Improving handwashing among older children in emergency settings: a multi-method exploration of behavioural determinants and behaviour change approaches

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Declaration

I, Julie Watson, confirm that the work presented in this thesis is my own.
Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Handwashing with soap (HWWS) is effective in reducing the transmission of important infectious diseases such as diarrhoea and acute respiratory infections (ARIs). Diarrhoea and ARIs remain two of the leading causes of child morbidity and mortality, with especially high rates among children in humanitarian emergency settings. Rates are highest among children under-five; however older children (children aged 5-14) also bear a large burden of these diseases. Older children begin to take responsibility for their own behaviour so promoting HWWS among this age group can achieve a significant public health impact. What works in HWWS interventions targeting older children in emergency settings, however, is unclear.

This PhD thesis aims to understand the determinants of handwashing behaviour among older children in emergency settings and identify potentially effective approaches to HWWS interventions targeting this population. The thesis synthesises research from a systematic review assessing the effectiveness of different behaviour change techniques (BCTs) employed across hand hygiene interventions for older children, a study exploring the perceived determinants of older children's handwashing behaviour in an internally displaced persons (IDP) camp in Northern Iraq, a trial of a novel HWWS intervention employing motivational drivers, also in this IDP camp, and a qualitative study exploring NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children.

Findings suggest HWWS interventions targeting older children in humanitarian emergencies should be fun, interactive, and as low-resource as possible so that they are simple, quick to implement, and easy to replicate. Using 'positive' motivational drivers, including play and nurture, creating a physically enabling environment that includes environmental cues, and leveraging social norms were all approaches found to be potentially effective. Interventions should build on a basic package of BCTs which ensure handwashing facilities and materials are available, if not already, and older children understand how to perform HWWS. Formative research should be undertaken to establish existing levels of health-related knowledge of handwashing and determine if health-based messaging is included. If so, this should be carefully designed to engage older children and create a tangible link between HWWS and health. To aid improvements in intervention effectiveness, the NGO sector must make HWWS promotion for older children in emergency settings an organisational priority. New interventions should be evaluated as rigorously as possible within the context to build the evidence base and approaches that prove successful should be standardised and shared across the sector.

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I would firstly like say a very big thank you to my supervisors, Robert, Ollie, and Bob for all their support over my PhD journey. You have greatly helped me to push my thoughts further throughout this process, develop my skills, and build my confidence as a researcher. Thank you for taking me on as your PhD student and finding time in your busy schedules for the numerous calls, reviews, and questions!

A special thanks to Ollie for also mentoring me throughout and always pushing me to keep going when motivation and confidence was low - I couldn't have done it without your pep talks and random, but 100% necessary, deadlines!

Thank you also to my colleagues in the Environmental Health Group who have shared words of wisdom and support throughout, and to Save the Children without whom this opportunity would not have arisen.

I am also very thankful to my lovely parents who never failed to check in on me and ask how it is all going. Their excitement for my graduation alone was at least one motivation to finish!

Last, but not least, thank you to my husband who has been through this journey with me, supported me in all kinds of ways and borne the brunt of my times of doubt. And to my daughter, Suri, who was born in the last year of the PhD. She doesn't know yet, but I am thankful to her for letting me sneak away to write and for those rare few nights where she slept well while I worked next to her under the covers!

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List of Abbreviations

ARI	Acute Respiratory Infection
BCD	Behaviour Centred Design
BCT	Behaviour Change Technique
BCW	Behaviour Change Wheel
CFS	Child-Friendly Spaces
CHAST	Child Hygiene and Sanitation Training
COM-B	Capability, Opportunity, Motivation, Behaviour
DALY	Disability-Adjusted Life Year
ELRHA	Enhanced Learning and Research for Humanitarian Assistance
FOAM	Focus on Opportunity, Ability, Motivation
GBD	Global Burden of Disease
GDP	Gross Domestic Product
HWWS	Handwashing With Soap
IBM-WASH	Integrated Behavioural Model for Water, Sanitation and Hygiene
IDP	Internally Displaced Persons
JMP	Joint Monitoring Programme
KAP	Knowledge, Attitudes, and Practice
LMIC	Low- and Middle-Income Country
LSHTM	London School of Hygiene and Tropical Medicine
NGO	Non-governmental Organisation
RANAS	Risk, Attitudes, Norms, Abilities and Self-regulation
RCT	Randomised Controlled Trial
SDG	Sustainable Development Goal
STH	Soil-Transmitted Helminth
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

CHAPTER 1

Introduction to the Thesis

HWWS is an important public health intervention that can reduce the transmission of various infectious diseases; particularly water, sanitation, and hygiene (WASH) related diseases. Although concentrated among children under-five, older children (age 5-14) also bear a large burden of these diseases (1). Older children begin to take agency over the cleanliness of their own hands and so promoting HWWS among this age group is essential. This is especially so in humanitarian emergency settings where disease risk is heightened due to overcrowded and unsanitary conditions (2, 3). There is a need for effective HWWS promotion interventions for older children in humanitarian emergencies. However, there have been few studies among this age group, and it is unclear how best to promote HWWS among older children in the context in which these interventions are designed and implemented (4). This PHD research aims to address this need.

PhD Research Context

In 2016, following an earlier collaboration on a scoping study which found ‘a large gap in knowledge and practice when implementing emergency WASH interventions for children’ (5) and a subsequent systematic review which applied a more formal lens (4), Save the Children approached me, in my capacity at LSHTM, to design and pilot an innovative HWWS promotion intervention targeting children between the age of 5 and 12 in a humanitarian emergency setting. The intervention was intended to be simple and rapidly deployable, requiring minimal training for hygiene promoters, and consisted of a soap with a toy embedded inside that aims to encourage children to practice HWWS more frequently. The concept was simple - the more a child washes their hands with the soap the faster they will reach the toy inside. It was hypothesised that the intervention would increase HWWS by appealing to a child’s inherent motives of play and curiosity. Play and curiosity often feature in behaviour change interventions targeting children, usually to encourage their participation in intervention activities. However, we do not know if interventions appealing to the motives of play and curiosity are an effective way to change handwashing behaviour among older children, particularly in emergency settings, or if children’s behaviour may be driven more strongly by different motives.

More broadly, the systematic review mentioned above, undertaken prior to my PhD registration, aimed to determine the effectiveness of HWWS interventions targeting children in low and middle-income countries (LMICs) but instead highlighted a large gap in knowledge on how best to promote HWWS among children in humanitarian emergency settings (4). This review (Appendix A) found very few studies which met the inclusion criteria, and none were conducted in emergency settings.

Further, due to high heterogeneity across the studies, a meta-analysis was not undertaken, and conclusions could not be made as to the effectiveness of child-targeted HWWS interventions in general, or the best intervention approaches.

While it is important to assess if one individual approach is promising (i.e., it contributes to an increase in HWWS) – as part of this PhD I assess Save the Children's proposed intervention – and to build the scant evidence base, it is equally important to determine if this is among the best ways to promote HWWS to older children in humanitarian emergency settings. In these settings resources are typically very limited and the disease burden is high, so it is of fundamental importance to allocate resources in the most effective way.

Since we know the evidence base on HWWS interventions for older children in humanitarian settings is extremely scarce, it also necessary to situate this within the broader context, i.e., non-humanitarian settings, to validate the findings, which this multi-method PhD research also aims to achieve.

Research Aims and Objectives

The aim of this research is to identify potentially effective approaches to HWWS promotion interventions targeting older children with a focus on older children in humanitarian emergency contexts.

The specific objectives of this research are to:

1) Review the current behaviour change techniques used across hand hygiene interventions targeting older children and assess their relative effectiveness.
2) Identify the motivational drivers and other determinants of handwashing behaviour among older children in a humanitarian emergency context.
3) Test the use of play and curiosity motives in a rapidly deployable HWWS intervention for older children in an emergency context.
4) Understand NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children.

