागते आहे किंवा? Observe if there is any measuring mark made by CHP on the storage container?

1. याच (Yes) (Skips to 505)
2. ना (No)
8. प्रयोजन नय (निर्दिष्ट करणे)(Not applicable) (specify) ___________

504b. अन्य कोन पातळी की निचे एक पानी मापार जन्य दाग घेऊन गिरायले? Is there any other container with measuring mark made by CHP?

1. याच (Yes)
2. ना (No) (Skips to 505)
8. प्रयोजन नय (निर्दिष्ट करणे)(Not applicable) (specify) ___________ (skip to 505)

504c. पातळी देखात वसला Ask to show the container

1. पातळी देखाते पोर्डे Has shown the container
2. पातळी देखाते पोर्डे(Skips to 505) Could not show the container
3. पातळी देखाते राजी ना(Skips to 505) Did not agree to show the container

504d. पातळी दिसूना कि करूने? What do you do with the container?

1. ब्रेनिंग घरा बिंदूकलेपण पानी राखून To store chlorinated water
2. फूटीनो पानी राखून To store boiled water
3. अन्य क्रिया बऱ्यात राखून Use for other purpose specify-----purpose Specify: ________________
4. बऱ्यात ना या Does not use

505. आपल्याच्या बाडीत का आज परिशोधित पानी आहे? (Do you have boiled or treated drinking water at home today?)

1. याच (Yes)
506. अपनी किफ़ाबे खाओग्राप पानी परिशोधन करेंगे? (एकाधिक उत्तर एहसासा) (How did you treat this water?) (Multiple answers allowed)

1. हालोटाब ब्याबार करे (Used halotab) (skip to 508)
2. वाटरगार्ड ब्याबार करे (Used waterguard) (skip to 508)
3. क्रोरिंग दिस्पेंसर ब्याबार करे (Used Chlorine dispenser) (skip to 508)
4. फिल्टर ब्याबार करे (Used filter) (skip to 508)
5. पानी जूटें (Boiled water)
6. फिटकिरी ब्याबार करे (Used fitkiri) (skip to 508)
7. पानी परिशोधन करे ना (Do not treat water) (skip to 508)
77. अन्यान्य (Other) (skip to 508)

507. यदि बोलें 'पानी जूटें', जिज्ञासा करने: गत दो दिन में कैसे अपनी पानी पुनरुत्थित किया?
(If the person reports about boiling, ask: How many times within last 2 days you boiled your water? ______ times)

508. अपनी बेडरूम में पानी देखने के पश्चात खाओग्राप पानी देने अनुशंसा पूर्वक अग्रणी से बेडरूम में एक ग्लास खाओग्राप पानी दिन
(पानी अनुग्रह समय लक्ष करने और नीचे प्रत्येक ग्लास बॉक्स करने और प्रणयक कोड करना। हाँ = 1 एंड ना = 0 बसें)

[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. ग्लास या ब्याबारकर पानी दालार पूर्व ग्लास/ब्याबारकर हुआ किया?
Glass/container washed before water obtained?________

उत्तर यदि हाँ हंगांव हैल्नॉ जिज्ञासा करने If the answer is yes then observe(multiple answers allowed)

a1. क्रोरिंग पानी किया किया हुआ किया Washed with chlorinated water

a2. क्रोरिंग नहीं पानी किया किया हुआ किया Washed with unchlorinated water
a3. सबा किया किया हुआ किया Washed with soap

a4. अन्य कोना उपादान किया किया हुआ किया Washed with other materials
b. चालार पूर्व हात धुएगा किना? Hands washed with water (no soap) before water obtained?

c. चालार पूर्व साहान दिया हात धुएगा किना? Hands washed with soap before water obtained?

d. ग्लास बा पादित्त दला पानी भिड़ेर तर हात बा हातेर आंशिक लेने किरा? Hands/fingers came into contact with water?

e. ग्लास बा पादित्त पानी भर तर ता पानी पानेर भिड़ेर सुबियेर पानी भरा हुआ लेने किरा? Glass dipped into water?

f. पानी पाने पानी भर तर लया जोतिमुख के मारा चामा/मारा बल्कर करा हुआ लेने किरा? Ladle used to obtain water?

g. पानी पाने पानी लेने पानी चलेले किना? Water poured from container?

h. अन्याय्या (लिहित)? Other (Specify)

509. FRA एक्सारएक्सी H₂S परीक्षा जन मध्ये तम्य संरक्षित पानी नमूना साहय करेल? (FRA collected stored water sample for H2S test?)

1. हा Yes
2. ना (कोणते मला माहिती) No (reason of not collecting water)

510. FRA एक्सारएक्सी संरक्षित पानी भर तर परीक्षा जन मध्ये संरक्षित पानी नमूना साहय करेल? (FRA collected storedwater sample to check residual chlorine?) (applicable for arm 1,2 and 3)

1. हा Yes
2. ना No (skip to 819)
8. पानी नमूने दिते राजी हय नाही (Refused to provide water sample)(skip to 819)

816. बांजू विशेषकृत पानी फलंदा एक्सारएक्सी पानी कोणते? (milligram/litre) | 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. अनुमानित कोणते समय आणि पानी विशेष करार जना खोरिर बांजू कर्ते करून थपते? -------:-------:-------:------- दिन : घंटा : मिनिट

(An 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 the household if participant doesn’t know)
819. Did the FRA collect stored water to do membrane filtration tests?

1. Yes
2. No (reason for not collecting the sample)__________________________
3. 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) চ্রিলাইটেড দিয়ে বিশৃঙ্খলা পানি পান করে (প্রশ্নাভাষ্য পরিষেবিত পানির তথ্য সংগ্রহ করা হবে) (col:o) এবং অপরিষেবিত (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 and c columns of the table auto treated will be obtained automatically from section D.)

<table>
<thead>
<tr>
<th>কর্ম বিশেষ পানি নিয়ন্ত্রণ করা নিয়ন্ত্রণ</th>
<th>সকল্যাম Ark=1</th>
<th>বেশিরভাগ সময় Most times=2</th>
<th>কমনও কমনও Sometimes=3</th>
<th>কখনই না Never=4</th>
</tr>
</thead>
<tbody>
<tr>
<td>কর্ম অটোমেটিকভাবে অবিভক্ত শারীরিক পানির ক্ষেত্রে Auto</td>
<td>কখনই না Never=4</td>
<td>কখনও কখনও Sometimes=3</td>
<td>বেশিরভাগ সময় Most times=2</td>
<td>সবসময় Always=1</td>
</tr>
<tr>
<td>নং (Serial number)</td>
<td>a1. ইউনিক পিডিএ (Unique ID in the PDA)</td>
<td>a2. ইউনিক কার্ড আইডিএ (Unique ID in the respondent’s ID card)</td>
<td>b. নাম (Name)</td>
<td>c. বয়স (Age)</td>
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</table>
### Section F: Chlorine Dispenser recognition and reported usage

(FRA-এফ আর এ একটি ছোপ চাচা রাখবে যাতে ইচ্ছেন এর সকল পদ্ধ থাকবে)(FRA will carry a flip chart with all the intervention products)
(FRA-উর্দু নাড়কে দোরসি ডিসপ্লের ছবি দেখবে এবং জিজ্ঞেস করবে:) (The FRA will show the respondent the picture of chlorine dispenser and will ask :)  

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>401  আপনি কি তিনিটি এটি কি? (Do you know what this is?)</td>
<td>1. ই (Yes)</td>
<td>2. না (No)</td>
</tr>
<tr>
<td>401a  আপনি/আপনার কম্পাউড কি আইনসিউডভাবে থেকে এই পণ্যগুলির কোনটি (ষোলিং ডিসপ্লের) প্রাপ্ত করেছিলেন? Did you or your compound receive any of these products (Chlorine dispenser) from ICDDR,B?</td>
<td>1. বর্তমান (Current compound)</td>
<td>2. পূর্ববর্তী (Previous compound)</td>
</tr>
<tr>
<td>401b  আপনি কোন কম্পাউড, এটি এখানে কিছু বিশুদ্ধ করেছেন ? [: Did you receive this chlorine dispenser in the compound you are currently living, or in the compound you were living previously?]</td>
<td>1. বর্তমান (Current compound)</td>
<td>2. পূর্ববর্তী (Previous compound)</td>
</tr>
<tr>
<td>402  আপনি বর্তমানে যে কম্পাউডে আছেন সেখানে কি এটি আছে অথবা আছে যে কম্পাউড থেকে তোলা 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]?</td>
<td>1. বর্তমান (Current compound)</td>
<td>2. পূর্ববর্তী (Previous compound)</td>
</tr>
<tr>
<td>403  আপনি কি এটি আসে কোন কম্পাউডে দেখতেছেন? (Have you seen this in another compound?)</td>
<td>1. ই (Yes)</td>
<td>2. না (No)</td>
</tr>
<tr>
<td>404  আপনি কি এটি সহজে চারেন আপনি এটি কি কাজে ব্যবহার করেন? (Can you tell me what you would use this for?)</td>
<td>1. খাবার পানি বিশুদ্ধ করার কথা উল্লেখ করেছে (Mentions to treat drinking water)</td>
<td>2. অন্যান্য Other -&gt; Skip to 801</td>
</tr>
<tr>
<td>405  আপনি/অথবা আপনার পরিবারের কেউ কি পানি বিশুদ্ধ করার কথা এটা দিয়ে একটি ব্যবহার করেছিলেন? (Did you yourself or anybody of your household use it at least once to treat drinking water?)</td>
<td>1. ই (Yes)</td>
<td>2. না (No)-&gt; Skip to 407</td>
</tr>
<tr>
<td>406  পানি বিশুদ্ধ করার জন্য শেষ বার কখন আপনি/অথবা আপনার পরিবারের কেউ এটা ব্যবহার করেছিলেন? (When was the last time you or anybody of your household used it to treat drinking water?)</td>
<td>1. আজই (Today)</td>
<td>2. গতকাল (Yesterday)</td>
</tr>
<tr>
<td>407</td>
<td>साधारणतः, आपनार बासात क्रोरिग उत्पेक्षार दिल्यामुळे कठोर झाली होय? (उत्तरांशी पडेले शोधन) (In general, how often does your household treat your drinking water with the chlorine dispenser?) (Read the answers to the participant)</td>
<td></td>
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<tr>
<td>512A</td>
<td>क्रोरिग दिल्याचा पाणी विभूषण करार पर पान कराल जन्य करत सय? अनेक करायला ता? (एकटी उत्तर द्या) How long do you wait after treating your water with chlorine to drink it? (This is a free response)</td>
<td></td>
</tr>
<tr>
<td>513A</td>
<td>१५ लीटराची झाली डिस्पेंसर कठोर झाली हा? (उत्तरांशी पडेले) How many turns of the chlorine dispenser would be appropriate for a 15-liter container? (Free response)</td>
<td></td>
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<tr>
<td>513B</td>
<td>आपल्या घरातील झाली क्रोरिग दिल्याचा विभूषण करार पान कराल जन्य आपल्या पाणी विभूषण करार पाणे आणि कठोर झाला चालू होईल? How many turns do you use for treating your water with chlorine in the water storage container?</td>
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<td>513C</td>
<td>एकेकरार्या पानी संचयन करार पाने झालेल्यात क्रोरिग नोंदणी ह्या सेट करून तांत्रिक परिशिष्ट करून FRA, estimate the volume of the water storage container which is used to treat water with chlorine in litres</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>प्रत्येक कारार झाला संचयन पाणे पर सयमय [Every time we collect water/always]</td>
<td></td>
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<tr>
<td>2.</td>
<td>पाणी संचयन पाणे पर बेशिरिवध समय (Most of the time when we collect water)</td>
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<td>3.</td>
<td>मासिक मासात कपल (Ocasionally/sometimes)</td>
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<tr>
<td>4.</td>
<td>अन्याय कपल नेशन/श्रीकाल/परिवार कपल (Only during dry season/summer)</td>
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<tr>
<td>5.</td>
<td>गंगा मोरकाल (Only during rainy season)</td>
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<td>6.</td>
<td>अन्याय कपल युने एक एनमाय डाकायाचे होईल बृष झाला (Only when there is increase in diarrhoeal patients in the community)</td>
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<td>77.</td>
<td>जनता (निमित्त करणे): ------------------ [OTHER (SPECIFY__)]</td>
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<td>9.</td>
<td>जाणिंदा (DON'T KNOW)</td>
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<td>8.</td>
<td>एकेकरया नांश (निमित्त करणे) (Not applicable) (specify) ____________</td>
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</tr>
<tr>
<td>1.</td>
<td>३० मिनिट ते ४५ मिनिटांमध्ये दोका समय ______ Any time between 30 and 45 minutes ______</td>
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<tr>
<td>2.</td>
<td>अन्य समय काठिन्य ______ Other time frame______</td>
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<tr>
<td>8.</td>
<td>एकेकरया नांश (निमित्त करणे) (Not applicable) (specify) ______</td>
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<tr>
<td>9.</td>
<td>जाणिंदा (DON'T KNOW)</td>
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<tr>
<td>1.</td>
<td>तिसरा ______ Three ______</td>
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<tr>
<td>2.</td>
<td>एकेकर ______ One ______</td>
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<tr>
<td>3.</td>
<td>दो तिसरा ______ Two ______</td>
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<tr>
<td>2.</td>
<td>जितून परिशिष्ट अर्थव्या आयुष्य ______ Other value or Don't Know ______</td>
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<tr>
<td>4.</td>
<td>तिसरा ताप (जाणिंदा नॉ=९९९) (एकेकरया नॉ=८६८) (Not applicable=888) (Don't know=999)</td>
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<tr>
<td>5.</td>
<td>एकेकर ६२ लीटर (एकेकरया नॉ=८६८) (Not applicable=888)</td>
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<tr>
<td>412</td>
<td>के बेदार डांग समय अपनारे पानी काकी डिस्पेंसर के काकी पुतःजार काज करे? (पारे शोधने ना) (Who is responsible for refilling the chlorine in your Chlorine dispenser most of the time?) (Not for read out)</td>
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<tr>
<td>1. केयारट्सकार/कमिउनिटी व्हार्डर/कम्पाउंड मानेजर (The compound manager/care taker/community volunteer)</td>
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<tr>
<td>2. परीक्षणक्रम प्रत्येक परिवार (या एक पानी का उद्घाटन करे) Every family (who use this water source) by rotation</td>
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<td>3. सब समय सत्रपार एकजन ज्ञेया देवक (A family volunteers all the time)</td>
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<tr>
<td>4. सबसमय सत्रपार एकजन ज्ञेया देवक (My family does it all the time)</td>
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<td>5. अमितडिरिकाररा विकासकरणके कमिउनिटी व्हार्डर कंपनी CHP of ICDDR,B/DSK</td>
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<td>7. अन्य (करियो) (Specify) (Other)</td>
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<td>8. प्रमाण न्याय (निर्देश करना) (Not applicable) (Specify) (Not applicable)</td>
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<td>9. जस्ता न्याय (Don’t know)</td>
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412b. के बेदार डिस्पेंसर करी रक्षाबल्क करने तिनी कि कंपाउंड के अन्यान्यानेरके पानी विष्कर करार जन्य एटी ब्यवहार करते नने? Do the person who maintain the Chlorine Dispenser allow others in the compound to use it to treat water?
   a) हाँ, सबसमय Yes, always |
   b) हाँ, केवल केवल Yes, sometimes |
   c) ना No

8. प्रमाण न्याय (निर्देश करना) (Not applicable) (Specify) (Not applicable) (Specify) (Not applicable)

9) जस्ता न्याय Don’t know

412c. के बेदार डिस्पेंसर आमार एव्ह आमार परिवार के खाला पानी के निरापद करने The chlorine dispenser makes water safe for me and my household
   1. फूटाचार येने सहजतेने easier than boiling |
   2. फूटाचार येने सहजतेने harder than boiling |
   3. प्राच्य एकदेखी about the same

8. प्रमाण न्याय (निर्देश करना) (Not applicable) (Specify) (Not applicable) (Specify)
Section G: ক্লোরিন ডিস্পেন্সারের জন্য তাৎক্ষণিক পর্যবেক্ষণ (Spot check for chlorine dispensers; source water testing):

801. আপনি কি আনুমান করে দেখানে ক্লোরিন ডিস্পেন্সারটি কোথায় রয়েছে? (যদি কম্পাউন্টিতে >1 Chlorine Dispensers থাকে, পানির উৎসের নিকটবর্তী Chlorine Dispenser র তথ্য লিপিবদ্ধ করন যেটা উত্তর দাতা ব্যবহার করে। যদি একই পানির উৎসের কাছে >1 Chlorine Dispensers থাকে, যেটা সম্পূর্ণ ভাবে কামরিত নেই Chlorine Dispenser-র তথ্য সংরক্ষণ করন। যদি উভয়টিই কার্যকর হয়, তাহলে যেটা সম্পৃক্ত পুন:ভাবে হয়েছে সেই Chlorine Dispenser-র তথ্য সংরক্ষন) (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 লেখাকোরা খাবার পানি সংগ্রহ করে (Near the water source from where people collect drinking water)
2. রাত্রি ঘোরের কাছে (Near the cooking area)
3. কম্পাউন্টের সেইদিগন্ধ কর্মন্দ (In the alley/corridor of the compound)
4. একটা কোন ভিত্তে (Inside a room)
5. কোন ক্লোরিন ডিস্পেন্সার নাই(নিশ্চিত করন) (There is no Chlorine Dispenser)[Skip to 818]
   (specify): ______________
7. অন্যান্য (নিশ্চিত করন) Other (specify): ______________

802. পানির উৎস যেখান থেকে লেখাকোরা পানি সংগ্রহ করে সেখান থেকে ক্লোরিন ডিস্পেন্সার কত দূরে? ___________ কম 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 দেখানেন, কতজন লেখক এটার সেবা নিতে আসে? (How many people Use this Chlorine Dispenser that you just showed me?)