Thesis Components

This thesis is presented using a research paper style format and comprises of six chapters, including this one, as summarised below.

Chapter 1 is an introduction to the PhD thesis. The chapter covers the context in which the PhD research is set, and the aim and objectives of the research.

Chapter 2 is a literature review covering the public health impact of HWWS and HWWS interventions, with a focus on older children in humanitarian emergencies. In this chapter, I also discuss in detail the main inspiration for this PhD thesis – a systematic review I undertook prior to PhD registration which highlighted a paucity of evidence around HWWS interventions targeting older children. This published systematic review is included in Appendix A.

Chapter 3 presents the results of a published systematic review of the effectiveness of behaviour change techniques (BCTs) used in hand hygiene interventions targeting older children. In this systematic review, a standard taxonomy was used to identify and classify BCTs employed in hand hygiene interventions. A novel approach was subsequently used to assess each BCT's contribution to intended intervention outcome and determine their relative effectiveness. The review was published in Social Science and Medicine in May 2021.

Chapter 4 presents the results of a published mixed-methods study exploring motivational drivers and other key determinants of handwashing behaviour among older children living in an IDP camp in Northern Iraq. Semi-structured interviews were conducted with older children, caregivers, and hygiene promoters, and then thematically analysed to identify key determinants. A quantitative rating exercise of a predefined set of key motives included in the Behaviour Centred Design approach was also completed by older children to determine each motive's relative importance to the children. The study was published in PLOS ONE in February 2020.

Chapter 5 presents the results of a proof-of-concept study testing a novel motivation-based, HWWS intervention delivered to older children in an IDP camp in Northern Iraq. This controlled before-after study assessed the effect of the intervention on older children's HWWS behaviour after one month. The intervention was designed with the intention of appealing to the motives of play and curiosity and involved the distribution of a modified soap bar with a visible toy inside (now named Surprise Soap) within a household-level, rapidly deployable, HWWS promotion session. Note that the studies presented in Chapter 4 and Chapter 5 were conducted within the same IDP camp to allow triangulation of findings; however, participants from each study were independent. The study was published in the International Journal of Hygiene and Environmental Health in September 2018.

Chapter 6 presents a paper prepared for publication which reports the results of a qualitative exploration of NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children. This study involved a thematic analysis of twenty-five in-depth, semi-structured interviews with NGO practitioners involved in designing, coordinating, implementing, or evaluating HWWS interventions targeting older children in development and humanitarian settings. This paper has been submitted to Global Health: Science and Practice.

Chapter 7 synthesizes the findings of the research, discusses its strengths and limitations as a body of work, includes recommendations for future HWWS interventions for older children, and proposes a future research agenda.

Appendices complement the body of the thesis, with supporting information related to each chapter.

Intellectual Ownership, Funding, and Ethical Approval

As mentioned above, Save the Children conceived the idea to embed toys inside of bars of soap to increase children's rates of HWWS. I was responsible for designing all other aspects of the intervention – specifically, the household session in which the soaps were distributed, and key activities designed to engage children. I led the design, implementation, data collection, and analysis of the proof-of-concept study in which this intervention package was evaluated. All other elements of research in this thesis were led by myself, with support and advice from my supervisors, advisory committee, and upgrading examiners. The Save the Children country office in Iraq provided logistical support to carry out the field work, including connecting me with hygiene promoters, supporting with hiring enumerators, and identifying households in the camp.

The proof-of-concept study (Chapter 5) and the study exploring the determinants of older children's handwashing behaviour (Chapter 4) were funded by a grant from the Humanitarian Innovation Fund, via ELRHA (Enhanced Learning and Research for Humanitarian Assistance). Both studies were undertaken as part of my role as a Research Fellow at the London School and Hygiene and Tropical Medicine (LSHTM). Research related to the systematic review (Chapter 3) and the exploration of NGO practitioner perspectives on the challenges to HWWS interventions (Chapter 6) were not funded and were undertaken independent of my LSHTM role.

All research activities presented in this thesis received the necessary ethical approvals from the LSHTM Ethics Review Committee and from Ethics Review Committees in the countries where the

research was implemented. Ethical approvals for research activities are detailed below and approval certificates can be found in Appendix H:

- Systematic review on the effectiveness of hand hygiene interventions (Chapter 3) – ethical approval not required.

- Handwashing determinants study (Chapter 4) – ethical approval granted from LSHTM (reference number: 14483) and Hawler Medical University (reference number: 1/16).

- Proof-of-concept study (Chapter 5): ethical approval granted from LSHTM (reference number: 14483) and Hawler Medical University, Iraqi Kurdistan (reference number: 1/16).

- Study on perceived challenges to HWWS interventions targeting older children (Chapter 6) – ethical approval granted from LSHTM (reference number: 14483).

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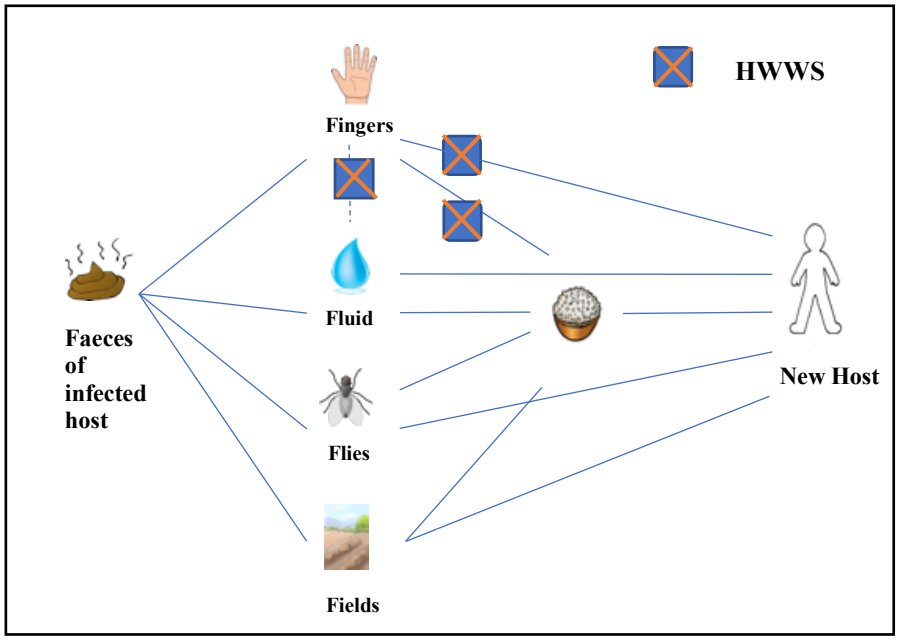
CHAPTER 2

Background

HWWS as a Public Health Intervention

HWWS is a key barrier to the transmission of a number of pathogens, including enteropathogens transmitted via faecal-oral pathways – a common cause of diarrhoeal disease (1). The F-diagram, first published by Wagner and Lanoix in 1958 (2), depicts the multiple transmission pathways of pathogens from the faeces of an infected host to a new susceptible host. This includes ingestion of food and water contaminated by faecal matter, person-to-person contact, and direct contact with infected faeces. By removing potentially harmful pathogens from hands, HWWS can intercept several of these pathways, directly (3), or indirectly, reducing the risk of diarrhoeal disease (Figure 1).

Figure 1: The F-Diagram



F diagram representing faecal-oral pathogen transmission pathways and handwashing as a transmission barrier. Adapted from Wagner and Lanoix, 1958 (1) and Kawata 1978 (2)

Despite substantial improvements in global health over the past three decades, diarrhoea is still ranked in the top ten causes of death and disability among all ages. Globally, diarrhoea was responsible for over 1.5 million deaths and over 80 million disability-adjusted life years (DALYs) in 2019 (4). Practising HWWS can reduce the risk of diarrhoea by between 23% to 48% (5-11) and of the overall burden of diarrhoeal disease by approximately 12% (12).

HWWS is also important in disrupting the transmission of acute respiratory infections (ARIs), another leading cause of death and disability. Although ARIs are primarily transmitted via the airborne route,

viruses and bacteria can also shed via the nose, mouth and anus and contaminate hands or objects (13). In 2019, ARIs were responsible for more than 2 million deaths and over 100 million DALYs, globally (4). HWWS can reduce the risk of ARIs by between 16% and 23% (14, 15) and overall disease burden of ARIs by approximately 13% (12).

The potential for large public health gains and the relatively low cost of HWWS means that HWWS promotion is ranked as one of the most cost-effective of all public health interventions (16-18). The cost of averting one DALY through hygiene promotion, including HWWS promotion, is just US$3.35 (19). The UN Sustainable Development Goals (SDGs) also recognises HWWS as crucial to achieving better health; SDG target 6.2 is to 'by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations' (20).

The WHO/UNICEF Joint Monitoring Programme (JMP) reports country, regional and global estimates of progress on drinking water, sanitation, and hygiene (WASH) and is responsible for assessing progress toward achieving SDG 6.2. The presence of a handwashing facility with soap and water on-premises has been identified as the priority indicator for global monitoring of hygiene. Households with a handwashing facility with soap and water available on-premises meet the criteria for a basic hygiene service. In 2020 the JMP reported that only 71% of the global population had access to basic hygiene services. This leaves 2.3 billion people who lacked basic hygiene services, including 670 million people with no handwashing facilities at all. Most of these people live in LMICs (21).

The Importance of Targeting HWWS Interventions at Older Children

Most deaths attributable to diarrhoeal disease and ARIs occur in children under-five, however, older children (classified here as age 5-14, and based on categories in the Global Burden of Disease studies (4)) also bear a substantial burden of these diseases. Globally, diarrhoeal diseases and ARIs are the third and fourth leading causes of mortality in older children accounting for over 14% (95,000) of deaths in this age group (4). In 2019, older children lost over 7.5 million years of life to diarrhoea and ARIs – over 33% of the total years of life lost (YLL) among this age group (4). Diarrhoea and ARIs are also responsible for over 10.5 million DALYs among older children, accounting for 12% of all DALYs caused by these diseases (4). HWWS can directly reduce the burden of these diseases.

The public health benefits of improving HWWS among older children extend beyond the reduction of diarrhoeal disease and ARIs. HWWS has also been linked to the reduction of a number of diseases

where the burden is greatest among older children, including trachoma (22) and some soil-transmitted helminth (STH) infections (23-26). There is also evidence to suggest that combined WASH interventions, which include HWWS, may have a small effect on longer term consequences among older children, such as undernutrition (27), although more recent studies have cast doubt on this (28-30). Rates of school absenteeism among older may also reduce with improved HWWS (31-35) and the reduced absence may be linked to improved academic attainments (36, 37) which in turn, is linked to economic and health benefits later in life (38).

HWWS interventions aimed at reducing infectious disease transmission among young children (under five) are predominately targeted at their caregivers – a logical approach considering they assume responsibility for much of the child's behaviour. Older children are gaining more independence. They are likely joining or are already in school and have more responsibility for their own behaviour, including washing their hands. Directly targeting interventions at these children to encourage them to practice HWWS is therefore of great public health importance.

Delivering HWWS interventions to older children can also achieve benefits external to the recipient child. Older children may act as effective agents of change for behavioural practices in the community and can take an active role in their handwashing practices as well as that of other family members (39-43). Further, children who adopt good handwashing practices from a young age may be more likely to take these habits into adulthood and transfer skills, knowledge and practices on to their future families (44-47).

Handwashing Practices Among Older Children

Despite the well-known public health benefits of HWWS, rates of HWWS are low. The most recent study estimates that, in 2015, only 26% of potential faecal contact events (i.e., using a sanitation facility or cleaning a child's excreta) were followed by HWWS, globally (48). This estimate is based on data restricted to observed handwashing occasions among adults. There is limited data available on the prevalence of HWWS among older children. However, an earlier study which included the available data estimated global prevalence of HWWS after faecal contact to be just 19% (6). This suggests that older children's HWWS may be lower than that of adults. The true prevalence of HWWS may be even lower than these published estimates due to the inherent difficulties in measuring handwashing behaviour. Although the above estimates were based on data from structured observations which are considered the gold standard for measuring handwashing behaviour (49), they are still at risk of bias as people tend to alter their behaviour in the presence of an observer (50-52). This bias is likely to lead to some inflation of HWWS estimates.

Global monitoring of SDG 6.2 shows that many older children lack access to a handwashing facility with soap and water. Not only are there billions of people, including older children, who lack access to a basic hygiene service in the home but JMP monitoring in schools finds that 19% of schools lack soap at their handwashing facilities and 25% of schools have no handwashing facilities at all (53). Given that people without access to a designated handwashing facility are half as likely to HWWS after potential faecal contact (48), these JMP figures may also be indicative of low rates of HWWS among older children.

Handwashing in Humanitarian Emergencies

A humanitarian emergency is 'an event or series of events that represent a critical threat to the health, safety, security or wellbeing of a community or other large group of people, usually over a wide area' (54) and can be caused by natural disasters such as earthquakes and floods and/or man-made disasters such as armed conflicts.

In humanitarian emergencies public health infrastructure is often compromised and emergencies are commonly characterized by overcrowded living conditions, a lack of access to safe and sufficient quantities of water, sanitation, and basic health services, increased exposure to disease vectors and food insecurity (55-58). In this fragile and highly contaminated environment, the risk of infectious disease transmission is high, thereby threatening the health of already vulnerable populations (59).

Practising HWWS in these settings is crucial to reduce disease transmission. Studies evaluating the impact of HWWS in humanitarian emergencies are extremely scarce and have focussed on adults. However, the few studies available have reported significantly positive impacts, as in stable settings. In a Malawi refugee camp, regular soap provision was associated with a 27% reduction in diarrhoea (60) and studies have shown HWWS can reduce the odds of contracting cholera by 80% during an outbreak (61, 62).

As in stable settings, HWWS prevalence in humanitarian emergencies is low, even when soap is available. A study among refugees in South Sudan reported that, while most households had access to adequate soap and water, and HWWS was promoted, fewer than half practised HWWS after toilet use (63). An earlier study conducted in three long-term refugee camps in Thailand, Kenya, and Ethiopia, also found that the proportion of defecation events followed by HWWS was just 20% across all three camps (64).

Heightened Need for HWWS Interventions Targeting Older Children in Humanitarian Emergencies

Children can constitute more than 50% of a crisis-affected population (55). High rates of malnutrition among this population elevate their susceptibility to infectious diseases such as diarrhoea and ARIs (65). Mortality studies among older children in humanitarian emergencies are rare but are concordant with studies in stable settings reporting diarrhoea and ARIs among the leading causes of death in this age group. Overall, diarrhoea can account for more than 40% of all deaths in an acute humanitarian emergency (57) and ARIs account for up to 30.8% of deaths in older children (66). HWWS interventions targeting older children in emergencies therefore represent an especially important public health intervention. However, despite the great need, the prevalence of HWWS among older children in humanitarian emergencies is even lower than that of adults; one study found that refugee children under-15 practised 1.27 times less HWWS than their older counterparts (63).