1. প্রতিকী শাখা সাধারণত কাছের পানির উৎস থেকে পানি সংগ্রহ করে (Everyone who usually collects water from this nearby source)
2. বেশীরভাগ লেখক যারা সাধারণত কাছের পানির উৎস থেকে পানি সংগ্রহ করে (Most of the people who usually collect water from this nearby source)
3. ভালো মধ্য অন্ধ সম্প্রদায় কাছের 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. अन्य (निर्दिष्ट करना)(others)(specify):_____

9. जानिना Don't know

804. क्लोरिन डिस्पेंसर के उपर कौन डाकना छिल किए (पर्यवेक्षण करें लिखना) [Is there lid on the Chlorine Dispenser holder? (Observe and record)]
   1. हाँ (Yes)
   2. ना (No)

805. सेलोने क्लोरिन टांके छिल किए? [Is there chlorine tank present? (Observe and record)]
   1. हाँ (Yes)
   2. ना (No)

806. क्लोरिन टांके के उपर कौन डाकना छिल? (पर्यवेक्षण करें लिखना) [Is there a cap on the chlorine tank? (Observe and record)]
   1. हाँ (Yes)
   2. ना (No)
   3. पर्यावरण करता समय है (Not possible to check it)

807. टांके कौन क्लोरिन छिल किए? (पर्यवेक्षण करें लिखना) [Is there chlorine in the tank? (Observe and record)]
   1. हाँ (Yes)
   2. ना (No)

807a. क्लोरिन डिस्पेंसर कटापा पूर्ण आखर पर्यवेक्षण करना Please observe how full chlorine dispenser is:
   1. खाली Empty
   2. आंशिक पूर्ण Partly full
   3. सम्पूर्ण पूर्ण Full
   4. पर्यवेक्षण करता समय है Not possible to observe

808. चादी टी धिल आवागां छिल किए? (पर्यवेक्षण करें लिखना) [Is the valve in place? (Observe and record)]
   1. हाँ (Yes)
   2. ना (No)

808a. क्लोरिन डिस्पेंसर के छिल आखर किए? (पर्यवेक्षण करें लिखना) Is there any leakage in the chlorine dispenser?
   1. हाँ (Yes)
   2. ना (No)

809. चादी बार केन्द्र क्लोरिन डिस्पेंसर कच्चा होता है? _____ साल, _____ दिन _____ घरा आप (When was the Chlorine Dispenser refilled last time? _____ weeks, _____ Days, _____ Hour ago)

809a. क्लोरिन डिस्पेंसर के छिल आखर किए? (Is the cue card currently present near on/near the chlorinechlorine dispenser?)
   1. हाँ (Yes)
   2. ना (No)
811. Is there a reservoir available near the chlorine dispenser/to the designated place?
   1. Yes
   2. No (skip to 818)
   8. Not applicable (specify) ________ -> Skip to 818

812. Is there water in the reservoir (FRA will check and record)?
   1. Yes
   2. No (skip to 818)
   8. Not applicable (specify) ________ -> Skip to 818

813. Is the water in the reservoir (Any type of vessel) treated with chlorine?
   1. Yes
   2. No (skip to 818)
   8. Not applicable (specify) ________ -> Skip to 818

814. Approximately how long ago was chlorine used to purify water in the reservoir? _____:_____ hh:mm ago

815. Level of residual chlorine in the water stored in the reservoir ________ (mg/L) [Range: 0.01 to 3.5]

818. Did the FRA collect water from the source to do H₂S tests?
   1. Yes
   2. No, reason for not collecting the sample (specify) ________
   8. Not applicable (specify) ________
Section H: হাত ধোয়ার অভ্যাস প্রথম/পুরুষে উঠা (Spot checks for handwashing stations and uptake of hand washing behaviour):

উজ্জীরাতাকে জিডিজেস করুন: আপনি প্রায়শঃ কোথায় হাত ধোয়া তা আমাকে দেখান Ask the respondent: “Can you please show me where you most often wash your hands?”

1101. পর্যবেক্ষণ: কোনো প্রায়শঃ জিডিজেস করুন: প্রায়শঃ হাত ধোয়ার ছানাটি কি একাধিক পরিবার কর্ক্ষণ্য ব্যবহার হয় কিনা?
Observation/ask if needed: primary handwashing station is shared between multiple households?

1. হঁ (Yes)
2. না (No)
3. জানি না (Don’t know)

1102. পর্যবেক্ষণ: হাত ধোয়ার প্রায়শঃ ছানা কোথায় তা লিপিবদ্ধ কর্ক্ষণ (Observation: Record the location where the primary handwashing station is located)

1. ঘরের মধ্যে Indoors
2. বাহিরে কোন স্থান Indoors in a specific place
3. স্থান No specific place (skips to 1109)
4. দেখাতে রাজি না (১১০৯ নং প্রশ্নে চলে যান) No permission to see (skips to 1109)

7. অন্যান্য (নির্দিষ্ট কর্ক্ষণ)( Other, specify )

1103a. পর্যবেক্ষণ কর্ক্ষণ এবং কোন মাপন: (এফএআরএএর জন্য নির্দেশনা: অনুমান করুন, যে বামার বাড়ির তারীর ছানাটি কোথায় তার তুলনা কর্ক্ষণ এবং এরা প্রক্ষণ ছানাটি পরিমাপ কর্ক্ষণ ) 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. র্কাঙ্কার থেকে দূরত স্থান দূরত Distance from kitchen_________Steps
2. টুয়েল থেকে দূরত Distance from toilet ___________Steps
3. বাড়ির তারীর ছানা থেকে দূরত Distance from food preparation area ___________steps

1105. পর্যবেক্ষণ: হাত ধোয়ার জন্য নির্ধারিত ছানায় পানি আছে কি? বলুন কোনো লিপিবদ্ধ করুন (পানি দেখাতেই অনুমান হলো “ যা ” লিপিবদ্ধ করুন). Observation: Is water present at the specific place for handwashing? (Record code in box) (You must actually see water to record “yes”):

22
1. হঁ (Yes)

2. না (No)

1106. পর্যবেক্ষণ: হাত ধোয়ার ছাড়া নিয়ম লিখিত কোন উপাদানগুলো আছে? (দেখুনে “ হঁ ” এর জন্য নিম্নের বর্ণে “ 1 ” লিখুন এবং না দেখুনে “ না ” এর জন্য নিম্নের বর্ণে “ 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)

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<td>1. গোলাপ/হাত ধোয়ার সাবান (Body/hand soap)</td>
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<td>2. কাপড় ধোয়ার সাবান (laundry bar)</td>
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<td>3. ডিট্রিযংক্ল (Detergent (powder))</td>
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<td>4. বলল সাবান (Liquid soap other than soapy water)</td>
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<td>5. খালাবাদন ধোয়ার সাবান (Dishwashing soap)</td>
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<td>6. ছাছি (Ash)</td>
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<td>7. মাল্টস/শস্ত্রু (Mud/Sand)</td>
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<td>8. বাল্টি (Bucket)</td>
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<td>9. বেসিন (Basin)</td>
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<td>10. টাবল/টিউবোয়েল (Tubewell)</td>
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<td>11. কলসিয়াল হাল বাল্টি (ICDDR.B কক্ষের সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)</td>
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<td>12. সাবান পানি (soapy water in bottle provided by icddrb)</td>
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<td>13. কলসিয়াল Kolshi or other containers</td>
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<td>14. কোনো কিছুই নাই (Nothing is there)</td>
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<td>15. ধোয়ারের সাবান (Soap pasted on the wall)</td>
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<td>16. কিউর্কার্ড (Cuecard)</td>
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<td>17. আইসিডিডিইআরবির সেয়া গামলা Basin provided by icddrb</td>
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<td>18. আইসিডিডিইআরবির সেয়া টুল Stool provided by icddrb</td>
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19. **Soapy water in some other container, not the one provided by icddrb.**

1107. 0. 1. **Body/hand soap**
2. **Laundry bar**
3. **Detergent (powder)**
4. **Liquid soap**
5. **Dishwashing soap**
6. **Ash**
7. **Mud/Sand**
8. **Bucket**
9. **Basin**
10. **Tubewell**
11. **Red bucket with tap (provided by ICDDR,B)**
12. **Soap water bottle provided by icddrb**
13. **Kolshi or other containers**
14. **Nothing is there**
15. **Soap pasted on the wall**
16. **Cuecard**

17. **Basin provided by icddrb**
18. **Stool provided by icddrb**

19. **Soapy water in some other container, not the one provided by icddrb**
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 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 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/পুড়া সাবান কেনার টাকা শেয়ার করেন? Do you share money for buying the soap/detergent for making soapy water?
   1. হ্যা Yes
   2. না No

1107c1. আপনি কি নিজে সাবানপানি তৈরীর জন্য সাবান/পুড়া সাবান কিনেন? Do you yourself buy the soap/detergent for making soapy water?
   1. হ্যা Yes
   2. না No

1107d1. আপনি কি সাবানপানি তৈরীতে সাহায্য করেন? Do you help prepare the soapy water?
   1. হ্যা Yes
   2. না No
1107a.  The soap dispenser is on a table which the community member can access.  Please observe the volume of soap in the bottle provided by icddrb. (If in q1106 option 12 is selected then applicable)

1. ................................................................. ’পূর্ণ বোতল Bottle full
2. ................................................................. ’অপেক্ষায় পূর্ণ বোতল Bottle partly full
3. ................................................................. ’�োতলের নীচে অল্প পরিমাণ Only small amount of soap water at the bottom
4. ................................................................. ’খালি বোতল Empty
5. .................................................................

1107aa1.  Please observe the status of the cap on the soapy water bottle.

a) কার্তিক বছরের উপযোগী দক্ষিণ বছরের cap, বিন্ধ নেইFunctional usable cap, not leaking
b) দক্ষিণ বছরের cap, বিন্ধ নেই Cap is present, but leaking
c) দক্ষিণ বছরে cap, বিন্ধ নেই Cap is broken/missing
d) তাপন সাবানবোতলের বেলে নেই No soap water bottle is present

1107a2.  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 অপরিষ্কার 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.  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 পরিবারের কিভাবে সাবানবানির মাধ্যমে সাহায্য করেন? How you or your family have contributed to make this soapy water?
1107f1. Are you sharing money for buying the soap/detergent for making soapy water?

3. Yes
4. No

1107g1. Are you sharing soap/detergent for making soapy water?

3. Yes
4. No

1107h1. Are you helping to prepare the soapy water?

3. Yes
4. No

1107b. Please observe volume of soapy water in other type of container provided by icddrb

1. Bottle full
2. Bottle partly full
3. Only small amount of soapy water at the bottom
4. Empty

1107bb1. Please observe the status of the cap on the soapy water bottle.

a) Functional usable cap, not leaking
b) Cap present, but leaking
c) Cap broken/missing
d) No soapy water bottle is present

1107bb2. Please observe and record how clean is the soapy water bottle?

a) Very clean (0)
b) **Parichar** Clean (1)

c) **Parichar** and Na Aparichar na Neither clean nor dirty (2)

d) **Aparichar** Dirty (3)

e) **Na Aparichar** Very dirty (4)

1108. Aparni ki duya kore aparna diye saboran diye asebeno saboran andi aparni saborangtai hata khora have haint the water to be filled and filled. (Andi saboran diye na kore) Can you please bring your own soap that you normally use for washing hands to this handwashing station, if not already there?

Hata khora saboran ane kate somay leochele? __________ second (Prayojna Na=888) (Nabha sake rabi na=666)((Not applicable=888) (Do not agree to bring soap=666)

1109. Hain lale bari kore, theb the kine parini ahe? If the Red bucket is there, does it have water in it?

1. Yes

2. Nai (1110a nangshe chale yan) (No) (skip to 1110a)

8. Prayojna Nai (nindori koren) (Andi arome 2 take nangshe chale yan anibhane 1111 nangshe chale yan) (Not applicable) (specify):____ (if arm 2 skip to 1110a otherwise skip to 1111)

1110. Sange kai bhum parini ahe? How much water is in there?

1. Bari sumpurta bari The container is full

2. Bari bichrata bari The container is partly full

3. Neeche the orshha samana parini ahe Only small amount of water at the bottom

4. Khali Empty

1110a. Aincisitikaiinobir deya kalbas lale bari hain sange (sange he shehe deye hain) na kore andi eis koppaude nei deye hain the kaalhe jichhe kaido bhalo bari bari bari kore ahe? If the red bucket with tap provided by ICDDR,B is not there (where it was installed), and if the compound was given it, ask the respondent where the red bucket is?
1. It was returned to the CHP to fix it
2. It is kept in the compound manager’s/landowner’s house
3. It is kept at my/some other person’s home
4. It is kept in kitchen
5. It is kept in other place of the compound
6. It has been sold
7. It has been stolen
8. It was returned to the CHP as they don’t use it
77. Other

88. Not applicable (It is there where it was installed)
9. Don’t know

1110b. If red bucket with tap is there, what is the status of the Red bucket?

1. Functional
2. a. leaking
   b. tap missing
   c. tap broken
   d. Others

8. Not applicable

1110c. What is the status of the lid of the red bucket with tap?

1. Lid cracked
2. Is there but not covering the bucket
3. It covers the bucket completely
4. It covers the bucket partially
5. Missing
8. Not applicable
1110d. केंद्र (कंपनी लाल बालक) पानी भरे? (Who refills the water in the red bucket?)

1. कंपनी के स्टेंडर्ड / मॅनेजर / कमिट्टी ने (the compound caretaker/manager/community volunteer

2. कंपनी के केंद्र के आवास यार के द्वारा (There are someone in the compound who are willingly doing this)

3. प्रत्येक खाने के पानी के एक करे (Every household does it in shift)

4. अंतेक आमं आमर द्वारा (Any one in the family does it)

5. निर्दिष्ट केंद्र नहीं हैं (No specific person but its gets done)

6. केंद्र नहीं है। No one refills it

7. अन्य (Other)

8. प्रश्न नहीं है। Not applicable.

1110e. आपने कि कंपनी हान के आवास के शासन के द्वारा (Bucket) पुनर्भरण की है? Have you ever refilled the reservoir (Bucket) of the handwashing station with water?

1. हाँ Yes.

2. ना No

3. मने करते पारिंदा Cant remember

4. प्रश्न नहीं है। Not applicable.

1110f. यदि हां, आपने कि कंपनी स्टेंडर्ड हान के आवास के द्वारा (Bucket) पुनर्भरण की है? If Yes to q1110e, did you refill the reservoir of the handwashing station during the past week?

1. हाँ Yes.

2. ना No

3. प्रश्न नहीं है। Not applicable

1110g. आपने कि कंपनी हान के आवास के द्वारा (Bucket) पुनर्भरण की है? Have you ever emptied the basin under the handwashing station?

1. हाँ Yes.

2. ना No

3. मने करते पारिंदा Cant remember
4. প্রশ্নের নয় Not applicable (888) if basin absent

1110h. এই 1110g বলল হাচ্ছে, আপনি কি বিশেষ সরাসরি হাত ধৌত করে স্টেশনের নিচের বেসিনটি খালি করেছেন? If Yes to q1110g Did you empty the basin under the handwashing station during the past week?

1. হাচ্ছে Yes
2. না No
3. মনে করতে পারছিনা Cant remember
4. প্রশ্নের নয় Not applicable

1111. যদি অন্য কোন পাতলা থাকে তাহলে দেওয়ার কোনটিতে যে পানি আছে? If there are other kinds of containers, is there water in any of those?

1. হাচ্ছে (Yes)
2. না (ঘরে চলে যান) (No) (skip to 1115)
8. প্রশ্নের নয় (স্পেকিফিক) (ঘরে চলে যান) (Not applicable) (specify): ______ (skip to 1115)

1112. দেখানো কতটুকু পানি আছে? একাধিক পাতলা পানি থাকলে বড় পাতলার পরিবেশন কর্মসূচী How much water is in there? [If there are >1 container with water, record the status of the largest container]

1. ড্রাম/ বাল্টিক/অন্য কোন পাতলা সম্পূর্ণ ভর্তি The container is full
2. ড্রাম/ বাল্টিক/ অন্য কোন পাতলা 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 (আইসিইডি আর্সেনিক দেওয়া লাল বাল্টিক ছাড়া) কোন পাতলা কি কম্পাউন্ডের সাথে যোগাযোগ করে? Is any of these containers (other than the red bucket given by ICDDR,B) for communal use?

1. হাচ্ছে (Yes)
2. না (ঘরে চলে যান) (6115 নং ঘরে চলে যান)
8. প্রশ্নের নয় (নির্দিষ্ট করা) (Not applicable) (specify): ______ (skip to 1115)
1114. के एते पानी भरे? (बाहिरी दोड़ बालति जाड़ा)एकाकिक पान काले बड़ी का वर्ता जिज्ञासा करना (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. कम्प्यूटर के क्या केंद्र/ मायानेरां/कम्युनिटी भल्लाडियां (the compound caretaker/manager/community volunteer)

2. कम्प्यूटर के केंद्र के अपो बारा ब्रसाय माना एटा करे (There are someone in the compound who are willingly doing this)

3. प्रत्यक्ष ब्रान्य हालकम एटा करे (Every household does it in shift)

4. दिनिन्कर केंद्र नेि No specific person but its get done

5. केंद्र भरे ना No one refills it

6. गृह माह आचार परिवारह एटा करे Only my family do it

7. अन्य (Other)

1115. यदि साधारण पानी थाके, तब टांकपट खाली होले के पूर्ण करे? (If soapy water bottle is there, who refills the soapy water bottle?)

1. कम्प्यूटर के क्या केंद्र/ मायानेरां/कम्युनिटी भल्लाडियां (the compound caretaker/manager/community volunteer)

2. कम्प्यूटर के केंद्र के अपो बारा ब्रसाय माना एटा करे (There are someone in the compound who are willingly doing this)

3. प्रत्यक्ष ब्रान्य हालकम एटा अंश नेमा (Every household contributes for it)

4. एते टांकपट ब्लाकिपटक ब्राकार ब्राम्बार जाना (This bottle is for personal use)

5. दिनिन्कर केंद्र नेि No specific person but its get done

6. केंद्र भरे ना No one refills the bottle

7. अन्य (Other)

8. प्रज्ञाना न्याय (निर्दिष्ट करना) Not applicable(specify):_____

9. जानिना Don’t know

10. गृह माह आचार परिवारह एटा करे Only my family do it

1116. उद्योगको जिज्ञास करना: एते ब्रान्य जाड़ा आपनी की अन्य कोप्या हां बोन?
(Ask the respondent: “Is there anywhere else you wash your hands?”)

1. हाँ (Yes)
2. ना (1130 नं ग्रंथ सच यान) (No) (skip to question 1130)

1117. पर्यावरण करण्ड/हाल्डने जिज्ञासा करण्ड: हात धोयार जितीय प्रथम स्थान ति किं एकाधिक परिवार कर्यक्रम प्रयोग मध्ये किंना?

(Observation/ask if needed: secondary handwashing station is shared between multiple households?)

1. हाँ (Yes)
2. ना (No)
3. जाणून ना (Don't know)

1118. पर्यावरण: हात धोयार जितीय प्रथम स्थान कोणत ता संगणक करण्ड (Observation: Record the location of the secondary handwashing station.)

1. घराने मध्ये इंडूर
2. घराने बाहेर कोणत निश्चित स्थान ओटायदर्शात (Outdoors in a specific place)
3. निर्दिष्ट कोणत स्थान पेक्षा 1130 नं ग्रंथ सच यान) No specific place (skips to1130) 4. पैकोटे राजी ना(1130 नं ग्रंथ सच यान) No permission to see (skips to1130)
7. अन्य (निर्दिष्ट करुन)--------- Other, specify

1119a. पर्यावरणकरण्ड एवं कोपम मापन: (एफआरएच जिज्ञासा; अरुणकरण्ड कब याची काही ते धुंचेचे घर करण्ड एवं एस्ट ग्रेट दुरुत्व परिमाप करण्ड) 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. बऱ्याच घराने एळते दूरी Distance from kitchen____________Steps
2. टॅलेटी एळते दूरी -----------------------कोपम Distance from toilet___________Steps
3. खाणे तैलीय प्रथम स्थान एळते दूरी --------------------------कोपम Distance from food preparation area -------------------steps

1121. पर्यावरण: हात धोयार प्रथम निर्दिष्ट स्थान पाहण सते की? (केवळ संगणक करण्ड) (पाहण देखात अभ्यासक " हां " संगणक करण्ड)

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. हाँ Yes
2. ना No
### 1122. Question: 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.)

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<td>1.</td>
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<td></td>
<td>Body/hand soap</td>
<td>laundry bar</td>
<td>Detergent (powder)</td>
<td>Liquid soap</td>
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<td>5.</td>
<td>6.</td>
<td>7.</td>
<td>8.</td>
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<td></td>
<td>Dishwashing soap</td>
<td>Ash</td>
<td>Mud/Sand</td>
<td>Bucket</td>
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<td>9.</td>
<td>10.</td>
<td>11.</td>
<td>12.</td>
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<td></td>
<td>Basin</td>
<td>Tubewell</td>
<td>Red bucket with tap (provided by ICDDR,B)</td>
<td>Soapy water in bottle provided by icddr</td>
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<td>13.</td>
<td>14.</td>
<td>15.</td>
<td>16.</td>
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<td></td>
<td>Kolshi or other container(s)</td>
<td>nothing is there</td>
<td>Soap pasted on the wall</td>
<td>Cuedcard</td>
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<td>17.</td>
<td>18.</td>
<td>19.</td>
<td>17.</td>
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<td></td>
<td>Basin provided by icddrb</td>
<td>Stool provided by icddrb</td>
<td>Soapy water in other some other container, not the one provided by icddrb</td>
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<td>77.</td>
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<td>Other, specify</td>
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**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.)

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কম্পাউন্ডের সকলের ব্যবহারের জন্য হয় তাহলে ১ ডিমেন। 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. গোলার/হাড় খোয়ার সাবান (Body/hand soap)
|____| 2. কাপড় খোয়ার সাবান (Laundry bar)
|____| 3. ডিটেরেন্ট (Powder) (Detergent (powder))
|____| 4. এরিয়া সাবান (Liquid soap)
|____| 5. খালকান্দ খোয়ার সাবান (Dishwashing soap)
|____| 6. ছোট (Ash)
|____| 7. মাটি/বালু (Mud/Sand)
|____| 8. বালি (Bucket)
|____| 9. বেসিন (Basin)
|____| 10. টাবল/টিউবওয়েল (Tubewell)
|____| 11. মিয়াক বালি (ICDDR,B কর্তৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)
|____| 12. সাবান পানি (Soapy water in bottle provided by icddrb)
|____| 13. কাপড়ি Kolshi or other containers
|____| 14. কোন খোয়ায়া নাই (Nothing is there)
|____| 15. দেয়ারের সাবান (Soap pasted on the wall)
|____| 16. কিউকার্ড (Cuecard)
|____| 17. অইনিডিডিইভারির দেয়া গামলা Basin provided by icddrb
|____| 18. অইনিডিডিইভারির দেয়া মাংস Stool provided by icddrb
|____| 19. অইনিডিডিইভারির দেয়া সাবানপানির বোলেল ছাড়া অন্য কোন বোজন সাবানপানি Soapy water in some other container, not the one provided by icddrb

|____| 77. অন্যান্য (নিদর্শন কর্মক্ষ) ______ other, specify

**Instruction for PDA team:** If 1123-12 is 2 then have to show these questions below

1123b. How you or your family have contributed to make this soap water?

1123c. 1. Yes 2. No

1123d. 1. Yes 2. No

1123a. “Observe volume of soapy water in bottle provided by icddrb (বদলি ১১২২ নং প্রশ্নে ১২ নং অপশন নিলেট করা হয় তাহলে প্রশ্নায়) (If in q1122 option 12 is selected then applicable)

1. Bottle full
2. Bottle partly full
3. Only small amount of soapy water at the bottom
4. Empty
1123a1.  The status of the cap on the soapy water bottle.  Please observe the status of the cap on the soapy water bottle.

c) Functional usable cap, not leaking
f) Cap is present, but leaking
h) No soapy water bottle is present

g) Cap is broken/missing

1123a2.  Please observe and record how clean is the soapy water bottle?

a) Very clean (0)
b) Clean (1)
c) Neither clean nor dirty (2)
d) Dirty (3)
e) Very dirty (4)

Instruction for PDA team: If 1123-19 is 2 then have to show these questions below

1123e1.  Do you or your family have made any contribution to make this soapy water?

1. Always
2. Sometimes
3. Never (skip to 1123b)

1123f1.  How you or your family have contributed to make this soapy water?

1123g1.  Do you yourself buy the soap/detergent for making soapy water?
1123h1. आपने कि साबुनपानी तैयार करना? Do you help prepare the soapy water?

1. याः Yes
2. ना No

1123b. आइसाइडिजिआरबिया द्वारा साबुनपानी के बोतल छाड़ अन्य कोई बोतल साबुनपानी थाने से पर्यावरण करना एवं देखने देखने के लिए "Observe volume of soapy water in other type of container provided by icddrb" (यदि 1122 नं. प्रश्न 19 नं. अपशन चिह्नित करा हय मे तहलेन में योजा) (If in q1122 option 19 is selected then applicable)

1. पूर्ण बोतल Bottle full
2. आंशिक पूर्णा बोतल Bottle partly full
3. बोतल नीट अति परिमाण द्वारा साबुनपानी Only small amount of soapy water at the bottom
4. बोतल Empty

1123bb1. साबुनपानी के बोतल के दांकन का अवस्था पर्यावरण कर्म है Please observe the status of the cap on the soapy water bottle.

i) कार्यपट बंद करने उपयोगी दांकन, खुदी नीट Functional usable cap, not leaking
j) दांकन आज बिखरे, खुदी है गुद्रे Cap is present, but leaking
k) दांकन बंद है खुदी है गुद्रे Cap is broken/missing
l) कोई साबुनपानी के बोतल नीट No soapy water bottle is present

1123bb2. साबुनपानी के बोतल केवल केन्द्रित करने आज का पर्यावरण कर्म है एवं दिशित कर्म Please observe and record how clean is the soapy water bottle?

a) भूष वर्गीय Very clean (0)
b) परिसार Clean (1)
c) परिसार और ना अपरिसारण Neither clean nor dirty (2)
d) अपरिसार Dirty (2)
3) युव अपरिष्कार Very dirty (4)

1124. आपनी कि दया करें आपनार निजेचे साबणे निजेचे आसपास वाढ्या साबणे त आपनी एक हात धोया गेल्याने हात धोयासाठी किंवा बाबताल करें. Can you please bring your own soap that you use for washing hands to this handwashing station if not already here?

हात धोयासाठी किंवा बाबताल करत समय लेगेली? How long did it take to bring the soap to the handwashing station? ___________ seconds(प्रयोज्या ना=888) (सेखीते राजी ना=666)(Not applicable=888) (Do not agree to bring soap=666)

1125.यदि कलसांस लाल वाढ्या थाकें, तरे ताते कि पानी आहे?If the Red bucket with tap is there, does it have water in it?

1. हा (Yes)
2. ना (No) (skip to 1126)
8. प्रयोज्या ना(निर्दिष्ट करून) (Not applicable)(specify):_____ (skip to 1126)

1125a सोक्यात कितीतरु पानी आहे? How much water is in there?

1. तुम्हारे सोक्याने पूर्ण अतिरिक्त The container is full
2. तुम्हारे सोक्याने अवय अतिरिक्त The container is partly full
3. नीचे अंश तरु लाल असा पानी आहे Only small amount of water at the bottom
4. बाल्या Empty

1125b. के एक(कलसांस लाल वाढ्या) पानी असा? (who refills the water in it?)

1. कम्प्याउंडच्या कोर्यांटेक्स/ म्यानेजर/कम्युनिटी करेट्टर (the compound caretaker/manager/community volunteer)
2. कम्प्याउंडच्या फेडल केळी आहे या वेळ येथे एटा करा (There are someone in the compound who are willingly doing this)
3. प्रत्येक देाही पालकांमध्ये एटा करा (Every household does it in shift)
4. निर्दिष्ट केले नाही No specific person but its get done
5. केले करत ना No one refills it
6. পরিবারের প্রত্যেকে কে করে Only my family do it

7. অন্যান্য (Other)

1125c. আপনি কি কখনও হাত ধোয়ার স্টেশনের বীজার্ডরটি (বালপাতি) পুনরায় ভরেছেন? Have you ever refilled the reservoir (Bucket) of the handwashing station with water?
   1. Yes
   2. No
   3. নিয়মে পারি না Cant remember
   4. গুরুত্ব নয় Not applicable.

1125d. যদি 1125c হয় হয়, আপনি কি বিভিন্ন সময়ে হাত ধোয়ার স্টেশনের বীজার্ডরটি পুনরায় ভরেছিলেন? If Yes to q1125c, did you refill the reservoir of the handwashing station during the past week?
   1. Yes
   2. No
   3. নিয়মে পারি না Not applicable

1125e. আপনি কি কখনও হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছেন? Have you ever emptied the basin under the handwashing station?
   1. Yes
   2. No
   3. নিয়মে পারি না Cant remember
   4. গুরুত্ব নয় Not applicable (888)

1125f. যদি 1125f হয় হয়, আপনি কি বিভিন্ন সময়ে হাত ধোয়ার স্টেশনের নিচের বেসিনটি খালি করেছিলেন? If Yes to q1125f Did you empty the basin under the handwashing station during the past week?
   1. Yes
   2. No
   3. নিয়মে পারি না Cant remeber
   4. গুরুত্ব নয় Not applicable

1126. যদি কোন ক্ষর থাকে তাহলে বাস্তলোর কোনটিতে কি পানি আছে? If there are other kinds of containers, is there water in any of those?
   40
1. হ্যা (Yes)

2. না (No) 8. প্রজেয়া নয় (নির্দিষ্ট করা) (Not applicable)(specify):_____

1127. এর মধ্যে (আইনিকভাবে দেওয়া কলসহ লাল বালুতি ছাড়া) কোন পাত্র কি কম্পাউডারের সবাই ব্যবহার করে? Is any of these containers (other than the Red bucket with tap given by ICDDR,B) for communal use?

1. হ্যা (Yes)

2. না (1129 নং প্রশ্নে চলে যান) No(skip to 1129)

8. প্রজেয়া নয় (নির্দিষ্ট করা) (Not applicable)(specify):____ (1129 নং প্রশ্নে চলে যান) No(skip to 1129)

1128. কে এতে পানি ভরে? (আইনিকভাবে দেওয়া লাল বালুতি ছাড়া) Who refills the water in it? (Other than the Red bucket with tap given by ICDDR, B) একাধিক পাত্র থাকলে বড়ুটির কথা জিজ্ঞাসা করুন If more than one, ask about the largest container.

1. কেয়ারটেকার/মানচিত্র/কমিউনিটি ভক্তিবাদী (the compound caretaker/manager/community volunteer)

2. কম্পাউডারের কেউ কেউ আছে যারা খেজায় এটা করে (There are someone in the compound who are willingly doing this)

3. প্রত্যেক খানায় পালাকা এটা করে (Every household does it in shift)

4. নির্দিষ্ট কেউ নেই No specific person

5. কেউ তার না No one refills it

6. শুধুমাত্র আমার পরিবারই এটা করে Only my family do it

7. অন্যান্য (Other)

1129. যদি সারা পানি থাকে, তবে বোতলটি খালি হলে কে পূর্ন করে? (If soapy water bottle is there, who refills the soapy water bottle?)

1. কেয়ারটেকার/মানচিত্র/কমিউনিটি ভক্তিবাদী (caretaker/manager/community volunteer)

2. কম্পাউডারের কেউ কেউ আছে যারা খেজায় এটা করে (There are someone in the compound who are willingly doing this)

3. প্রত্যেক খানায় এতে অংশ নেয় (Every household does it in shift)

4. এই বোতলটি ব্যাবহারকারীর ব্যবহারের জন্য (This bottle is for personal use)

5. নির্দিষ্ট কেউ নেই No specific person but it gets done
6. केउ भरे ना No one refills the bottle

7. अन्य (Other)

8. प्रजाया (यथा (निर्दिष्ट करना)) (Not applicable)(specify):

10. अपने पारिबारिक एक करे Only my family do it

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. एक एक खानाय मो न 5-13 वर्ष के भें बांजा आधियार? Is there any child aged (≥5 years to ≤13 years) present now at home?

1. हाँ Yes

2. ना, एक एक बांजा नहीं No, there is no such child in this home (skip to 1139)

3. ना, बांजा कै ए रुड़रे यासाय नेइँNo, the child is not present at this moment (skip to 1139)

1131. बांजा कै यस केटा? __________ वर्ष what was the age of the child? __________ Years

1132. बांजा कै कल? What was the sex of the child?

1. पुरुष (Male)

2. महिला (Female)

1133. बांजा कै का भाषा भुज़े मथिल? (Did the child wash his/her hand?)