Current Evidence on the Effectiveness of HWWS Interventions Targeting Older Children

In 2017 I published a systematic review on the effectiveness of hygiene promotion interventions targeting children in LMICs (67). This was the first systematic review to explore the effectiveness of child-targeted hygiene promotion interventions in LMICs. The review highlighted limited evidence on HWWS interventions targeting children, their overall effectiveness, and which approaches work best. The review included published studies reporting randomised controlled trials (RCTs), non-randomised controlled trials, and concurrently controlled before-after studies evaluating the effect of child-targeted hygiene promotion interventions on diarrhoea, soil transmitted helminth infections, and hygiene behaviour. Only eight studies met this inclusion criteria, reflecting a lack of high-quality studies on hygiene promotion interventions for children. All eight studies promoted HWWS among older children attending primary school, and each intervention employed different strategies. Mixed results were reported across the studies and, due to the heterogeneity of both the intervention components and reported outcomes, a meta-analysis was not possible. This meant that the effectiveness of hygiene promotion interventions for children could not be assessed, nor could recommendations as to the most effective approaches be made. Further, as the focus of the review was on assessing the effectiveness handwashing intervention generally, individual intervention components were not categorised using a standard taxonomy which could facilitate comparison.

The intervention components for studies included in the review are shown in Table 1 and study outcomes and effects are shown in Table 2 according to original classifications in the review. The published version of the review is included in Appendix A.

Table 1: Approaches to HWWS Interventions Targeting Children

Study	Intervention Components
Al-delaimy 2014 (68)	Fun activities (comic books, drawing, puppet shows, nursey song videos, mascot)
Bieri 2013 (69)	Educational cartoon, group discussions, drawing and essay competitions
Bowen 2007 (70)	Standard intervention: 40-minute classroom session (animated videotape, hygiene competition, posters) Expanded intervention: standard intervention + peer handwashing monitors
Graves 2011 (71)	Poster design competition
Gyorkos 2013 (72)	60-minute class on STH transmission and prevention and poster display
Nicholson 2014 (73)	Fun activities (songs, poems and stories), environmental cues (wall hanger etc.), HWWS rewards (stickers, toys, animals etc.), children encouraged to advocate HWWS at home, HWWS pledges for children and mothers and 'Best Mums' club.
Pickering 2013 (74)	Distribution of hygiene promotion kits for teacher-use (posters, stickers, classroom activities, DVD, promotional songs)
Talaat 2011 (33)	Fun activities (e.g., games), poster displayed near sinks, songs. Supervised HWWS twice daily.

Table 2: Study Outcomes and Effects

Outcome	Study	Outcome Measurement	Outcomes measured	Positive Effect
BEHAVIOUR	Al-delaimy 2014 (68)	KAP survey	Washing hands before eating	✓
			Washing hands after defecation	✓
			Washing hand with soap	✓
	Bieri 2013 (69)	Observations	Washing hands after toilet	✓
	Graves 2011 (71)	Observations	Handwashing	×
	Gyorkos 2013 (72)	KAP survey	Washing hands after toilet	×
			Using soap when washing hands after toilet	×
			Washing hands before eating	×
			Using soap when washing hands before eating	

Outcome	Study	Outcome Measurement	Outcomes measured	Positive Effect
	Nicholson 2014 (73)	Soap wrapper collection	Soap consumption	✓
	Pickering 2013 (74)	Observations	***Soap Intervention***	
			Hand cleaning after toilet use	×
			Soap intervention – hand cleaning before eating	×
			Hand Sanitizer Intervention	✓
			Hand cleaning after toilet use Before eating	×
DIARRHOEA	Bowen 2007 (70)	Teacher records	***Standard Intervention***	
			Diarrhoea Incidence	×
			Expanded Intervention	
			Diarrhoea Incidence	×
	Nicholson 2014 (73)	Caregiver interviews	<u>Predictive relative risk reduction (Intention to treat analysis)</u>	
			Target children	×
			Children aged ≤ 5 (non-target)	✓
			Children 6-15 (non-target)	✓
			Whole families	✓
	Pickering 2013 (74)	Student interviews	***Soap Intervention***	
			Diarrhoea prevalence	×
			Sanitizer Intervention	
			Diarrhoea prevalence	×
	Talaat 2011 (33)	Teacher records	School absence due to diarrhoea	✓
STH	Al-delaimy 2014 (68)	Laboratory analysis	*A. lumbricoides* re-infection	×
			A. lumbricoides infection intensity	✓
	Bieri 2013(69)	Laboratory analysis	STH Incidence	✓
			STH infection intensity	×
	Gyorkos 2013(72)	Laboratory analysis	*A. lumbricoides prevalence*	×
			A. lumbricoides infection intensity	✓
KNOWLEDGE	Al-delaimy 2014 (68)	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓
	Bieri 2013 (69)	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓
	Gyorkos 2013(72)	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓

Importantly, the 2017 systematic review found no studies conducted in humanitarian emergency settings, representing another critical gap in the literature.

In humanitarian emergencies, HWWS promotion is typically undertaken by relief agencies. These relief agencies, mostly international non-governmental organisations (NGOs) and United Nation (UN) agencies, typically provide training manuals and tool kits to guide local staff in hygiene (including handwashing) promotion activities. Approaches recommended by these agencies often focus on educating children on the links between hygiene and health delivered via a range of methods including traditional, didactic messaging, Child Hygiene and Sanitation Training (CHAST), child-to-child approaches, peer education, and school health clubs (75).

These recommended and practiced approaches, however, are not supported by evidence of their effectiveness. There has been very little published systematic examination of the specific strategies employed by agencies during humanitarian emergencies, even for adult-targeted interventions. Existing systematic reviews of WASH interventions in humanitarian emergencies have all highlighted the extremely limited number of HWWS studies conducted in such settings (60, 76-79) and none of the HWWS interventions evaluated in these studies targeted older children.

Although published evaluations of HWWS interventions targeting older children in humanitarian emergency settings are scarce, prevailing high rates of disease and low prevalence of HWWS among older children in these settings indicates that they lack effectiveness. According to a growing number of WASH researchers, health is not an effective motivator of behaviour change outside of disease outbreaks (80-83). Given we know that these interventions often focus on delivering health-related messages, this may be one reason for their lack of effectiveness. Health messages are also difficult to deliver consistently and are dependent on well trained, skilled delivery staff (84, 85). Two challenges to implementing HWWS interventions in emergencies, according to humanitarian WASH professionals, are the demand they put on time and labour resources, making them difficult to scale (86). These challenges may well be a function of interventions focusing on health-related messaging and are particularly pertinent in humanitarian emergencies, where resources are limited (87, 88).

Alternative intervention approaches to HWWS interventions targeting older children in humanitarian emergencies are needed that are effective, simple to implement, and rapidly deployable, but it is still not clear what these approaches are.

Theory-based Approaches to Designing Handwashing Interventions

Behaviour scientists argue that interventions may be more effective when informed by behavioural theory (89-92). To aid the design and evaluation of WASH interventions, a number of theoretical models and frameworks have been developed. These models and frameworks draw on multiple social, psychological, and behavioural theories (93-96) to explain the wide range of determinants that influence WASH behaviours and WASH behaviour change.

A behavioural determinant is any factor that strongly influences and affects behaviour. While operationally distinct, the determinants identified in each of these theoretical models and frameworks largely align. Most consider aspects related to the individual (psychological determinants) as well as aspects of their social and physical environment. Examples of such models and frameworks include, FOAM (Focus on Opportunity, Ability, Motivation) (97), IBM-WASH (Integrated Behavioural Model for Water, Sanitation and Hygiene) (98), and RANAS (risk, attitudes, norms, abilities and self-regulation) (99). These models and frameworks all aim to identify determinants of WASH behaviours, and some (e.g., RANAS) offer specific strategies to modify determinants to change behaviours.

For a behaviour change intervention to be effective, at least some of the determinants of the target behaviour must be addressed (97-100). While there are no published studies on the determinants of children's handwashing behaviour in humanitarian emergencies, several studies have reported on determinants of children's handwashing in stable settings. These studies have been almost exclusively school-based. Some used theoretical approaches to identify or explain determinants, but most do not. Though termed differently across these studies, in general, the determinants of children's handwashing behaviour in stable settings are reported to include: 1) sufficient time to wash hands – related to whether children have competing priorities; 2) attractiveness, accessibility, and cleanliness of facilities – determining if facilities are desirable, 3) social norms, including adult modelling of regular handwashing behaviours; 4) daily school routines to set HWWS as a social norm; 5) individual health-related knowledge about HWWS; 6) knowledge of how and when to practice HWWS, reflecting perceived self-efficacy and; 7) motivation to perform HWWS (101-108). The relative salience of these determinants will vary between individuals and across settings. Studies are needed in humanitarian emergencies to understand what the determinants of children's handwashing are in these settings.

Two theoretical approaches to the design and evaluation of behavioural interventions that were used at multiple stages of this thesis are the Behaviour Centered Design (BCD) approach and the Behaviour Change Wheel (BCW) (100). BCD has been used in the design, implementation, and evaluation of successful behaviour change interventions, including HWWS (109). This approach provides both a theory of change and five-step process for designing, implementing, and evaluating interventions. The BCD approach builds on the Evo-Eco theory which is based on the insight that

brains evolved to provide adaptive behavioural responses to rapidly changing or complex environmental conditions (110). The Evo-Eco theory describes the factors that affect behaviour within the brain, body, and environment and the influence of behavioural settings, an idea first put forward by the ecological psychologist Rodger Barker in the 1950s (111). The Evo-Eco theory postulates that 15 human motives, shown in Figure 2, have evolved to drive behaviour in all human experiences and solve evolutionary important goals, for example, finding food or a long-term mate. A more recent study has validated the existence of these motives (112). It is argued that by identifying the motives that can be associated with the target behaviour and designing an intervention in which practising the behaviour fulfils these motives, the target behaviour can become a habit via reinforcement learning (113).

Figure 2: The Human Motives (Evo-Eco Theory)

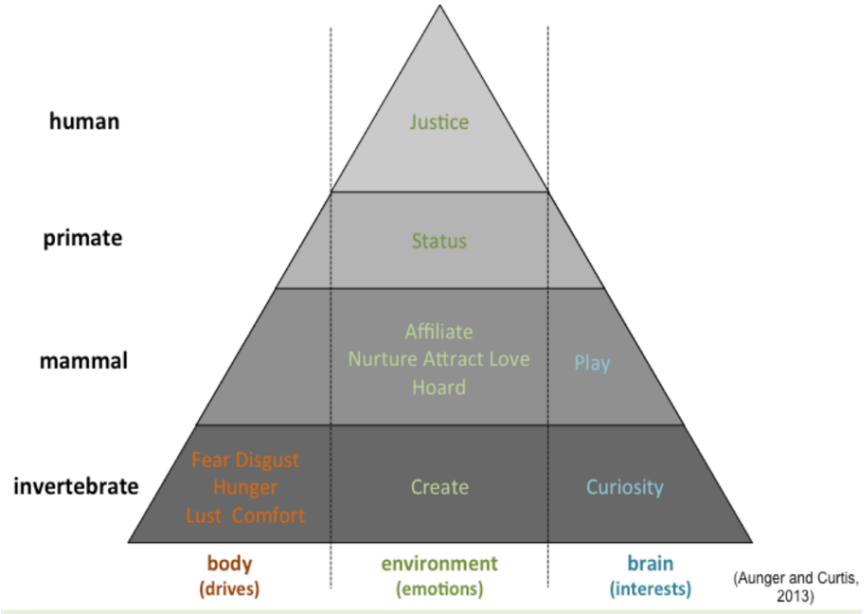
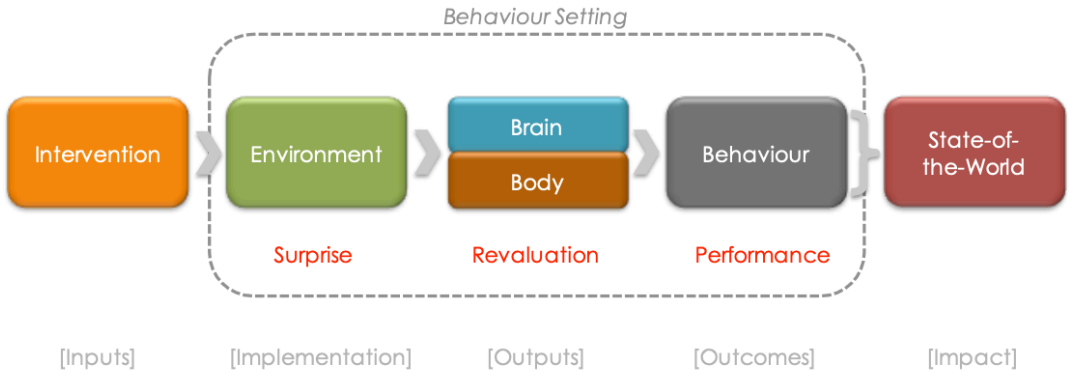


Image sourced from Aunger and Curtis 2013 (110)

The BCD Theory of Change pictured in Figure 3 elaborates on this, positing that behaviour change will occur when an intervention disrupts settings with a surprising new stimulus which is counter to the brain's predictions, forcing revaluation of the target behaviour (either by making existing motives more salient or by adding new motives to a behaviour), such that new behavioural performances result, and are presumably rewarded (100).

Figure 3: Behaviour Centred Design: Theory of Change

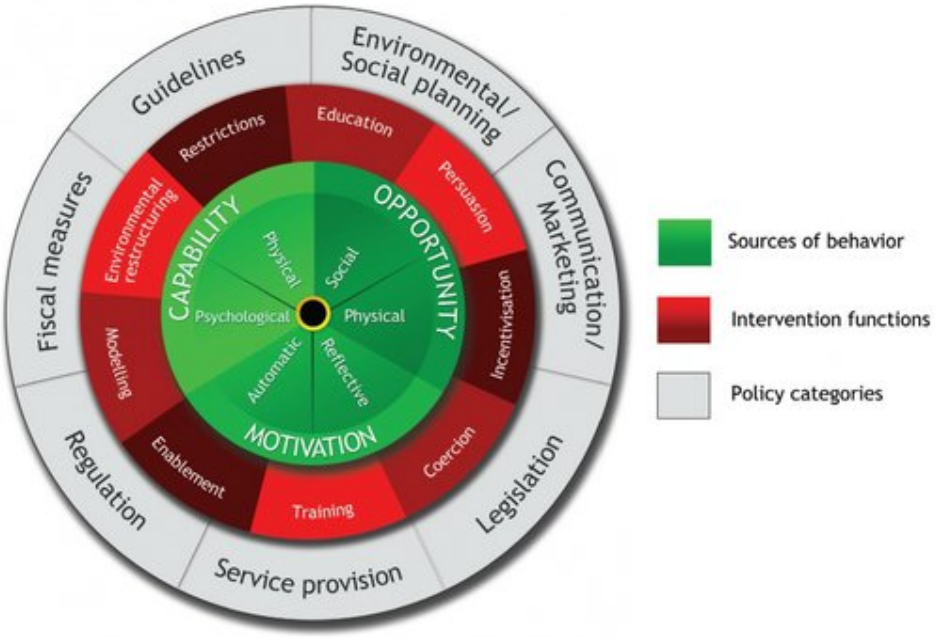


(Image sourced from: Aunger and Curtis, Health Psychology Review. 2016; 10(4): 425–446)

One published and frequently cited example of the application of the BCD approach is the SuperAmma Trial (109). This trial tested a novel intervention that did not use health messaging but instead focused on the motives of disgust, nurture, and affiliation to change handwashing behaviour. The evaluation found a 28% increase in HWWS at 12-months' follow-up providing evidence in support of motive-based strategies. The SuperAmma Trial predominately targeted adults. We do not yet know if human motives can be harnessed to improve children's HWWS behaviour. If so, it would be key to target motives that are most important for children. The concept of using motives to address HWWS in older children directly informed Chapter 4 and Chapter 5 of this thesis.