1. हाँ Yes

2. ना, निर्दिष्ट करना-------{1139 नं का घापा चला याना) No, (Skip to 1139) specify---------

1134. बांजा कै दोहें का भुजे मथिल? (Did he/she wash both the hands?)

1. हाँ (Yes)

2. ना (No)
1134a. বাজারটি 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. পর্যবেক্ষকৃত হাত ধোয়ার স্থানগুলো দ্বিতীয় অন্য হাত ধোয়ার স্থান At another handwashing station not spot checked earlier

4. পায়াখানার ভিতরে In the latrine

5. বাজারের ভিতরে In the kitchen

6. ঘরের ভিতরে inside his/her room

7. অন্যান্য নির্দিষ্ট করুন Other (specify)

1135. বাজারটি তার হাত ধোয়ার জন্য কী ব্যবহার করেছিল? (What did he/she use to wash his/her hands)

একাধিক উপর এরগুলো (Check all that apply)

1. ................................................................................................................ Soap
   a. Body/hand soap গোষ্ঠীর/হাত ধোয়ার সাদান
   b. Laundry bar কাপড় ধোয়ার সাদান
   c. Dish washing soap খালোপানি ধোয়ার সাদান
   d. তৃতীয় সাদান Liquid soap

2. সাদান পানি (Soapy water in bottle provided by icddrb))

3. ছাই Ash

4. সাদান অথবা ছাই ছাড়া অন্য উপাদান;নির্দিষ্ট করুন (Material other than soap or ash; specify ___

5. পানি Only water

6. সাদানের সাদান (Pasted soap on the wall)

7. মাটি/বুলা (Mud/Sand)

8. বালতি (Bucket)

9. বেলিস (Basin)

10. টাবে/টিউবেল (Tubewell)

11. কালসে লাগে বালতি (ICDRB কৃত্রিম সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)
12. कपसि Kolshi or other containers

13. पृष्ठ साबन Detergent powder

1136. साबन दे ना किने का अवस्थान है? To what extent lather was formed?

1. अनेक फेना A lot of lather

2. अछू के फेना A little lather

3. फेना दे ना यानी No visible lather

8. भ्रमण के नाम Not applicable (Those who did not use soap for washing hands)

1137. कत समय धरे हात धुएँ गये हैं? (स्टेप ओएक्चर दोहो गन्दा ) _____________ sec

The total time to spend for washing hands? (Timed with a stop watch) _________________ sec

1137a. बाढ़ पी के धो तो पानी नियंत्रित था? From where did he/she use water to wash her hands?

1. सरासरी मिउनिसिपाल कन्क/हाय पांच/टाइबवालेके Directly from the municipal tap/hand pump/tubewell (skip to 1137f)

2. लाल बालची काम करती पानी नियंत्र हुई Water stored in Red Bucket provided by icddrb

3. घर में सारक्षित पानी नियंत्र Water stored in another container within household (skip to 1137f)

4. मिउनिसिपाल लाइने सारक्षित पानी हुई Water stored from municipal line(skip to 1137f)

7. अन्य निर्देश करने Other (specify) _______________ (skip to 1137f)

1137b. बाढ़ पी क लाल बालची कन्क तो पानी नियंत्रित था? Did he/she use pour water through the tap of the red icddrb bucket?

1. ................................................................. ibraltar Yes

2. ................................................................. ibraltar No

1137c. बाढ़ पी क लाल बालची उपर तो पानी नियंत्रित था? Did he/she draw water from the top?

1. ................................................................. ibraltar Yes

2. ................................................................. ibraltar No

1137d. बाढ़ पी क चलने पानीत धरे हात धुएँ गये हैं? Did he/she wash hand(s) under running water?

1. ................................................................. ibraltar Yes
2. ...................................................................................... ना No

1137e. बांटी टी कि आईसिटिडिअबरनर देया हात देयार वेिने हात डबिया पूरेिल? Did he/she wash hand(s) by
dipping in washbasin?

1. ...................................................................................... ह्या Yes
2. ...................................................................................... ना No

1137f. बांटी हात देयार जन्य ये उपाशालगि बाबसा केिल सेवलि कोख छिल?एकाकिः उजर एहोगा Where were the
materials that the child used for HW? (Check all that apply)

1. प्रधान हात देयार घाने_At the primary handwashing station spot checked earlier
2. बांटी प्रधान हात देयार घाने_At the secondary handwashing station spot checked earlier
3. पर्‌येंक्रम कारत हात देयार घानो बांटी अन्य कोन हात देयार घाने_ At another handwashing station not
spot checked earlier
4. पाखानार भितरेःIn the latrine
5. पाखानारे भितरे In the kitchen
6. घरे भितरे inside his/her room
7. अन्य निर्दिः करने Other (specify)

1137g. हात देयार समय बांटीटी बाबा-मा अन्य कोन प्राप्त बायक बांटी कि ताकें देयार उपकरण दियें साहय केिल? Was
a parent/adult helping child with providing handwashing materials to him/her during the
demonstration?

1. ...................................................................................... ह्या Yes
2. ...................................................................................... ना No ( Skip to 1138)

1137h. बांटीटी बाबा-मा अन्य कोन प्राप्त बायक बांटीटी हात देयार जन्य ये उपाशालगि एने दियेंति सेवलि कोख छिल? were
the materials that the parent/caregiver/adult bring to the child for HW? Check all that apply एकाकिः उजर एहोगा

1. प्रधान हात देयार घाने_At the primary handwashing station spot checked earlier
2. बांटी प्रधान हात देयार घाने_At the secondary handwashing station spot checked earlier
3. The child was at another handwashing station not spot checked earlier

4. In the latrine

5. In the kitchen

6. Inside his/her room

7. Other (specify)

1137. Did an adult give instructions or reminded the child about how to wash hands?

1. Yes
2. No

1138. How were hands dried?

1. Cloth other than own clothing
2. Own clothing
3. Air dry (reflects intentional drying before moving on to other activities or touching anything else)
4. Did not dry hands before moving on to other activities or touching anything else

If there is a child <5 years 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 (≥17 years) 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 (≥17 years) to go to the usual place where they wash hands after defecation and demonstrate washing hands. The field worker will note

1139. The person who will demonstrate washing hands was...

1. Care giver of <5 years
2. Another adult female
3. An adult male

1140. What is the sex of that person (who agreed to demonstrate to wash hands in front of the interviewer?)
1. Male
2. Female

1141. Did the respondent wash his/her hand?
1. Yes
2. No (Skips to 1147a)

1142. Did he/she wash both the hands?
1. Yes
2. No

1142a. Where (the place) did the person demonstrate washing his/her hands?
1. In the primary handwashing station
2. In the secondary handwashing station
3. In the latrine
4. In the kitchen
5. Inside his/her room
6. Other (specify)

1143. What did he/she use to wash his/her hands? (Multiple answers allowed)
1. সাবান (BarSoap)
   a. Body/hand soap গলায়ের/হাত ধোয়ার সাবান
   b. Laundry bar কাপড় ধোয়ার সাবান
   c. Dish washing soap খাবার ধোয়ার সাবান
   d. তরল সাবান Liquid soap

2. সাবান পানি (Soapy water)

3. ঢাই Ash

4. সাবান অথবা ঢাই ছাড়া অন্য উপাদান;নির্দিষ্ট করুন (Material other than soap or ash; specify)

5. পুল পানি Only water

6. দেয়ালের সাবান (Pasted soap on the wall)

7. মাটি/বালু (Mud/Sand)

8. বালতি (Bucket)

9. বেসিন (Basin)

10. টাব্লিচিউল্ট্রেল (Tubewell)

11. কলসহ লাল বালতি (ICDRB কর্তৃক সরবরাহকৃত) Red bucket with tap (provided by ICDDR,B)

12. কলসহ Kolshi or other containers

13. পূঁজা সাবান Detergent powder

11.4. সাবানের কেনা কি অবশ্যই ছিল? To what extent lather was formed?

1. অনেক কেনা A lot of lather

2. অল্প কেনা A little lather

3. কেনা দেখা যায়নি No visible lather

8. প্রশ্নের দর Not applicable (Those who did not use soap for washing hands)

11.45. কত সময় ধরে হত ধুলো ছিল? (How long did the water last?) _________ সেকেন্ড
The total time to spend for washing hands (timed with a stop watch) __________ sec

1145a. বাণীটি কোথা থেকে পানি দিয়েছিল? From where did he/she use water to wash her hands?

1. সরাসরি মিউনিসিপাল কল/হাত পান্সা/টিউবওয়েল থেকে Directly from the municipal tap/hand (skip to 1145f)
2. বাণীটির 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 নিদিষ্ট করন Other (specify) _______________ (skip to 1145f)

1145b. বাণীটি কি আইসিডিভিআরবি থেকে দেয়া কলসহ বাণীটির কল থেকে পানি দিয়েছিল? Did he/she use-pour water through the tap of the red icddrb bucket?

1. হ্যা Yes
2. না No

1145c. বাণীটি কি বাণীটির উপর থেকে পানি নিয়েছিল? Did he/she take water from the top of the red bucket?

1. হ্যা Yes
2. ................................................................. না No

1145d বাণীটি কি চলামান পানির নীচে হাত দূষিত হয়েছিল? Did he/she wash hand(s) under running water?

1. হ্যা Yes
2. না No

1145e. বাণীটি কি আইসিডিভিআরবি দেয়া হাত ধৌয়ার বেসিনে হাত তুষিয়ে দূষিত হয়েছিল? Did he/she wash hand(s) by dipping in washbasin?

1. ............................................................................. Yes
2. ............................................................................. No

1145f. বাণীটি হাত ধৌয়ার বেসিনে হাত দূষিত করেছিল সেঙ্গলি কোথায় ছিল? একাধিক উত্তর গ্রহণযোগ্য Where were the materials that he/she used for HW? (Check all that apply)
1. At the primary handwashing station spot checked earlier
2. At the secondary handwashing station spot checked earlier
3. At another handwashing station not spot checked earlier
4. In the latrine
5. In the kitchen
6. Inside his/her room
7. Other (specify)

1146. How were hands dried? (How were hands dried?)

1) Cloth other than respondent’s/his/her own clothing
2) Respondent’s/his/her own clothing
3) Air dry (reflects intentional drying before moving on to other activities or touching anything else)
4) Did not dry hands before moving on to other activities or touching anything else

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. Is soapy water present in the compound/household?

1. Yes
2. No (skip to 1004)

1147. To what extent lather was formed?

1. A lot of lather
2. A little lather
3. No visible lather
1148. কত ডাকনা দূধ্যা সাবান মিশানো হয়েছে? (জানিনা=২৯৯) Ask the respondent or the person who prepared the soapy water how much of detergent powder was added? ____________ caps (Don’t know=999)

1149. দূধ্যা 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

1150. সাবানপানি তৈরীতে কোন ব্র্যাডের দূধ্যা সাবান ব্যবহার করা হয়েছে? Which brand of detergent powder was used to prepare this soapy water?

1. হৈল Wheel
2. কেয়া Keya
3. সার্ক এক্সেল Surf excel
4. জেট Jet
5. নির্দিষ্ট ব্র্যাড নেই No specific brand
6. অন্য অন্য Other
7. রিন Rin
8. জানিনা Don’t know

1151. এফএ এ অনুমানরূপে আপনার ব্যক্তিগত মতামত দিবেন যে সাবানপানি সঠিকভাবে মিশিত, মতৈব পাতলা, মতৈব বেশি সাবানের মত ছিল কিনা। এই সাবানপানিটির ক্ষেত্রে আপনার কোনো কেন্দ্রীতে সিদ্ধ শেখায় ০ = মতৈব পাতলা, ১ = মতৈব পাতলা, ২ = সঠিকভাবে মিশিত, ৩=অতি সাবানের মত এবং ৪ = মতৈব 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 ———
7/3 ———
6/2 ———
5/1 ———
4/0 ———

Section I: Handwashing Station recognition and reported usage
FRA এফএ এসকল ইন্টারভিউনে পাপাসহ একটি ফ্লিপ চার্ট বহন করবে (FRA will carry a flip chart with all the intervention products.)

FRA এফএ এসকল ইন্টারভিউনে পাপাসহ একটি ফ্লিপ চার্ট বহন করবে।
FRA 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. Are you familiar with this (soap water)? (Do you know what this is? Bottle with soapy water)

1. Yes
2. No

1004a. Have you ever used compounds with soap-like substances? Did you receive BOTTLE for making soapy water from ICDDR, B/DSK?

1. Yes
2. No

| 1004b | 1. Current compound (Bottle received)
2. Previous compound (Bottle received)
3. Both (Bottle received)
4. Neither (Bottle received)

| 1004c | 1. Current compound (Bottle received)
2. Previous compound (Bottle received)
3. Both (Bottle received)
4. Neither (Bottle received)

1004d. Did you ever use it?

1. Yes
2. No (skip to 1005)

1005a. What is the purpose of using soapy water? (Interviewer, ask for each one below and write “1” for “yes” in the box below, write “0” for “no” in the box below)

1. For washing clothes
2. For washing utensils
3. For bathing
4. As a shampoo
5. হাত ধোয়ার কাজে for handwashing--☐

1005b. আপনি/আপনার পরিবারের অন্য কেউ শেষ করে এটি ব্যবহার করেছিলেন? (সাধারণকারী গতিক) When did you or someone in your household use soapy water for handwashing last?

1. আজই (Today)
2. পূর্ববছর (Yesterday)
3. এক সপ্তাহের মধ্যে (Within one week)
4. এক মাসের মধ্যে (Within one month)
5. 1 – 6 মাস (1 – 6 months)
6. হয় মাস আগে (More than six months ago)
99. যদি না (Don’t remember)

যদি পক্ষে হয় তাহলে নীচের প্রশ্নটি হাজির নাইয়ে 1005 এ চলে যান or yesterday then ask 1005c otherwise skip to 1005

1005c. আপনি গতকাল সাবানপানি দিয়ে কোথায় হাত ধোয়ান? 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. হঁচি Yes
2. না No
3. জানিনা! Don’t know.
8. প্রয়োজন নয় Not applicable.

1005. ২ মাস আগে 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. হঁচি Yes
2. না (1008ঃঃঃঃ চলে যান)No(skip to 1008)
9. জানিনা! (1008 এ চলে যান) Don’t know (skip to 1008 )

1006. ২ মাস আগে আপনি অথবা আপনার পরিবারের কোন সদস্য কতবার নিজেরা আপনাদের পরিবারের জন্য সাবানপানি তৈরী করেছেন(হাজির নয়=৮৮) (নির্দিষ্ট করন)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 ঢুঁড়া সাবান মিশানো হয়? (জানি=১৯৯) Ask the respondent how much of detergent powder is added for making soapy water? ______ caps (Don’t know=999)  

1006c. ঢুঁড়া সাবান কি পরিমাণ পানিতে মিশানো হয়? (জানি=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 (No, bottle was empty) ( )  
3. না (No) (১০০৯া না চেলে যান) ([skips to 1009a]) = কোন বোতল ছিল না no bottle  

1009. সাবান পানি দেখাতে কতকগণ সময় লেগেছিল?------------- (লেবেল)  

1009aa1. সাবানপানির বোতলের ঢাকনার অবস্থা পর্যবেক্ষণ করুন Please observe the status of the cap on the soapy water bottle.  

- m) কারণ বয়বহর উপযোগী ঢাকনা বিদ্রুপেই Functional usable cap, not leaking  
- n) ঢাকনা আছে কিন্তু চিঠি হয়ে গেছে Cap is present, but leaking  
- o) ঢাকনা চেলে নেয়ার পরিক্রমা হয়েছে Cap is broken/missing  
- p) কোন সাবানপানির বোতল নেই No soapy water bottle is present  

1009aa2. সাবানপানির বোতল বহন পরিচালকের জন্য তার পর্যবেক্ষণ 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 অপরিষ্কার ও 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)]

1009a. আপনি/আপনার পরিবার কি সাবান পানি তৈরী করার জন্য ডিটারেঞ্জ পাউডার কিনেছেন? Have you/household bought detergent powder for making soapy water?
1. হ্যা Yes
2. না No
3. জানিনা Don’t know.
4. গ্রেসেনা নয় Not applicable

1009a. আপনি কী গত দুই সপ্তাহের মধ্যে সাবানপানি তৈরীর জন্য তুলুড়া সাবান কিনেছেন? (Did you purchase detergent powder for making soapy water in the last two weeks?)
1. হ্যা (Yes)
2. না (No)
8. গ্রেসেনা নয় Not applicable
9. জানিনা Don’t know

1010. এই কম্পাউন্ডে কি এমন কোন ঘর আছে যে ঘরের সদস্যরা নিজেরা গত দুই সপ্তাহে 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. হ্যা Yes
2. না No
9. জানিনা Don’t know

1011. আপনার প্রতিবেশী/কম্পাউন্ডের কেউ কি আছে যে গত দুই সপ্তাহে সকলের ব্যবহারের জন্য সাবান পানি তৈরী করেছে? (একাধিক উত্তর উপলব্ধ)
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 ফ্যালাক্সিয়ার/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. A family volunteered to do that
5. Other
6. No one did it
7. Don’t know

1011a. How long does a full bottle of soapy water last in your compound? [Instruction for PDA team maximum 30 weeks]

1011b. The soapy water bottle makes handwashing for me and my household
1. easier than before
2. harder than before
3. about the same
4. Not applicable

1012. Do you know what this is? (Red bucket with tap and stool and basin supplied by ICDDR,B)
1. Yes
2. No

1013a. Did you receive Red bucket with tap, stool and basin from ICDDR,B?
1. Yes
2. No

1013b. Where did you receive the red bucket with tap, stool and basin from ICDDR,B?
1. Current
2. Previous
3. Both
4. Neither
1013c.  Does the compound you are currently living or in the compound you were living previously contain the substance H=Y‡b†hK¤úvD‡ÛAv‡Qb|fP/YgZ.

| 1.  | Current compound (1) |
| 2.  | Previous compound (2) |
| 3.  | Both (3) |
| 4.  | Neither (4) |

1013.  Did you ever use it?

1.  Yes

2.  No (skip to 1014)

1013d.  For what purpose do you use the red bucket?  Does the compound you are currently living or in the compound you were living previously contain the substance H=Y‡b†hK¤úvD‡ÛAv‡Qb|fP/YgZ.