The Behaviour Change Wheel (BCW) is a consensus-based synthesis of nineteen behaviour change frameworks and draws on a wide range of disciplines and approaches. It provides a systematic way of identifying relevant intervention functions (broad strategies for inducing the target behaviour) and policy categories (ways to support and implement these strategies) based on what is understood about the target behaviour. At the core of the BCW is the Capability, Opportunity, Motivation, Behaviour (COM-B) model of behaviour which considers different influences on behaviour. The COM-B model postulates that interactions between an individual's capability, opportunity, and motivation determines a person's behaviour. Surrounding the core of the BCW is a layer of nine intervention functions, each with the ability to affect at least one of the underlying factors of behaviour (COM). The outer layer – the rim of the wheel - identifies seven policy categories that can support the delivery of these intervention functions.

Figure 4: The Behaviour Change Wheel



(Image sourced from: Michie et al, Implementation Science, 2011)

To operationalise the BCW, the nine general intervention functions can be translated into behaviour change techniques (BCTs) using Michie and colleagues' taxonomy of BCTs (114). BCTs are the smallest observable and replicable components of behaviour change interventions that on their own have the potential to change behaviour and can be used individually or in combination (115). They are the 'active ingredients' of an intervention. Michie and colleagues' BCT Taxonomy Version 1 collates a list of 93 distinct, consensually agreed BCTs (114). Each of these BCTs can be linked to one or more of the intervention functions and specify the content of an intervention.

The BCT taxonomy can also be used to categorise intervention components in existing interventions. For example, this taxonomy has been used to categorise and assess intervention components in physical activity and healthy eating (116), diabetes (117), gestational weight (118) and cardiac rehabilitation (119). Categorising and testing components enables the design of better interventions by identifying and incorporating the most effective components (i.e., active ingredients) into new interventions. There are no equivalent examples of this in the field of HWWS promotion for children, leaving a gap in our knowledge of which BCTs work best to change children's handwashing behaviour. In Chapter 3 of this thesis the BCT taxonomy is used to categorise intervention components in hand hygiene interventions targeting older children.

The effectiveness of HWWS interventions is not just dependant on the BCTs it employs. As depicted by the outer layer of the BCW, and in the other behaviour change frameworks and models mentioned, there are many other external factors that determine an intervention's effectiveness. Several studies have explored wider contextual factors influencing the effectiveness of school-based handwashing interventions in stable settings. Beyond the availability of handwashing hardware (a common issue in schools in LMICs) (106, 120-123), a lack of human capacity, technical capacity, insufficient funding, institutional support, and intervention fidelity and adherence are all contextual factors thought to hinder the effectiveness of HWWS interventions targeting children in schools (120, 124, 125). The contextual factors influencing HWWS interventions targeting older children in humanitarian settings, in and out of schools, must also be understood and this knowledge applied to the design of future interventions.

Literature Synthesis

Given the: (a) clear public health benefit of HWWS, (b) low prevalence of HWWS among older children, (c) high burden of WASH-related infectious disease in older children, (d) lack of knowledge about the key drivers of handwashing behaviour among older children, and (e) the challenges of implementing HWWS interventions in emergency settings, research is needed to identify the best approaches to HWWS promotion for older children to support the efficient allocation of limited resources available in an emergency response. This PhD research addresses this gap in knowledge.

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CHAPTER 3

Research Paper 1: Effectiveness of behaviour change techniques used in hand hygiene interventions targeting older children – A systematic review

The research paper presented below addresses research objective 1): review the current behaviour change techniques used across hand hygiene interventions targeting older children and assess their relative effectiveness.

The systematic review was inspired by Gardner et al.'s 2016 review of behaviour change strategies used in sedentary behaviour reduction interventions among adults. Authors used a standard taxonomy to identify BCTs and a novel promise ratio to quantitively compare these BCTs because a meta-analysis was deemed not possible (1). Past reviews of handwashing interventions, including my 2017 review, have often been unable to perform meta-analyses because of high heterogeneity among interventions - from the techniques employed, to the delivery setting, and the measured outcomes. Given this is the reality of the available literature, the need for a new approach to quantitively synthesising handwashing intervention data was clear and the promise ratio approach had yet to be adopted in reviews of handwashing studies. Given the authors of Gardner et al recognised that their findings were weakened by the inclusion of low-quality studies, and as it was also necessary to include studies of varying quality in my review, I expand Gardner's analysis methodology to incorporate a risk of bias weighting which accounts for this as much as possible.

Note that this review refers to 'hand hygiene' rather than HWWS as this encompasses both HWWS and disinfecting hands with hand sanitiser. There is likely little difference in intervention techniques used to promote HWWS and use of hand sanitiser and, as the availability of published HWWS intervention studies is limited, expanding the inclusion criteria to hand hygiene interventions would capture more data.

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Effectiveness of behaviour change techniques used in hand hygiene interventions targeting older children – A systematic review

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ABSTRACT

Background: Promoting good hand hygiene in older children is an important measure to reduce the burden of common diseases such as diarrhoea and acute respiratory infections. The evidence around what works to change this behaviour, however, is unclear.

Objectives: To aid future intervention design and effective use of resources, this review aims to identify the individual components used in hand hygiene interventions and assesses their contribution to intended behavioural change.

Methods: We systematically searched seven databases for experimental studies evaluating hand hygiene interventions targeting children (age 5–12) and quantitively reporting hand hygiene behaviour. Interventions in each study were categorised as 'promising', or 'non-promising' according to whether they led to a positive change in the targeted behaviour. Behaviour change techniques (BCTs) were identified across interventions using a standard taxonomy and a novel promise ratio calculated for each (the ratio of promising to non-promising interventions featuring the BCT). 'Promising' BCTs were those with a promise ratio of ≥2. BCTs were ranked from most to least promising.

Results: Our final analysis included 19 studies reporting 22 interventions across which 32 unique BCTs were identified. The most frequently used were 'demonstration of the behaviour', 'instruction on how to perform the behaviour' and 'adding objects to the environment'. Eight BCTs had a promise ratio of ≥2 and the five most promising were 'demonstration of the behaviour', 'information about social and environmental consequences', 'salience of consequences', 'adding objects to the environment', and 'instruction on how to perform the behaviour'.

Conclusions: Our findings suggest that hand hygiene interventions targeting older children should employ a combination of promising BCTs that ensure children understand the behaviour and the consequences of their hand hygiene habits, appropriate hardware is available, and social support is provided. Researchers are encouraged to consistently and transparently describe evaluated interventions to allow promising components to be identified and replicated.

1. Introduction

Hand hygiene is a critical measure for the prevention of communicable disease. Handwashing with soap alone can reduce both diarrhoea and acute respiratory infections (ARIs) by over 20% (Aiello et al., 2008; Cairncross et al., 2010; Freeman et al., 2014; Wolf et al., 2018) and has been linked to the reduction of certain neglected tropical diseases such as trachoma (Stocks et al., 2014) and some soil-transmitted helminth infections (Strunzet al., 2014).

Older children - children age 5–14 as often defined in Global Burden of Disease studies (Kyuet al., 2018) - are an important target group for hand hygiene interventions. Although the greatest burden of diarrhoea and ARIs is borne by children under-five, these diseases are also some of the leading causes of mortality among older children; they account for over 19% of all deaths in this age group globally (World Health Organization, 2020).