1.  For washing clothes

2.  For washing utensils

3.  For bathing

4.  To store water

5.  For handwashing

6.  To wash vegetables

7.  Others specify

1014a.  When did you or your household use red bucket with tap for handwashing last?

1.  Today

2.  Yesterday

3.  Within one week

4.  Within one month

5.  1 – 6 months

6.  More than six months ago

7.  Never
99. মনে নাই (Don’t remember)

যদি গতকাল হয় তাহলে নীরব 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? ------রাত সময়

1014c. গত দুই সপ্তাহের মধ্যে আপনি কত বার যদি 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------ঘণ্টা

-----Day (জানিনা=৪৯৯) (Don’t know=৯৯৯)

1014c. compound মানের যদি 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) হী,তিনি এটা সকালের চেলা রাখেনYes, he always puts it out in the open
b) হী,তিনি এটা কখনও কখনও চেলা রাখেন এবং কখনও কখনও তালাবক রাখেনYes, he sometimes puts it out in the open, and sometimes keeps it locked up

c) না,তিনি এটা সকালের চেলা রাখেনNo, he always keeps it locked up
d) এটা সবার ব্যবহার উপযোগী জায়গায় আছেIt is in common place
e) এজনের নয় Not applicable নিন্দিত করে লিখুন

1014f. .. হাত ধোয়ার স্টেশনটি(বালতি এবং সাবার পানি) যদি রক্ষাবেদন 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) হী, সর্বদা Yes, always
b) হী, কখনও কখনও Yes, sometimes
c) না No
d) জানিনা Don’t know
e) এজনের নয় Not applicable নিন্দিত করে লিখুন
The bucket with stool and basin makes handwashing for me and my household
1. आपने चेहरे संज करेंगे easier than before
2. आपने चेहरे कपरों करेंगे harder than before
3. प्यार एक रेखा about the same
8. ४) हाथ के Not applicable शनिनिक के लिए (नहीं)

1014. आपने धोया एक सान हात धोया के केबान के सानन (सानन पानी छाड़ूँ) आहे कि?

Right now, do you have any soap (other than soapy water) in the house that you use for handwashing?

1. हा (Yes)
2. ना (1018 नं प्रश्न याचे यान) [No (Skips to 1018 )]
9. जानिना (1018नं प्रश्न याचे यान)Don’t know (Skips to 1018)

1015. आपढ़ी की आपके सानाने देखायें (पर्यायकरण क्रमांक) Can you show me the soap? (Observe)

1. हा (Yes)
2. ना, सानन देखा याचे ना (अन्य की कोष द्वारा द्वारा हात, धोया सानन, इत्यादि) [ 1018 नं प्रश्न याचे यान]No, soap unobservable (in use elsewhere, none in the house, etc.) (Skips to1018)

1016. देखायें कक्ष कौन समय नियंत्रित कोरा हैं?______________ देखा

(How long did it take to show the soap? ______________second)

1017. ज्ञात के सान के सानन? (पर्यायकरण पर पूर्ण बनस्ता) हा = 1 एग्ज ना = 0) What kind of soap is it? (Fill in based on observation. Put 1= Yes and 0=No)

|____| 1. कापड़ धोया सानन (laundry bar soap)
|____| 2. जिहार्जेट पाउडर ( detergent powder)
|____| 3. हाइप्नोजिक सानन (dish soap)
|____| 4. गोचर/हात धोया सानन (body/hand soap)
|____| 5. तरण सानन (Liquid soap)
|____| 7. अन्याया (शनिनिक के लिए)______________ (Other ______________)
1018. Do you have any spare unused soap in the house? (a second bar/package that is unopened)

1. Yes
2. No

1019. Can you show me the soap? (observe)

1. Yes
2. No

1020. (How long did it take to show the soap? ____________ seconds)

1021. What kind of soap is it? (Fill in based on observation. Put 1=Yes and 0=No)

<table>
<thead>
<tr>
<th></th>
<th>1. Laundry bar soap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Detergent powder</td>
</tr>
<tr>
<td></td>
<td>3. Dish soap</td>
</tr>
<tr>
<td></td>
<td>4. Body/hand soap</td>
</tr>
<tr>
<td></td>
<td>5. Liquid soap</td>
</tr>
<tr>
<td></td>
<td>7. Other</td>
</tr>
</tbody>
</table>

1022. If the respondent showed bar soap(s) in q 1017 or 1021, how many bars of each size did he/she show you?

1. Small
2. Medium
3. Large
1023. 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. Did you purchase laundry bar soap in the last two weeks?

1. **্যা (Yes)
2. না | **1026 না এখন চলে যান | No (skip to 1026)
3. জানিনা | **1026 না এখন চলে যান | Don’t know (skip to 1026)

1025. How much money did you spend on laundry soap in the last two weeks? _______ taka (don’t know=999)

1025.1. Have you/your household ever bought bar soap for handwashing?

1. **্যা Yes.
2. না No
3. মনে করতে পারেনা Cant remeber
4. বহুল Not applicable

1025.2. Have you/your household ever bought detergent for handwashing?

1. **্যা Yes.
2. না No
3. মনে করতে পারেনা Cant remeber
4. বহুল Not applicable
1026. Did you purchase hand/ body soap in the last two weeks?

1. Yes
2. No
3. Don’t know

1027. How much money did you spend on hand/ body soap in the last 2 weeks? _______ (taka) (don’t know=999)

1028. How many bars of each size hand/ body soap did you buy in the last one month? ____

1. Small
2. Medium
3. Large

1029. Is there any place within this compound where soap has been attached to the wall?

1. Yes
2. No (1001) Skip to 1001
3. Don’t know (skip to 1001)

1031. Can you show me the soap/soaps attached to the wall? (observation) (>1 response allowed)

1. In the latrine
2. In the kitchen
3. In the handwashing station
4. No soap could be observed
5. Other place (specify)
Section J: উত্তরদাতার হাত ধোয়ার অভ্যাস সম্পর্কিত তথ্য (Respondent’s reported hand washing practice :)

1001. আমি এখন আপনাকে যে পণ্যগুলির নাম বলে আপনি কত ঘন্ধন এগোলো দিয়ে হাত ধোনা? নিচের তালিকাটি পড়ুন এবং জিজ্ঞাসা করুন তারা এটি ‘সবসময়’, ‘বেশিরভাগ সময়’, ‘কখনও কখনও’ এবং ‘কখনই না’ ক্ষেত্রে চার্ট করে। এখানে যা 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’]

<table>
<thead>
<tr>
<th>হাত ধোয়ার পদ্ধতির নাম</th>
<th>1. সবসময় Always</th>
<th>2. বেশিরভাগ সময় Most of the time</th>
<th>3. কখনও কখনও sometimes</th>
<th>4. Never কখনই না</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. body/hand soap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>গোলাসলের /হাত ধোয়ার সারাঙ্গ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. dish soap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>চলাসায়ন হাত ধোয়ার সারাঙ্গ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. laundry soap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>কাপড় ধোয়ার সারাঙ্গ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ash ছোট</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Soapy water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>সারাঙ্গধোম</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. only water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>পানি</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. mud মাটি</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. powdered detergent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ঝুঁড়া সারাঙ্গ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Soap pasted on the wall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>তোরানারের সারাঙ্গ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1002. আপনি এখন আপনাকে যে কাজগুলির কথা বলব আপনি কত ফন্দা এই কাজগুলির ক্ষেত্রে তথ্য পানি দিয়ে হাত ধরেন? [নীচের তালিকাটি পড়ে শোনান এবং হ্যান্ড সার্ফিন তারা এটি ‘সবসময়’, ‘হ্যান্ড ব্যাটেক্স’, ‘কখনও কখনো’ এবং ‘কখনই নাকি কিছু করে’, গ্রহণ 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’]

<table>
<thead>
<tr>
<th>হাত ধোয়ার সময়</th>
<th>1. সবসময়</th>
<th>2. বেশিরভাগ সময়</th>
<th>3. কখনও কখনো সময়</th>
<th>4. কখনই না</th>
<th>8. গ্রহণ নয় (নির্দিষ্ট করুন)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to wash hands</td>
<td>Always</td>
<td>Most of the time</td>
<td>sometimes</td>
<td>never</td>
<td>not applicable(specify): _</td>
</tr>
<tr>
<td>a. খাওয়ার পূর্বে</td>
<td>Before eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. খাওয়ার পর</td>
<td>After eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. বাচাকে খাওয়ানোর আগে</td>
<td>Before feeding a child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. বাচাকে সৌজন্যের পর</td>
<td>After cleaning the child’s anus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. মাছ/মাংসের থাকার পর</td>
<td>After cutting fish or meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. পায়াচাঁদার পর</td>
<td>After</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>defecation</td>
<td></td>
<td></td>
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<td>---</td>
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</tr>
<tr>
<td>g. শাকসবজি কাটার আগে, Before cutting vegetables,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 1. before cutting fruit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 2. before cutting salad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 3. before mashing any food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. রামা করা খাবার হোয়ার পূর্বে Before touching cooked food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. রামা করা খাবার হোয়ার পর After touching cooked food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1003. আমি এখন আপনাকে যে কাজগুলির কথা বলে আপনি কত খনন এই কাজগুলির ক্ষেত্রে সবাদ/সবানপানি দিয়ে হাত ধোন? শীতের তালিকাটি পড়ে শোনান এবং জিজ্ঞাসা করলেন তারা এটি 'সবান' , 'বেশিরভাগ সবান', 'কখনও কখনও' এবং 'কখনই না' কিন্তু চোখ করে।

### 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’]

<table>
<thead>
<tr>
<th>Time to wash hands</th>
<th>1. सबसेमय Always</th>
<th>2. बेशियरभाग समय Most of the time</th>
<th>3. कখनबोबोSometimes</th>
<th>4. कखनईने Never</th>
<th>8. प्रमांकन (मिलिंग करन)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. खाब्या पूर्वे Before eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>not applicable(specify):</td>
</tr>
<tr>
<td>b. खाब्या पर After eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>c. বাচ্চা‌কে খাওয়ানোর আগে</td>
<td>Before feeding a child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. বাচ্চা‌কে সৌচনোর পর</td>
<td>After cleaning the child's anus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. মাছ/মাংস কাটার পর</td>
<td>After cutting fish or meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. পায়েখানার পর</td>
<td>After defecation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. শাকসবজি কাটার আগে</td>
<td>Before cutting vegetables,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 1. before cutting fruit</td>
<td>ফল কাটার আগে</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 2. before cutting salad</td>
<td>সাল্ড কাটার আগে</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g 3. before mashing any food</td>
<td>কোন ভূতা‌ করার আগে</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. রামা করা খাবার হৌয়ার পূর্বে</td>
<td>Before touching cooked food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. রামা করা খাবার হৌয়ার পর</td>
<td>After</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Section K: Knowledge about water and hand hygiene


Kabae a eko ujukj yara satho mafuwy yara xosho yori yara Apaoni yara koreone, Ami ekarta ujarerungu tikun: (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:)

#### Taya rana kopa sahej, Apaoni ki ebi mafuwy satho ekemate na dimat? (Cooking rice is easy. Do you agree or disagree with this statement?)

**Jiki ekemate hen:** Tikaahshe - Apaoni ekemate yor taya rana kopa sahej. Ewane, Ami jana te chawebi Apaoni ebi ufikir satho kckt beene ekemate.

Apaoni kikvoro yosho o Apaoni ebi ufikir satho kchh yara ekemate yosho. Taya rana kopa sahej yarena yosho Apaoni voro yosho yara ekemate ebi ufikir satho taya rana kopa sahej? (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?).

**Jiki dimat hen:** Tikaahshe - Apaoni ebi ufikir satho dimat yosho taya rana kopa sahej. Ewane Ami jana te Chawebi Apaoni ebi ufikir satho kckt beene dimat. Apaoni kikvoro yosho o Apaoni ebi ufikir satho kchh yara ekemate yosho Apaoni voro yosho yara ekemate ebi ufikir satho taya rana kopa sahej? (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.

<table>
<thead>
<tr>
<th>301A</th>
<th>301B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiling drinking water is the best way to protect against diarrhea</strong></td>
<td><strong>Water that looks clear is safe to drink</strong></td>
</tr>
<tr>
<td>1. Sumpa pyit (Strongly disagree)</td>
<td>1. Sumpa pyit (Strongly disagree)</td>
</tr>
<tr>
<td>2. Kkutta pyit (Slightly disagree)</td>
<td>2. Kkutta pyit (Slightly disagree)</td>
</tr>
<tr>
<td>3. Kkutta ekemate (Slightly agree)</td>
<td>3. Kkutta ekemate (Slightly agree)</td>
</tr>
<tr>
<td>4. Sumpa ekemate (Strongly agree)</td>
<td>4. Sumpa ekemate (Strongly agree)</td>
</tr>
</tbody>
</table>
| 301L | আমি বিবেকানন্দ কাবি দে পানিতে অন্তুষ্ট কানি না তাতালেই পানিটা পরিকার।
I believe water is clean if it does not have a funny taste | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301M | আমি বিবেকানন্দ কাবি দে পানি তখনই পরিকার হয় যদি তা দৃষ্টিভঙ্গিতে বা ক্রোধে দ্রাক্ষের কারণ হয়
I believe water is clean if it has been treated with chlorine or boiled | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301C | পানি পরিষ্কার করে ডায়ারিয়া প্রতিরোধ করা যায় (Treating drinking water will protect against diarrhea) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301D | থুলোর, পানি দিয়ে হাত ধৌলাই যেতো । (After using the toilet, it is okay to just rinse hand with water) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301E | খাবার পর সাদান দিয়ে হাত ধৌলাই ডায়ারিয়া প্রতিরোধের একটা তেজস্ক্রীপ্ত উপায়। (Washing hands with soap after eating food is an important way to protect against diarrhea) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301F | বাচ্চাদের চোখে করানোর পর, যদি আঘাত হয়ে ভাঙ্গনা দেয়া থাকে, তেলু তখন হাত ধৌলাই উচ্চ (After cleaning a child’s bottom, it is only important to wash hands if you can see feces on your hands) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301G | পা খাবার দেওয়া ডায়ারিয়া হবে (Eating spoiled foods will cause diarrhea) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301H | ফল, বাজার, লোহা খাবার অসাবজ্জ হাতে ধৌলাই জা নয় (It is not important to wash hands before touching fruits and vegetables) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301I | কালোরা ভাঙ্গনা দিয়ে ডায়ারিয়ার মত রোগ প্রতিরোধ করা যাবে না (Taking cholera vaccine will not protect against cholera and diarrhea) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
| 301J | খাবার পরিষ্কার করে হাত ধৌলাই জা নয় (It is important to wash hands before touching food that is to be served) | 1. সম্পূর্ণ সমর্থন (Strongly disagree)  
2. কিছুটা সমর্থন (Slightly disagree)  
3. কিছুটা অনুমতি (Slightly agree)  
4. সম্পূর্ণ অনুমতি (Strongly agree) |
(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.)

<table>
<thead>
<tr>
<th>A. ফুটিয়ে (Boiling)</th>
<th>302A1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. হ্যাঃ (Yes)</td>
<td>302A2</td>
</tr>
<tr>
<td>2. না(No)</td>
<td>ফেলল SKIP CODES নাই (PLEASE NOTE – NO SKIP CODES ON THESE)</td>
</tr>
<tr>
<td>3. জানি না (Don’t know)</td>
<td>ফেলল</td>
</tr>
<tr>
<td>4. জানি না (Don’t know)</td>
<td>302B1</td>
</tr>
<tr>
<td>5. জানি না (Don’t know)</td>
<td>302B2</td>
</tr>
<tr>
<td>6. জানি না (Don’t know)</td>
<td>302B3</td>
</tr>
<tr>
<td>7. জানি না (Don’t know)</td>
<td>302C1</td>
</tr>
<tr>
<td>8. জানি না (Don’t know)</td>
<td>302C2</td>
</tr>
<tr>
<td>9. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
<tr>
<td>302A2 গেল SKIP CODES নাই (PLEASE NOTE – NO SKIP CODES ON THESE)</td>
<td></td>
</tr>
<tr>
<td>1. হ্যাঃ (Yes)</td>
<td>302B1</td>
</tr>
<tr>
<td>2. না(No)</td>
<td>302B2</td>
</tr>
<tr>
<td>3. জানি না (Don’t know)</td>
<td>302B3</td>
</tr>
<tr>
<td>4. জানি না (Don’t know)</td>
<td>302C1</td>
</tr>
<tr>
<td>5. জানি না (Don’t know)</td>
<td>302C2</td>
</tr>
<tr>
<td>6. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
<tr>
<td>7. জানি না (Don’t know)</td>
<td>302A3</td>
</tr>
<tr>
<td>8. জানি না (Don’t know)</td>
<td>302B3</td>
</tr>
<tr>
<td>9. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. কাপড় দিয়ে ঝেকে (Filtering with a cloth)</th>
<th>302B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. হ্যাঃ (Yes)</td>
<td>302B3</td>
</tr>
<tr>
<td>2. না(No)</td>
<td>302C1</td>
</tr>
<tr>
<td>3. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
<tr>
<td>4. জানি না (Don’t know)</td>
<td>302A1</td>
</tr>
<tr>
<td>5. জানি না (Don’t know)</td>
<td>302A2</td>
</tr>
<tr>
<td>6. জানি না (Don’t know)</td>
<td>302B1</td>
</tr>
<tr>
<td>7. জানি না (Don’t know)</td>
<td>302B2</td>
</tr>
<tr>
<td>8. জানি না (Don’t know)</td>
<td>302B3</td>
</tr>
<tr>
<td>9. জানি না (Don’t know)</td>
<td>302C1</td>
</tr>
<tr>
<td>10. জানি না (Don’t know)</td>
<td>302C2</td>
</tr>
<tr>
<td>11. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
<tr>
<td>302B3 ফেলল (Not effective)</td>
<td></td>
</tr>
<tr>
<td>1. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
<tr>
<td>2. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
<tr>
<td>3. কাঝর না (Not effective)</td>
<td>302A1</td>
</tr>
<tr>
<td>4. কাঝর না (Not effective)</td>
<td>302A2</td>
</tr>
<tr>
<td>5. কাঝর না (Not effective)</td>
<td>302B1</td>
</tr>
<tr>
<td>6. কাঝর না (Not effective)</td>
<td>302B2</td>
</tr>
<tr>
<td>7. কাঝর না (Not effective)</td>
<td>302B3</td>
</tr>
<tr>
<td>8. কাঝর না (Not effective)</td>
<td>302C1</td>
</tr>
<tr>
<td>9. কাঝর না (Not effective)</td>
<td>302C2</td>
</tr>
<tr>
<td>10. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. জলানি ফেলল (Sedimentation)</th>
<th>302C1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. হ্যাঃ (Yes)</td>
<td>302B3</td>
</tr>
<tr>
<td>2. না(No)</td>
<td>302C3</td>
</tr>
<tr>
<td>3. জানি না (Don’t know)</td>
<td>302A1</td>
</tr>
<tr>
<td>4. জানি না (Don’t know)</td>
<td>302A2</td>
</tr>
<tr>
<td>5. জানি না (Don’t know)</td>
<td>302B1</td>
</tr>
<tr>
<td>6. জানি না (Don’t know)</td>
<td>302B2</td>
</tr>
<tr>
<td>7. জানি না (Don’t know)</td>
<td>302B3</td>
</tr>
<tr>
<td>8. জানি না (Don’t know)</td>
<td>302C1</td>
</tr>
<tr>
<td>9. জানি না (Don’t know)</td>
<td>302C2</td>
</tr>
<tr>
<td>10. জানি না (Don’t know)</td>
<td>302C3</td>
</tr>
<tr>
<td>302B3 ফেলল (Not effective)</td>
<td></td>
</tr>
<tr>
<td>1. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
<tr>
<td>2. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
<tr>
<td>3. কাঝর না (Not effective)</td>
<td>302A1</td>
</tr>
<tr>
<td>4. কাঝর না (Not effective)</td>
<td>302A2</td>
</tr>
<tr>
<td>5. কাঝর না (Not effective)</td>
<td>302B1</td>
</tr>
<tr>
<td>6. কাঝর না (Not effective)</td>
<td>302B2</td>
</tr>
<tr>
<td>7. কাঝর না (Not effective)</td>
<td>302B3</td>
</tr>
<tr>
<td>8. কাঝর না (Not effective)</td>
<td>302C1</td>
</tr>
<tr>
<td>9. কাঝর না (Not effective)</td>
<td>302C2</td>
</tr>
<tr>
<td>10. কাঝর না (Not effective)</td>
<td>302C3</td>
</tr>
</tbody>
</table>
| D. ফিটকারি [Aluminum sulphate (fitkiri)] | 302D1 | 1. হঁ (Yes)  
2. না(No) -> 302I1  
9. জানি না (Don't know)  
> 302E1 | 302D2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302E1 | 302D3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
|---|---|---|---|---|
| I. চায়ের দোকানে পান করার জন্য পানি কেনা Buying water to drink at the tea stalls | 302I1 | 1. হঁ (Yes)  
2. না(No) -> 302J1  
9. জানি না (Don't know)  
> 302E1 | 302I2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302E1 | 302I3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
| J. কেবল চা বা অন্য পরম তরল পান করা Only drinking tea or other hot liquid | 302J1 | 1. হঁ (Yes)  
2. না(No) -> 302E1  
9. জানি না (Don't know)  
> 302E1 | 302J2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302E1 | 302J3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
| E. ক্রেসিং টাবেলেট (Chlorine tablets) | 302E1 | 1. হঁ (Yes)  
2. না(No) -> 302F1  
9. জানি না (Don't know)  
> 302F1 | 302E2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302F1 | 302E3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
| F. ক্রেসিং পাউড়ফার (Chlorine powder) | 302F1 | 1. হঁ (Yes)  
2. না(No) -> 302G1  
9. জানি না (Don't know)  
> 302G1 | 302F2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302G1 | 302F3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
| G. ফিল্টার (Filter) | 302G1 | 1. হঁ (Yes)  
2. না(No) -> 302H1  
9. জানি না (Don't know)  
> 302H1 | 302G2 | 1. হঁ (Yes)  
2. না(No)  
9. জানি না (Don't know)  
> 302H1 | 302G3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
| H. ক্রেসিং দিস্পেন্সার (Chlorine dispenser) | 302H1 | 1. হঁ (Yes)  
2. না(303 নং পণ্ড্রু চলে) (No) (skip to 303)  
9. জানি না (303 নং পণ্ড্রু চলে) (Don't know) (skip to 303) | 302H2 | 1. হঁ (Yes)  
2. না(302H3-এর পর 303a-303d স্কিপ হবে) (after 302H3 skip 303a-303d)  
9. জানি না (Don't know) (302H3-এর পর 303a-303d স্কিপ হবে) (after 302H3 skip 303a-303d) | 302H3 | 1. কার্আকর না (Not effective)  
2. বিচিত্র কার্আকর (Somewhat effective)  
3. অত্যাচা কার্আকর (Very effective) |
<table>
<thead>
<tr>
<th>303a</th>
<th>Chlorine dissolves in the water for 24 hours after treatment. The fact that chlorine stays in the water 24 hrs after treatment motivates me to chlorinate my drinking water.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Strongly disagree (Strongly disagree)</td>
</tr>
<tr>
<td></td>
<td>2. Slightly disagree (Slightly disagree)</td>
</tr>
<tr>
<td></td>
<td>3. Slightly agree (Slightly agree)</td>
</tr>
<tr>
<td></td>
<td>4. Strongly agree (Strongly agree)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>303b</th>
<th>Chlorine's presence as a residue is evident. The smell of chlorine helps me judge if the water is safe to drink.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Strongly disagree (Strongly disagree)</td>
</tr>
<tr>
<td></td>
<td>2. Slightly disagree (Slightly disagree)</td>
</tr>
<tr>
<td></td>
<td>3. Slightly agree (Slightly agree)</td>
</tr>
<tr>
<td></td>
<td>4. Strongly agree (Strongly agree)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>303c</th>
<th>I like the taste of chlorinated water.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Strongly disagree (Strongly disagree)</td>
</tr>
<tr>
<td></td>
<td>2. Slightly disagree (Slightly disagree)</td>
</tr>
<tr>
<td></td>
<td>3. Slightly agree (Slightly agree)</td>
</tr>
<tr>
<td></td>
<td>4. Strongly agree (Strongly agree)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>303d</th>
<th>I like the smell of chlorinated water.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Strongly disagree (Strongly disagree)</td>
</tr>
<tr>
<td></td>
<td>2. Slightly disagree (Slightly disagree)</td>
</tr>
<tr>
<td></td>
<td>3. Slightly agree (Slightly agree)</td>
</tr>
<tr>
<td></td>
<td>4. Strongly agree (Strongly agree)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>303e</th>
<th>Modern countries around the world always drink chlorinated water.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Strongly disagree (Strongly disagree)</td>
</tr>
<tr>
<td></td>
<td>2. Slightly disagree (Slightly disagree)</td>
</tr>
<tr>
<td></td>
<td>3. Slightly agree (Slightly agree)</td>
</tr>
<tr>
<td></td>
<td>4. Strongly agree (Strongly agree)</td>
</tr>
</tbody>
</table>
303d  | The smell of chlorine is not as noticeable after getting used to it

| 1.  | Strongly disagree
| 2.  | Slightly disagree
| 3.  | Slightly agree
| 4.  | Strongly agree

303  | पानी फूटानेर जन्य आपनार गांव आहे किती?
(Do you have access to gas to boil your water?)
| 1.  | यास (Yes)
| 2.  | ना (No)

304  | यदि आपनार बांसाय विवेच पानी ना घाता ता होणे आपण की करता?
(What do you do if you do not have treated water at home?)
| 1.  | सरासरी उत्स ह्या पानी करी (Drink directly from source water)
| 2.  | घरे संस्कृतकृत अविवेच पानी पानी करी (Drink untreated stored water)
| 3.  | वातसे पानी किती नेती (Buy bottled water)
| 4.  | प्रविधिकृत का घरेलू या घरेलू गांव विवेच पानी करी (Take water from the neighbours who are known to treat their water)
| 5.  | कफ्फ आवरण पानी पानी करी (Never drink untreated water)
| 6.  | अन्य (निरंतिक करण) Other (specify)
| 7.  | अन्य (निरंतिक करण) Other (specify)
| 8.  | अन्य (निरंतिक करण) Other (specify)

304a  | यदि आपनार बांसाय विवेच पानी ना घाता ता होणे आपण की करता?
(What do you do if you do not have treated water at home- I will read a list (and collect any further options)
| 1.  | सरासरी उत्स ह्या पानी करी (Drink directly from source water)
| 2.  | घरे संस्कृतकृत अविवेच पानी पानी करी (Drink untreated stored water)
| 3.  | वातसे पानी किती नेती (Buy bottled water)
| 4.  | प्रविधिकृत का घरेलू या घरेलू गांव विवेच पानी करी (Take water from the neighbours who are known to treat their water)
| 5.  | कफ्फ आवरण पानी पानी करी (Never drink untreated water)
| 6.  | कफ्फ आवरण पानी पानी करी (Never drink untreated water)
| 7.  | कफ्फ आवरण पानी पानी करी (Never drink untreated water)
| 8.  | कफ्फ आवरण पानी पानी करी (Never drink untreated water)

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Section I: Exposure to the ICVB Behavior Change Intervention by icddrb/dsk CHPs –Ask all arms
1032a. আপনি কি কখনও অপনার খাতায় পানি চর্চা করার দরকারে বিস্তারিত করেছেন এবং নির্দেশাদি সম্পর্কে বিবরণ দেন আলোচনায় অংশ নিয়েছিলেন অথবা করেন কাজ করে চর্চা করেছিলেন কি? Have you ever had any discussion or received any information about treating your drinking water with chlorine and safe storage, ?

1. হ্যা Yes
2. না (1032c নং প্রশ্নে চলে যান) No (skip to 1032c)

1032b. আপনি কর সাথে আলোচনা করতেন অথবা কাজ কর 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. আইসিডিভি এক্সপার্ট এবং ডিসেলের সিইএসআই ইচ্ছারী Ieddr,b/DSK CHPs
4. অন্য কোন এনআইও সিইএসআই পি Other NGO CHPs
5. দোকানের ব্যবসায়ী অথবা চিকিৎসক Medical practitioner
6. বিদ্যালয় থেকে শিক্ষক School based interaction
7. মসজিদ থেকে মসজিদ based interaction
8. পাত্রবিবেকী সহকারী Neighbor
9. অন্য(নির্দিষ্ট করুন) Other (Specify): ---------

1032b1. তারা আপনাকে কি কি দেখিয়েছে? What materials did they show you?
1. ফ্ল্যাচকার্ট/বই Flipchart/Book
2. পানি বিদ্যুত করি সম্বন্ধে বিভিন্ন কারণে কংকটিত Cue card on how to use dispenser
3. ফ্ল্যাচকার্ট Flash card
4. পোস্টার Poster
5. স্টিকার Sticker
6. কিছুই দেখিয়েন Nothing
7. অন্যান্ত other

1032c. আপনি কি কখনও অপনার খাতায় পানি চর্চা করার দরকারে বিস্তারিত করেছেন আলোচনায় অংশ নিয়েছিলেন অথবা এই বিষয়ে কোন তথ্য পেয়েছেন? Have you ever had any discussion or received any information about handwashing with soap/soapy water?... 

1. হ্যা Yes
2. না (1032c নং প্রশ্নে চলে যান) No (skip to 1032c)

1032d. আপনি কর সাথে আলোচনা করতেন অথবা কাজ কর 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. আইসিডিভিআরিনি/ ডিএসকে সিএইচপি  Icdrr,b/DSK CHPs
4. অন্য কোন এনজিওর সিএইচপি  Other NGO CHPs
5. চিকিৎসাশালীদের কাছ থেকে Medical practitioner
6. স্কুল থেকে School based interaction
7. মসজিদ থেকে Mosque based interaction
8. প্রতিবক্ষী Neighbor
9. অন্যান্য (প্রদর্শিতকৃত) Other (Specify):---------

1032d1. তারা আপনাকে কি কি দেখিয়েছে?  What materials did they show you?
1. ছায়াচার্ট/বই Flipchart/Book
2. হাত ধোয়া কিছুক কিউকার্ড Cue card on how to wash hands
3. ফ্ল্যাষকার্ট Flash card
4. পোস্টার Poster
5. স্টিকার Sticker
6. কিছুই দেখায়নি Nothing
7. অন্যান্য নিষ্ঠুর করান other(Specify):---------

1032d2. ডিএসকের সিএইচপি কি কখনো হাত ধোয়ার কৌশল দিয়েছে? Has DSK CHP ever provided instruction on handwashing?
1. হঁয় Yes
2. না No
3. জানিনা Don't know

1032d3. ডিএসকের সিএইচপি কি কখনো হাত ধোয়ার টেস্ট এর ব্যবহার সম্পর্কে কৌশল দিয়েছে? Has DSK CHP ever provided instruction on using the handwashing station?
1. হঁয় Yes
2. না No
3. জানিনা Don't know

1032d4. ডিএসকের সিএইচপি কি কখনো ক্লাইরিন থারা পানি বিভিন্ন কৌশল দিয়েছে? Has DSK CHP ever provided instruction on water chlorination?
1. হঁয় Yes
2. না No
3. জানিনা Don't know

1032d5. ডিএসকের সিএইচপি কি কখনো ক্লাইরিন ডিসপেনসার ব্যবহারের কৌশল দিয়েছে? Has DSK CHP ever provided instruction on using the Chlorine Dispenser?
1. হঁয় Yes
2. না No
3. জানিনা Don't know.

1032e. আইসিডিভিআরিনি এবং ডিএসকের কিছু কমিউনিটি সাপ্তাহিক যারা তাদের আইডি কার্ডে লোগো ব্যবহার করে এবং তারা কিছু প্রতিবক্ষীকে পরামর্শ দিয়েছে যথেষ্ট অন্যদেরকে করে না। আপনি কি আপনার প্রতিবক্ষীর ঘরে তাদেরকে দেখেছেন? There are community health promoters sponsored by an organization known as DSK and by icddrb — 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. ঘা Yes

2.  না No

q1032f. আপনার পরিবারে/কমপ্লেক্সে পাতা জুন'২০১১ থেকে এখন পর্যন্ত আইসিডিরিভিআরবিবি/ ডিএসএকের কোন সিইচপি কি পরিবর্তনে এসেছিল? Have your household/compound received any visit by any icddr,b/DSK CHP from June 2011 to until today?