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Evidence suggests that improving hand hygiene among older children may also reduce school absenteeism (Nandrup-Bus, 2009; Talaat et al., 2011; Willmott et al., 2015). By the age of five, children have typically begun attending school; then, they are expected to practice hand hygiene independently and can subsequently act as agents of change, passing on hygiene messages they receive to their family and peers (Adair et al., 2013; Bresee et al., 2016; Onyango-Ouma et al., 2005). Furthermore, many habits established during childhood years can persist through to adulthood (Kelderet al., 1994; Movassagh et al., 2017; Pressman et al., 2014). For these reasons, effective interventions targeting older children which aim to improve their hand hygiene behaviour are likely to achieve significant public health impacts.

The rationale for targeting hand hygiene interventions at children is strong but the evidence around which intervention approaches work best is unclear (Mbakayaet al., 2017; Watson et al., 2017). Hand hygiene is influenced by different social, environmental, and behavioral determinants, which may vary from context to context, and different approaches are needed to address these determinants and change behaviour (Curtis et al., 2009; White et al., 2020). Published studies, however, often do not report which components of their interventions were successful, making it difficult to assess what works and how to best allocate resources. To aid future design and implementation of hand hygiene interventions, and to ensure the most efficient use of resources, it is important to identify the individual components of interventions that positively contribute to targeted changes in behaviour. In the behaviour change literature, these individual components are often labelled *behaviour change techniques* (BCTs) – the smallest observable and replicable components of behaviour change interventions that on their own have the potential to change behaviour; they can be used individually or in combination (Michieand Johnston, 2012).

Michie and colleagues have validated a 93-item hierarchically structured BCT Taxonomy (BCTTv1) of consensually agreed (by expert opinion), clear and distinct BCTs for specifying components of behaviour change interventions, for example, goal setting, social comparison, and habit formation (Michieet al., 2013). This taxonomy has been used to specify intervention techniques across a wide range of public health behavioural domains such as physical activity and healthy eating (Cradock et al., 2017; Samdal et al., 2017), sedentary behaviour (Gardner et al., 2016), gestational weight management (Soltaniet al., 2016), smoking (Brown et al., 2019a), cardiac rehabilitation (Heron et al., 2016), and HIV and STI prevention (De Vasconcelos et al., 2018). Although the taxonomy has been used recently to specify techniques in hand hygiene and environmental-disinfection interventions in settings likely to include children (Stanifordand Schmidtke, 2020), to our knowledge the BCTTv1 has not yet been used to assess the effectiveness of specific BCTs across hand hygiene interventions specifically targeted at older children.

In this systematic review, we aim to use the BCTTv1 to identify and classify the individual techniques used across hand hygiene interventions targeted at older children, assess their contribution to intended intervention outcomes, and determine their relative effectiveness. To navigate the problems consistently faced by past systematic reviews of hygiene interventions (Mbakayaet al., 2017; Watson et al., 2017) – namely finding too much heterogeneity across studies to perform meta-analyses or make conclusive recommendations – we have included interventions in low., middle-, and high-income countries as well as experimental study designs both with and without a control group. We then employed a novel approach to determining effectiveness – the promise ratio – first developed by Gardner et al. (2016). The promise ratio allows synthesis of heterogenous data by categorising interventions according to whether they are promising or not – i.e., whether they achieved a significant change in the intended outcome – and using these categories to assess the contribution of individual BCTs to 'intervention promise'.

2. Methods

The current systematic review is reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement (Moheret al., 2009) and a complete PRISMA checklist is available in Appendix S1.

2.1. Search strategy

Electronic searches were performed on 26 April 2020, by one reviewer (JW), using seven bibliographic databases: Medline (OvidSP interface), Embase (OvidSP interface), Global Health (OvidSP interface), IBSS, Africa-Wide Information (Ebsco Interface), CINHAL (Ebsco Interface), and Web of Science Core Collection (Web of Science interface).

The search strategy incorporated terms related to three concepts: (1) hand hygiene behaviour; (2) promotion; and (3) children. Medical Subject Headings (MeSH) terms and keywords were originally developed for the Medline database and subsequently adapted for use in the other databases using database-specific controlled vocabulary terms and search filters. A full description of the search strategy and search terms for the Medline database is included (Appendix S2). In addition to the search strategy described above, the reference lists of included articles were also hand searched for any relevant articles.

2.2. Inclusion criteria

Studies were eligible for inclusion if they met the following criteria:

Publication and language: Studies published in peer-reviewed journals on any date up to 26 April 2020 and available in English.

Types of study design: Randomised controlled trials (RCTs), non-randomised controlled trials (NRCTs), controlled before-after studies (CBAs), and before-after studies without a control group (BAs). For controlled studies, if there were multiple intervention arms and/or the control arm received an active comparator intervention, each study arm was reclassified as an individual BA study for analysis purposes.

Control group: RCTs, NRCTs, and CBAs were included if the control group received no intervention or basic standard care, or if the control group received another active comparator intervention and baseline and endline data were available to reclassify each study arm as an individual BA study. If these data were not available these studies were excluded.

Types of participants: Interventions targeting children aged 5–12 years. Note that although the term 'older children' typically refers to children age 5–14 we restricted our inclusion criteria to children age 5–12 as this range is the typical primary school age and intervention techniques adopted in primary and secondary school settings are likely highly heterogenous.

Types of settings: Studies in household, community, or school settings, in any country.

Types of interventions: Interventions aiming to change hand hygiene (defined as hand washing with soap or disinfecting hands with sanitiser).

Types of outcomes: Studies reporting a quantitative frequency measure for hand hygiene practice. Both observed and self-reported measurements were eligible for inclusion. Measures of hand hygiene technique were not an outcome of interest.

Observational studies, conference abstracts, editorials, commentaries, perspectives, short reports, case series, dissertations, and qualitative studies were not eligible for inclusion in this review. Studies with any number of children outside of the 5–12 age range were excluded. Studies specifically targeting children with an illness or disability (e.g., those with hearing impairments or learning difficulties) and studies in healthcare facilities or in any other non-school institution were also excluded to increase the generalisability of our findings. Studies in which the intervention was not well described, and where this information could not be obtained by contacting the author, were also excluded.

2.3. Data collection and analysis

2.3.1. Selection of studies

According to PRISMA guidelines, study screening and data extraction were initially conducted by one reviewer (JW) and a second reviewer (AC) cross-checked a sample of records and the extracted data for all studies. All studies retrieved from the database searches were imported into Endnote X8 (Thomson Reuters, New York, USA) and duplicates removed. Studies were screened for relevance by title and abstract, with non-eligible studies excluded. The full texts of the remaining eligible studies were subsequently assessed for inclusion and, in the case of any discrepancies, consensus was reached by discussion between the two reviewers (JW and AC). Where consensus could not be reached, a third reviewer (RD) arbitrated.

2.3.2. Data extraction and management

Data were extracted from each study in a pre-specified table recording the following information: (i) Author/s and Publication Date; (ii) Study Title; (iii) Study Design; (iv) Setting/Country; (v) Intervention Description; (vi) Study Population and Sample Size; (vii) Intervention Intensity (i.e. how much it was repeated); (viii) Length of Follow-up; (ix) Outcome Measure and method of assessment (reported or observed); and (x) Results (note: only data on our outcomes of interest were extracted).

2.3.3. Risk of bias assessment

To accommodate the multiple study designs included in the review, the risk of bias of each individual included study was assessed using an adapted combination of the tools developed by the National Heart, Lung and Blood Institute for controlled intervention studies and before-after studies with no control group (Nhlbi, 2018). Our adapted risk of bias assessment tool includes 14 items (detailed in Appendix S3). For each study, each of these 14 items were scored as 1 = 'yes', 0.5 = 'partially' (where applicable), and 0 = 'no' or 'not applicable'. The overall risk of bias in each study was subsequently calculated by summing up individual item scores, producing a risk of bias index of 0–14, with a score of 0 indicating the highest possible risk of bias and a score of 14 the lowest possible risk of bias. This scoring system restricted BA study designs to a maximum score of 10, as only ten items (items 1–10) were applicable. For BCT coding (see below), the overall risk of bias score for each study was converted to a percentage of the maximum possible score and expressed as a decimal.