1.  ঘা Yes

2.  না No

3.  জানি/কিনা Don't know

1032. গত একাদশ আপনার কম্পাউন্ডে কবরার কমিউনিটি বাস্তা কল্লী এসেছে?--------বার (মনে করতে পারবে না=999) (প্রশ্নার নং=888)(যদি '৮৮৮' হয় তাহলে প্রেরে সেকশনে চলে যান)How many times did an icddrb/dsk CHP visit your compound within last 1 month? ________times [put 999 if don’t remember] (Not applicable=888)

1034a. আইসিডিইরিভিআরবিবি/ডিএসএকের যে সিইচপি আপনার বাড়িতে আসে তার নাম কি? __________ (প্রশ্নার নং=888) (জানি/কিনা =৯৯৯) What is the name of the icddrb/dsk CHP who comes to your home/compound? __________ (Not applicable=888)(Don’t know=999)

1034b. উত্তরাদে যে সিইচপির নাম বলেছিল? Did the respondent mention the name of the CHP?

1. ঘা Yes

2.  না no

1034c. গত এক মাসের মধ্যে আপনি অথবা আপনার পরিবারের কোন সদস্য কবরার হাত থেকে অথবা পানি বিশ্বকরমের বিষয়ে চায়ের দেকানের আলোবার্নায় অংশগ্রহণ করেছেন? )?--------বার (প্রশ্নার নং=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 বাড়িরা কবরার আইসিডিরিভিআরবিবি/ ডিএসএকের বাড়িদের হাত থেকে অথবা পানি বিশ্বকরমের বিষয়ে অংশগ্রহণ করেছেন?--------বার (প্রশ্নার নং=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. আইসিডিরিভিআরবিবি/ডিএসএকের সিইচপি কি আপনার এবং আপনার কমল্যান্ডের সদস্যদের সাথে পানি বিশ্বকর্ম কর্তার মেশিনটি বানাওয়ার পূর্বে মেশিনটি কর্মীরা হাত থেকে লাল ব্যালিটি বসাবার হাত হবে ফিরিয়ে আনার মাধ্যমে? Did the icddr/bd CHP ask the people’s opinion on where to install any technologies/hardware?

1.  খুব ভাল  মান্যতা
2.  কিছুটা করেছিল  Somewhat
3.  করেনি did not ask
4.  প্রশ্নার নং নথি Not applicable
1034e. Are you able to remember the materials such as flipcharts/books etc, do you remember learning from looking at them,

1. A lot
2. Some
3. None
4. Not applicable

1034f. Regarding drinking water treatment, would you say that you learned from the icddrb/dsk CHP...

1. Many new things
2. Some new things
3. Nothing new
4. Not applicable

1034g. Regarding the water treatment machine and agent/material, do you find it...

1. Very useful
2. Somewhat useful
3. Not useful
4. Not applicable

1034h. Do you still need to look at the given instruction in the cue card placed by chlorine dispenser to treat water?

1. always
2. some times
3. never
4. Not applicable specify: ------
1034i. हात धोने के तरीके का अनुमान करनें हैं तो पानी कि मने करने एंग्लो--- Regarding the handwashing technologies/hardware, do you find them

1. ठीक से Very useful
2. किसी तरीके Somewhat useful
3. ना Not useful
4. अनुकूल Not applicable

1034j. आपने कि एक से होने का जना पानी भार की तरीके लागातार हात धोने का विषय किसी का देखने प्रयोजन है? Do you still need to look at the given instruction in the cue card placed by hand washing station?

1. सवाल तरीके always
2. केवल कुछ times
3. ना never
4. अनुकूल Not applicable specify------

1035. आपने कि अपने पानी सम्पर्क से आपने कोई समस्या के कारण कमिउसिटी शायद कमी के बने है? Did you share any of your concerns related to drinking water treatment with the CHP?

1. हाँ Yes
2. ना (1037 नं और तरीके या)
3. आपने अधिक है अधिक के I did not have any concerns (1037 नं और तरीके या)
4. अनुकूल Not applicable (1037 नं और तरीके या)
5. अनुकूल Don’t know(1037 नं और तरीके या)

1036. कमिउसिटी शायद कमी का आपने के कोई समस्या समाधान निर्माण किया था? Did the CHP help you find a solution?

1. हाँ, आंशिक रूप से Yes, partly
2. हाँ, पूर्ण Yes, complete solution
3. ना No

1037. आपने कि मने का विषय करने हैं एक तरीके समस्या कोई? Do you have problem now with water treatment?

1. हाँ Yes
2. ना No (skip to 1038)
3. अनुकूल Not applicable (skip to 1038)
1037a. If yes, has the problem prevented you from practicing water treatment?

1. A lot
2. Somewhat
3. Not at all

1038. You share any of your concerns related to handwashing with the CHP?

1. Yes
2. No (skip to 1040)
3. Did not have any concerns (skip to 1040)

8. Not applicable (skip to 1040)

1039. Did the CHP help you find a solution?

1. Yes, partly
2. Yes, complete solution

3. No

1040. Do you have problem now with handwashing?

1. Yes
2. No

8. Not applicable

1040a. If yes, has the problem prevented you from practicing handwashing?

1. A lot
2. Somewhat
3. Not at all
1041. আপনি কি আমাকে বলবেন যে কমিউনিটি বাড়া কর্মী আপনার বাড়িতে আসে তার ব্যবহার করা ক্ষুধাসুত্ব? Would you say that the CHP who visits you is very courteous, somewhat courteous, or not at all?

1. খুবই ব্যর্থ very courteous
2. কিছুটা somewhat courteous
3. একেবারেই না Not at all
8. প্রয়োজন নয় Not applicable

1041a. আপনি কি বলবেন যে, যেই কমিউনিটি বাড়া কর্মী আপনার বাড়িতে/ কম্পাউন্ডে আসে সে Would you say that the CHP who visits you:
1. হাত ধোয়ায় বাপারে বেশী কথা বলেছে Talked more about handwashing
2. ক্রান্তি ঘরা পানি বিষ্ণুর কারণ বাপারে বেশী কথা বলেছে Talked more about water chlorination
3. ক্রান্তি ঘরা পানি বিষ্ণুর কথা এবং হাত ধোয়া উভয় বাপারে সমানভাবে কথা বলেছে Talked equally about both handwashing and water chlorination
4. দুটোর কোনোটার বাপারে বিষ্ণুর কথা বলে নাই none of these are mentioned
8. প্রয়োজন নয় নিন্দিত করেন none of these are mentioned Not applicable specify

### Section La: Perceived Water Quality

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>Strongly disagree</th>
<th>Slightly disagree</th>
<th>Slightly agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>La1. ওয়ায়া সরবরাহকৃত পানি পানীর জন্য খুব নিরাপদ The water supplied by WASA is very safe to drink</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>La2. ওয়ায়া সরবরাহকৃত পানীর একটা ভাল যান্ত্রিক জন্য The water supplied by WASA has a good taste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La3. (যারা ১০৬ নং নগ্না শায়লো টিউবওয়েল বা ডিপ টিউবওয়েল উভয় নিয়েছেন তাদের জন্য) আমার টিউবওয়েলের সরবরাহকৃত পানি পানীর 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</td>
<td>5</td>
<td></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Question</td>
<td>Bengali Translation</td>
<td>English Translation</td>
<td></td>
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<tr>
<td>La4.</td>
<td>যারা ১০৬ নং প্রবেশ শালোনা টিউবওয়েল বা ডিপ টিউবওয়েল উত্তর দিয়েছেন তাদের জন্য) আমার টিউবওয়েলের সরবরাহকৃত পানির একটি ভাল ধান 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.</td>
<td></td>
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<td></td>
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<tr>
<td>La5.</td>
<td>টাব্ল/হ্যাই পাপের সরবরাহকৃত সাপ্তাহিক পানি সরাসরি পান করলে অসুখ হওয়া সহজ It is easy to get sick from drinking the supply water directly from the tap/hand pump.</td>
<td></td>
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</tr>
<tr>
<td>La6.</td>
<td>টাব্ল/হ্যাই পাপের সরবরাহকৃত পানি সরাসরি শিক্ষার দেয়া নিরাপদ The water coming direct from the tap/hand pump is safe to give to young children.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>La7.</td>
<td>টাব্ল/হ্যাই পাপের সরবরাহকৃত পানি সরাসরি পানির গুগন্ত মান খুব ভাল The water coming direct from the tap/hand pump is of high quality.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>La8.</td>
<td>টাব্ল/হ্যাই পাপের 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.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La9.</td>
<td>টাব্ল/হ্যাই পাপের সরবরাহকৃত পানি সরাসরি পান করলে আমার আমার হবার সম্ভাবনা আছে। I am likely to get dysentery if I drink water directly from the tap/hand pump.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La10.</td>
<td>টাব্ল/হ্যাই পাপের সরবরাহকৃত পানি সরাসরি পান করলে আমার জড়িত হবার সম্ভাবনা আছে। I am likely to get jaundice if I drink water directly from the tap/hand pump.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La11.</td>
<td>আমি খুবই উদ্বিগ্ন যে, আমার অভ্যন্তরে আমার পরিবারের কার্য কলেরা হতে পারে এবং এটা একটি বিপদজনক রোগ। I am very concerned that I or someone in my family will get cholera, and it is a dangerous disease.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>La12.</td>
<td>আমি খুবই উদ্বিগ্ন যে, আমার অভ্যন্তরে আমার পরিবারের কার্য আমার হতে পারে এবং এটা একটি বিপদজনক রোগ। I am very concerned that I or someone in my family will get dysentery, and it is a dangerous disease.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La13.</td>
<td>আমি খুবই উদ্বিগ্ন যে, আমার অভ্যন্তরে আমার পরিবারের কার্য জড়িত হতে পারে এবং এটা একটি বিপদজনক রোগ। I am very concerned that I or someone in my family will get jaundice, and it is a dangerous disease.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If 506 is 5 then

Section Lb: Practice of alternative behavior: Boiling water

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>Strongly disagree</th>
<th>Slightly disagree</th>
<th>Slightly agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lb1. । আমি আমার পানি ফুটিয়ে নিই কারণ এটা পানিকে অধিকতর পরিকার করে। I boil my water because it makes it cleaner</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb2. । আমি আমার পানি ফুটিয়ে নিই কারণ এটা ব্যাকটেরিয়াকে মেরে ফেলে যা আমাদেরকে অসুরু করতে পারে। boil my water because it kills bacteria that can make us sick</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb3. । আমি আমার পানি ফুটিয়ে নিই কারণ আমি আশা থেকেই পানি গরম করি। I boil my water because I am already cooking/heating water</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb4. । আমি আমার পানি ফুটিয়ে নিই কারণ এটা আমার জন্য করা সহজ। I boil my water because it is easy for me to do</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb5. । আমি আমার পানি ফুটিয়ে নিই কারণ আমার প্রতিবেশী এটা করে। I boil my water because my neighbor does it</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb6. । আমি আমার পানি ফুটিয়ে নিই কারণ সিএইচিপি আমাকে তা করতে বলেছে। I boil my water because the CHP told me to do</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb7. আমি আমার পানি ফুটিয়া কারণ আমি মনে করি যে এটা পানিকে নোরাপত করার জন্য কিছুই করেনা। I do not boil my water because I think it does nothing to make the water safe</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb8. আমি আমার পানি ফুটিয়া কারণ এটা সহজ এবং পানিনার অপচয় হয়। I do not boil my water because it is a waste of time and fuel</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb9. আমি আমার পানি ফুটিয়া কারণ আমার পানি ফুটাও না মত ঢাকা/অর্থ বা জায়গা নেই। I do not boil my water because I do not have the money or space to boil water</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lb10. আমি আমার পানি ফুটিয়া কারণ যে কোন স্থানে রেখে নিয়ে এটা পুরোরায় মৃদুক হয়ে থাকে। I do not boil my water because The water will be</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
recontaminated if left sitting anyways

Ib11. आमी आमार पানি ফুটাইনা কারণ আমার পরিবার পরম পানি পছন্দ করেন। I do not boil my water because My family does not like hot water

Section N: আর্থিক অবস্থা (Socio economic status)

601. সাক্ষাৎকার প্রশ্নাপনকারী কি পড়তে লিখতে জানেন? (Can the respondent read newspaper and/or write?)
   1. পড়তে ও লিখতে জানেন না (Cannot read or write)
   2. পড়তে জানে তবে লিখতে জানেন না (Can read but cannot write)
   3. পড়তে ও লিখতে জানেন (Can read and write)

602. সাক্ষাৎকার প্রশ্নাপনকারী সর্বোচ্চ কতদূর পড়তে পড়াশোনা করেন?
   (What is the highest level of education of the respondent? ________ years of education)

603. খানার ঘরটিতে কতগুলো কক্ষ আছে? (রাস্তার ও বাহরাম 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. স্বয়ং বাড়ি (Self owned)
   2. বাড়ি বাড়ি (Rental)
   3. সরকারি জমি (Government land)
   4. অন্য বাড়িতে ভাড়া না দিয়ে থাকে (Living in someone’s house without giving rent)
   7. অন্যান্য (নির্দিষ্ট করা) __________ (Other specify __________)

605. আপনার খানা সদস্যদের কি কোন বসতিভূমি আছে? (Does your household own any homestead land?)
   1. হঁ (Yes)
   2. না (No)
   8. বলতে রাজি হানি (Refused to say)
   9. জানি না (Don’t know)

606. আপনার খানা সদস্যদের কি বসতিভূমি ছাড়া অন্য কোন জমি আছে? (Does your household own any land other than homestead land?)
   1. হঁ (Yes)
   2. না (No)
   8. বলতে রাজি হানি (Refused to say)
9. জানি না (Don’t know)

607. আপনার খানাতে নিয়মে রাখা যে বিভিন্ন পদার্থ জিনিসপত্র আছে? (ঠাঁ=1, না=2 লিখুন) [Does your household/family own any of the followings? (WRITE 1—yes and 2—No)]

<table>
<thead>
<tr>
<th></th>
<th>(A) সাইকেল (পোডনা সাইকেল নয়) Bicycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(B) মটর সাইকেল  Motor cycle</td>
</tr>
<tr>
<td></td>
<td>(C) বেবীর টেলিফন/সিএইচ ফিসি Baby taxi/CNG</td>
</tr>
<tr>
<td></td>
<td>(D) ডিভিজন/ফ্যান Rickshaw/van</td>
</tr>
<tr>
<td></td>
<td>(E) টেডিভি/ডিভিটেরিয়াল টেরে টেরিয়াল Working radio/Cassette Player/CD player</td>
</tr>
<tr>
<td></td>
<td>(F) টেলিভিশন/ডিভিটিভি Working television/VCD</td>
</tr>
<tr>
<td></td>
<td>(G) কম্পিউটার Working computer</td>
</tr>
<tr>
<td></td>
<td>(H) মোবাইল ফোন (Working mobile Phone)</td>
</tr>
<tr>
<td></td>
<td>(I) বাদাম হার্দিয়া (Working refrigerator)</td>
</tr>
<tr>
<td></td>
<td>(J) বিড়াল/হার্দিয়া (Bed/chouki)</td>
</tr>
<tr>
<td></td>
<td>(K) সিফাট সেট (Sofa set)</td>
</tr>
<tr>
<td></td>
<td>(L) সেলাই মেশিন (Working sewing machine)</td>
</tr>
<tr>
<td></td>
<td>(M) আলো [locally made holder for clothings]</td>
</tr>
<tr>
<td></td>
<td>(N) আলো / পাক শুট (Blanket)</td>
</tr>
<tr>
<td></td>
<td>(O) আলোর ধাত্য/ক্রয়ন (কাঠ/স্টেল) [Almira/wardrobe (wooden/steel)]</td>
</tr>
<tr>
<td></td>
<td>(P) বিড়াল (Electricity connection)</td>
</tr>
</tbody>
</table>

608. আমাদের গবেষণার সুবিধায় আপনি কি পদার্থে আপনার পরিবারের মোট মাসিক আয় কত টাকা? (মোট মাসিক আয় হিসাব করার সময় আপনার সকল কেরা বিবেচনা করবো মোটের মোট। বাড়ী ভাড়া, কৃষি ইত্যাদি, ‘জানি না’ হলে ১৯৯৯ 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 রাত্রির জন্য প্রধানত কি ধরনের ফ্যাটলাই ব্যবহার করা হয়? (What kind of fuel do you use for cooking?)

1. কাটি/কাঠ কুলো (Wood/charcoal)
2. কেরোসিন (Kerosene)
3. প্রাকৃতিক গ্যাস (Natural gas)
4. বিড়াল (স্পেন্ডিয়াল ইট) [Electricity (Electric heater)]
5. হুইস্ক (Husk/Dust of Wood)
6. অন্যা/অন্যা __________________ (Other______)

83
610. What kind of toilet facility do the children less than three years old in your household use? (Ask and observe) (>1 answers allowed)

1. The child uses a sealed latrine in the home (Water sealed latrine in the home)
2. The child uses a pit latrine in the home (Pit latrine in the home)
3. The child uses a pit toilet outside the home
4. The child uses a toilet outside the home
5. The child uses a hanging latrine
6. The child uses a fixed place (No fixed place)
7. Other (Other) (skip to 611)
8. Not applicable (if there is no such children at home) (skip to 611)
9. Latrine without water seal in the home (Latrine Without Water seal in the home)
10. Latrine without water seal shared by multiple households (skip to 611)

610a. Where are potties emptied?

1. The child uses a sealed latrine in the home (Water sealed latrine in the home)
2. The child uses a pit latrine in the home (Pit latrine in the home)
3. The child uses a pit toilet outside the home
4. The child uses a hanging latrine
5. The child uses a fixed place (No fixed place)
6. Other (Other)

611. What kind of toilet facility do the adults in your household use? (Ask and observe)

1. The adult uses a sealed latrine in the home (Water sealed latrine in the home)
2. The adult uses a pit latrine in the home (Pit latrine in the home)
3. The adult uses a pit toilet outside the home
4. The adult uses a hanging latrine
5. The adult uses a fixed place (No fixed place)
6. Other (Other)
11. घर के बाहर फिक्स पानी निरोधक नहीं  (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.এফआরএ উত্তরদাতাকে এই প্রশ্নটি করতে না। তারা কেবল পর্যবেক্ষণ করবে এবং অপশনগুলো মিলিয়ে নিবে।

ইতিহাসমূহ Improved sanitation facilities
flush টয়লেট অথবা পানী খেলি ফুল করা টয়লেট [Flush or pour flush toilet flushed to:]
01 पानीसंपन्न पाईपरस का संयोजन करे हटा (Piped sewer system)
02 सेंटरिक टाइप के बसाना आहे (Septic tank)
03 सेंटरिक टाइप के खिड़की फ़्लाष करे या पानी खेले पायलाइन दुरु पिटे के मध्ये सरिये हटा हाय (Flush to pit latrine (Off set))
04 पिट टायलेट (स्नॅप एंड ओवरटैप सील आहें) [Pit latrine with slab & water seal]
05 पिट टायलेट (स्नॅप आहें किंवा ओवरटैप सील नेल तब ठकना नेला) [Pit latrine with slab & no water seal but with a lid]
06 वायु चलातम सूक्ष्मिता उपलब्ध टायलेट [Ventilated Improved Pit Latrine (VIP)]
07 पिट टायलेट याच स्नॅप आहें किंवा डिफाइनिटियल्मर वायर्स एंड ओवरटैप सील नेलिए [Pit Latrine with slab but without ventilation and no water seal]
08 कमचॉकियरिंग टायलेट (पायलाइन एंड पंपर करणे जन्य आलां हालां घर एंड साथे आलां कॉचाऊ पानी वायर्स आहें) [Composting toilet, (Composting toilet ensure separation of urine, water and excreta)]
09 पिट टायलेट याच दृष्टी गर्दे आहें (Dual Pit Latrine)

अनुप्रयुक्त पायलाइन Unimproved sanitation facilities
10 flush टायलेट अथवा पानी खेलि फूल करा टायलेट या कोने खाल, मिर्न,नौदी इत्यादि का संयोजन करा [Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]
11 पिट/गॉर्ड पायलाइन याच स्नॅप बनिए (एंड मशा /मअं याओ आसा करणे पारे एंड दूरदुरुष्च छड्डाय) [Pit latrine without slab / Open pit]
12 बालकिसाह उपलाइना (Bucket)
13 कूलफ पायलाइना (Hanging toilet)

उपयुक्त पायलाइन Open defecation
14 कोने पायलाइना नेलिए (कोप-बाड़ /कोला जागय) (No facility / bush / field )
612. Does more than one household share the same toilet?
   1. Yes
   2. No (Skips to q701)

613. How many households (including the respondent’s household) are there within this compound?

614. How many toilets are there within this compound?

701. Observe the condition of the clothing carefully (without asking anything) and record

   1. No holes/tears
   2. A few holes/tears
   3. Many holes/tears

702. Are there faeces visible in the compound (other than in a designated pile)?
   1. Yes
   2. No

703. Are there animal feces visible in the compound (other than in a designated pile)?
   1. Yes
   2. No

704. MAIN EXTERIOR Construction materials of the walls

   1. Mud/sticks/reeds/branches
   2. Corrugated iron/tin
   3. Fired bricks
   4. Wood
   5. Cement/concrete
   6. Other (Specify):

705. Construction material of the floor

   1. Earth/mud/dung/sand
2. সিমেন্ট/কঠিন (Cement/concrete)
3. কাঠ (Wood)
7. অন্যান্য (Other specify):__________________

706. জালার নির্মাণ উপকরণ: [-----] (Construction material of the roof)

1. মাটি/বালের কেড় (Mud, branches)
2. কাঠ (Wood)
3. ডিএলটিন (Corrugated iron/tin)
4. সিমেন্ট/কঠিন (Cement/concrete)
7. অন্যান্য (নির্দিষ্ট করুন) Other (specify):__________________

707. আপনার পরিবারের আবাসন এর ধরন কোথায় ফেলে? (পরিবেশণ করে ফেলুন) (How does your household dispose of most of its wastes? (ask and Observe) )

1. নির্দিষ্ট আয়তন (THROW IN A SPECIFIED PLACE)
   a. প্রস্তুতির মধ্যে স্থাপন করে রাখাDesignated pile in the compound
   b. ময়লা ফেলার নির্দিষ্ট স্থান/স্থান/স্থানDesignated Garbage dump
   c. ময়লা এসে নিয়ে যায়Collection service
   d. অন্যান্য others (specify)
2. নর্তকী/ঝাপ/জ্যানে (THROW IN DRAINS/ LAKES/ STREAMS)
3. যে কোন অপর প্রাপ্তবয়স্ক (No specific place to dispose the wastes)
7. অন্যান্য (নির্দিষ্ট করুন): ______ OTHER (SPECIFY)__________________

708. এই বাড়ির অর্থ সামাজিক অবস্থা কোন পর্যায়ে পড়ে? (সাক্ষাত্কার প্রান্তকর্তা তার নিজের পর্যবেক্ষণ এবং মূলদারের উপর ভিত্তি করে
একটি যোগ চিক দিয়েন) [In which category the socioeconomic status of this household fit? (Interviewer will circle an
option based on his/her own observation and assessment)]

1. বিতরিন (Very poor)
2. নিম্ন মোদবিদ (Somewhat poor)
3. মধ্যবিদ (Neither poor nor rich)
4. উচ্চ মোদবিদ (Somewhat rich)
5. বিতরিন (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) বৃহস্পতি বর্ষ এলাকা Hanging slum
Section P: H2S and E. coli water test results

820. What was the H2S test result of household stored water after 24 hours?

1. Water was found to be contaminated
2. Water was uncontaminated
3. (Not applicable)(specify):____

821. What was the H2S test result of household stored water after 48 hours?

1. Water was found to be contaminated
2. Water was uncontaminated
3. (Not applicable)(specify):____

822. What was the H2S test result of source water after 24 hours?

1. Water was found to be contaminated
2. Water was uncontaminated
3. (Not applicable)(specify):____

823. What was the H2S test result of source water after 48 hours?

1. Water was found to be contaminated
2. Water was uncontaminated
3. (Not applicable)(specify):____

824. E. Coli count in the stored drinking water ___/100ml [Put ‘888’ if not applicable.

825. 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

<table>
<thead>
<tr>
<th>Details</th>
<th>Reporting participant</th>
<th>Participant Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

## 1 Participant first/given name

## 2 Participant surname

## 3 Gender

- Male
- Female

## 4 Date of birth (day/month/year)

- DD - MM - YYYY

## 5 Relationship with Participant 1

1. Spouse / Partner
2. Child / Stepchild
3. Parent
4. Grandparent
5. Other / Unrelated

## 6 Country of birth

1. Australia
2. New Zealand
3. United Kingdom
4. Yugoslavia (including Serbia, Croatia, Bosnia)
5. Italy
6. Other

## 7 Main language spoken at home

1. English
2. Italian
3. Greek
4. Other

## 8 Does the person have any long term current skin problems such as psoriasis or eczema?

- Yes
- No

## 9 Does the person have current respiratory problems such as asthma or bronchitis?

- Yes
- No

## 10 Is the person attending childcare, school or any other education institution?

- Yes
- No

---

**Draft**

Page 1 of 2

329
### The Adelaide Rainwater Study Enrolment Questionnaire

<table>
<thead>
<tr>
<th>Details</th>
<th>Participant Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11 If YES to question 10, what type of institution?</strong></td>
<td>1</td>
</tr>
<tr>
<td>1 = Childcare</td>
<td>Code</td>
</tr>
<tr>
<td>2 = Preschool</td>
<td>Code</td>
</tr>
<tr>
<td>3 = Primary school</td>
<td>Code</td>
</tr>
</tbody>
</table>

| **12 If NO to question 10, what is the highest level of education completed?** | 1                  |
| 1 = Did not attend school                                              | Code               |
| 2 = Primary                                                            | Code               |
| 3 = Secondary / Commercial / Technical                                 | Code               |
| 4 = Trade qualification                                                | Code               |
| 5 = University / College                                               | Code               |

| **13 Current work status for person over 18**                          | 1                  |
| 1 = F/T paid work                                                      | Code               |
| 2 = P/T paid work                                                     | Code               |
| 3 = F/T home duties                                                   | Code               |

| **14 For which other activities do you use rainwater?**               | 1                  |
| □ Gardening                                                           |                    |
| □ Toilet flushing                                                     |                    |
| □ Washing clothes/laundering                                          |                    |
| □ Washing car                                                         |                    |
| □ Showering/bathing                                                   |                    |
| □ Other                                                               |                    |
| □ All                                                                 |                    |

| **15 Apart from rainwater, what other sources of water are available to you?** | 1                  |
| □ Mains water                                                         |                    |
| □ Bore water                                                          |                    |
| □ River/creek/dam water                                               |                    |

| **16 Does your household have any of the following pets?**         | 1                  |
| 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?** | 1                  |
| □ Yes                                                                 |                    |
| □ No                                                                  |                    |

| **18 Is there an accessible outdoor rainwater tap for water collection by study personnel?** | 1                  |
| □ Yes                                                                 |                    |
| □ No                                                                  |                    |

| **19 If NOT, is the householder willing to take an indoor sample?** | 1                  |
| □ Yes                                                                |                    |
| □ No                                                                  |                    |
# The Adelaide Rainwater Study

**Instructions:**

Use black or blue biro only.

Please mark like this:

- o  o  o  o

Not like this:

- x  o  o  o

## Section 1.

<table>
<thead>
<tr>
<th>1.1a Has the person been away from home overnight during the week?</th>
<th>1.1b Mark the day(s) away from home:</th>
<th>Overseas</th>
<th>Within Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>Yes</td>
<td>No</td>
<td>○</td>
</tr>
</tbody>
</table>

### 1.1b

If YES

STOP at this point if the person has been away from home every day of a week.

## 1.2a Has the person been swimming during the week?

### 1.2b

If YES

Where did they swim?

- Public pool/spa
- Private pool/spa
- River/dam/lake
- Ocean/beach

### 1.2b

(mark the days for each place)
<table>
<thead>
<tr>
<th>Section 2 - Gastroenteritis</th>
<th>Household ID:</th>
<th>Individual ID:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1a Has the person had diarrhoea?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.1b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>2.1c Mark the maximum number of loose bowel actions in a 24hr period:</td>
<td>○ 1 ○ 2 ○ 3 ○ 4+</td>
<td>○ 1 ○ 2 ○ 3 ○ 4+</td>
</tr>
<tr>
<td>2.2a Has the person had vomiting?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.2b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>2.2c Mark the maximum number of times per day vomiting occurred:</td>
<td>○ 1 ○ 2 ○ 3 ○ 4+</td>
<td>○ 1 ○ 2 ○ 3 ○ 4+</td>
</tr>
<tr>
<td>2.3a Has the person had nausea?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.3b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>2.4a Has the person had abdominal cramps / pains?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.4b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>2.5a Has the person had a fever?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.5b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>2.6a Has the person had chills or sweats?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
</tr>
<tr>
<td>If YES 2.6b Mark the day(s):</td>
<td>M T W F S S</td>
<td>M T W F S S</td>
</tr>
<tr>
<td>If NO to question 2.1a to 2.6a go to Section 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.7a Has the person consulted a doctor due to this illness? | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No |
| If YES 2.7b Was medication prescribed for this person? | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No |

2.8 Has the person been to a hospital due to this illness? | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No | ○ Yes ○ No |

Please continue on the page below.
### Section 2 - Gastroenteritis continued

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9a Has the person been absent from school/work/childcare or unable to carry out normal duties?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>If YES 2.9b Mark the day(s):</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.10 Has the person stayed in bed for part of the day or more?</td>
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</tr>
<tr>
<td>2.11a Has the illness caused another family member to take time off work/school to care for the sick person?</td>
<td></td>
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</tr>
<tr>
<td>If YES 2.11b Mark the day(s):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Section 3 - Respiratory symptoms

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1a Has the person had any respiratory symptoms or a cold?</td>
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</tr>
<tr>
<td>If YES 3.1b Has the person had a sore throat?</td>
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<tr>
<td>3.1c Has the person had a runny nose?</td>
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<tr>
<td>3.1d Has the person had a cough?</td>
<td></td>
<td></td>
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<tr>
<td>If NO to question 3.1a go to Section 4</td>
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<tr>
<td>3.2a Has the person consulted a doctor due to this illness?</td>
<td></td>
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<tr>
<td>If YES 3.2b Was medication prescribed for the person?</td>
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<tr>
<td>3.3 Has the person been to a hospital due to this illness?</td>
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<tr>
<td>3.4a Has the person been absent from school/work/childcare or unable to carry out normal duties?</td>
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<tr>
<td>If YES 3.4b Mark the day(s):</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>3.5 Has the person stayed in bed for part of the day or more?</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.6a Has the illness caused another family member to take time off work/school to care for the sick person?</td>
<td></td>
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<tr>
<td>If YES 3.6b Mark the day(s):</td>
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<td></td>
</tr>
<tr>
<td>Section 4 - Skin symptoms</td>
<td>Week 1</td>
<td>Week 2</td>
<td>Week 3</td>
<td>Week 4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>----------------------------------------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4.1a Has the person had any skin symptoms or infections?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES 4.1b Has the person had a rash?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1c Has the person had generalised itching?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1d Has the person had a skin infection?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If NO to question 4.1a STOP HERE</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2a Has the person consulted a doctor due to this illness?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES 4.2b Was medication prescribed for the person?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3 Has the person been to a hospital due to this illness?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4a Has the person been absent from school/work/childcare or unable to carry out normal duties?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES 4.4b Mark the day(s):</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5 Has the person stayed in bed for part of the day or more?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6a Has the illness caused another family member to take time off work/school to care for the sick person?</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td>○ Yes ○ No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES 4.6b Mark the day(s):</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td>M T W T F S S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>0.05</td>
</tr>
<tr>
<td>Beta</td>
<td>0.20</td>
</tr>
<tr>
<td>CV</td>
<td>0.3</td>
</tr>
<tr>
<td>Study area population (6 wards)</td>
<td>247,391</td>
</tr>
<tr>
<td>Number of clusters per arm</td>
<td>30</td>
</tr>
<tr>
<td>Average cluster size</td>
<td>2,749</td>
</tr>
<tr>
<td>Vaccine protective efficacy</td>
<td>0.65</td>
</tr>
<tr>
<td>Initial vaccine coverage</td>
<td>0.65</td>
</tr>
<tr>
<td>Annual Migration</td>
<td>0.25</td>
</tr>
<tr>
<td>Incidence rate</td>
<td>0.0016</td>
</tr>
<tr>
<td>Surveillance period (years)</td>
<td>2</td>
</tr>
<tr>
<td>Cumulative incidence among control clusters</td>
<td>0.0032</td>
</tr>
<tr>
<td>OPE during 1st year surveillance</td>
<td>0.316875</td>
</tr>
<tr>
<td>OPE during 2nd year surveillance</td>
<td>0.23765625</td>
</tr>
<tr>
<td>OPE at a mid- point of follow-up</td>
<td>0.277265625</td>
</tr>
<tr>
<td>Relative Risk</td>
<td>0.722734375</td>
</tr>
<tr>
<td>Cumulative incidence among vaccine clusters</td>
<td>0.00231275</td>
</tr>
<tr>
<td>Sample size required for individually randomized trial</td>
<td>43,173</td>
</tr>
<tr>
<td>Assumptions</td>
<td>Values</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>ICC</td>
<td>0.0002889246</td>
</tr>
<tr>
<td>Inflation factor (IF)</td>
<td>1.79</td>
</tr>
<tr>
<td>Sample size required for cluster randomized trial per arm</td>
<td>77,449</td>
</tr>
<tr>
<td>Sample size per cluster</td>
<td>2,582</td>
</tr>
<tr>
<td>Sample size per arm</td>
<td>77,460</td>
</tr>
<tr>
<td>Total sample size for 3 groups</td>
<td>232,380</td>
</tr>
<tr>
<td><strong>Total samples required including infants and pregnant women (3%)</strong></td>
<td><strong>239,352</strong></td>
</tr>
</tbody>
</table>
Appendix 4: Ethical Approval Letters
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.
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
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 up to 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
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