2.3.4. Coding of behaviour change techniques

We used Michie's BCTTv1 framework (Michie et al., 2013) (Appendix S4), to identify and code the BCTs used in intervention and control arms of the studies. Two reviewers (JW and AC), both who had successfully completed online training for use of the BCTTv1 (www.bct-taxonomy.com), independently coded the technical content of intervention and control groups and rated each of the 93 BCTs as either present or absent. The frequency at which individual BCTs were delivered within an intervention was not coded. The target of BCTs identified with the BCTTv1 was hand hygiene, as defined above. Where interventions targeted other behaviours, only the BCTs related to the relevant target behaviour were coded. Cohen's κ was calculated to measure inter-coder agreement (McHugh, 2012). Any disagreement over BCT coding between the researchers (JW and AC) was resolved by researcher consensus and where consensus could not be reached, a third researcher (RD), also experienced in BCT coding, mediated the decision.

2.3.5. Analysis of behaviour change techniques

The analysis of BCTs took place in four consecutive steps.

Step 1: The intervention/s in each study was given an 'intervention promise rating' according to potential to improve the specified outcome. Interventions were rated as: (i) 'Promising' (= 1) if, in studies with a control group, there was a statistically significant (at $p < 0.05$) increase in the targeted handwashing behavioral outcome in the intervention group compared to the control group at endline, or, if, in studies without a control group (including studies with only comparator intervention groups, which we redefined as before-after studies) there was a statistically significant ($p < 0.05$) increase in the handwashing behavioral outcome at the endline relative to baseline; (ii) 'Non-promising' (= 0) if there was no statistically significant change at $p < 0.05$, or a negative change in the handwashing behavioral outcome. This scale is adapted from that used by Gardner et al. (2016). Unlike traditional meta-analyses which require the same outcome to be measured in the same way across studies, it enables comparison of different outcome measures across studies. Instead of using Gardener's 3-point scale ('very promising', 'quite promising' and 'non-promising'), however, we only categorised interventions as 'promising' or 'non-promising' since our additional step of weighting promise ratio by the individual study's risk of bias (see below) naturally accounts for a lack of control group. Note that if more than one measure of the behavioral outcome was reported, only the most objective outcome was used in the rating (i.e., we selected observed measures over self-reported measures).

Step 2: Following the approach by Gardener et al. (2016), after coding, a 'promise ratio' was calculated for each BCT identified across the interventions of the included studies by dividing the number of 'promising' interventions featuring a specific BCT by the number of 'non-promising' interventions featuring that BCT:

$$BCT\ Promise\ Ratio = \frac{Number\ of\ 'promising'\ interventions\ featuring\ specific\ BCT}{Number\ of\ 'non-promising'\ interventions\ featuring\ specific\ BCT}.$$

Note that, for any given controlled study, we considered only those BCTs that featured exclusively in the intervention group (i.e., they did not also feature in the control group), because intervention 'promise' could not be confidently associated with a BCT if it featured in both intervention and control group.

BCTs must have been present in at least three interventions to be included in the promise ratio analysis. This was decided because, for a BCT to be considered 'promising', it must have been used in at least twice as many promising as non-promising interventions (i.e., promise ratio ≥ 2), and when weighting BCT promise ratios by risk of bias (see next step), it would be impossible for BCTs used at a low-frequency (in ≤ 2 interventions) to be rated as 'promising' unless both studies had a perfect risk of bias rating. Where BCTs were used in only promising interventions (three or more), the number of interventions in which they were used was reported as the promise ratio.

Step 3: To account for the different study designs and the reporting and analysis of studies, BCT promise ratios were weighted according to the risk of bias across the individual studies in which they were present. Each BCT promise ratio was multiplied by the mean risk of

bias score (on a scale of 0–1) across all interventions in which that BCT was present to give the weighted BCT promise ratio.

Step 4: BCTs were then ranked from the most promising to least promising according to their weighted BCT promise ratio.

2.4. Additional analyses

The association between an intervention's promise rating and the number of BCTs used in that intervention was assessed using Firth's penalized maximum likelihood logistic regression (firthlogit) to account for the small number of interventions and the skewedness in the intervention promise ratings. The firthlogit technique uses Firth's method to impose a bias term on the standard likelihood function that is sensitive to a small number of events, ultimately reducing the estimates towards zero (Devikaet al., 2016; Firth, 1993; Gim and Ko, 2017; Heinze and Schemper, 2002; Rojas, 2018). A Welch's two-sample *t*-test was performed to determine if there was a statistically significant difference ($p < 0.05$) between the number of BCTs used in non-promising interventions compared to promising interventions.

Co-occurrence patterns of promising BCTs were described using network plots. The number of times each pair of promising BCTs occurred within the same intervention was counted. These co-occurrences were then visualised in a network plot, in which each BCT was represented by a node. The width of each edge (line joining nodes) was proportional to the total number of co-occurrences of BCTs. The size of each node was proportional to the 'promise ratio'.

2.5. Sensitivity analysis

We excluded studies without a control group (i.e., BA studies) in a sensitivity analysis to check if this affected our results.

3. Results

3.1. Search results

Database searches identified a total of 5207 articles from Medline (751), Embase (1,412), Global Health (738), IBSS (76), AWI (456), CINHAL (719), and Web of Science (1,055). No further articles were identified through reference list screening. After de-duplication, a total of 3360 articles were screened by title and abstract and 94 articles were selected for full-text screening. Applying the pre-defined inclusion criteria, 19 articles were included in the final analysis, detailing 22 interventions. The flow diagram in Fig. 1 outlines the results of the database searches and the screening process, according to PRIMSA guidelines (Moheret al., 2015). Reasons for excluding the remaining 75 articles on full-text screening are given in Appendix S5.

3.1.1. General characteristics of included studies and interventions

The Appendix summarises study characteristics; full details of the characteristics of included studies can be found in online supplemental Appendix S6.

3.2. Settings

Fifteen (79%) of the included studies were conducted in low- and middle-income countries (LMICs) and the remaining 4 studies (21%) were conducted in high-income countries (HICs), classified as such by the World Bank (World Bank, 2019). Eighteen (95%) of the 19 included studies were implemented in schools and the one remaining study was a household-level intervention in an internally displaced camp in Northern Iraq. Eleven (58%) studies were conducted in rural settings, 7 (37%) in urban settings, and 1 (5%) study in a mix of urban and rural settings. The skewedness towards rural settings was more pronounced when looking at studies in LMICs only (11 studies in rural settings vs 3 studies in urban settings) whereas all 4 studies in HICs were conducted in urban settings.

3.3. Study design

Of the 19 included studies, 9 were RCTs (6 with a cluster design), 1 was a NRCT with a cluster design, 4 were CBAs, and 5 were BAs. For BCT coding and analysis, Grover et al., 2018 (Grover et al., 2018a), a cluster RCT, was redefined as two separate BA studies due to an active comparator group. Two of the studies: Pickering et al. (2013) and Snow et al. (2008) were multi-arm trials in which all intervention arms targeted hand hygiene behaviour, as defined in this review. The intervention arms in each of these studies were analysed individually and the effect of each intervention (compared to the control group) noted for each intervention arm.

3.4. Intervention

Intervention intensity varied from a single hygiene promotion session or initial infrastructure improvements only, to repeated sessions every two weeks over a six-month period. Length of follow-up ranged from one day to one year.

3.5. Outcomes

Observation was considered the most rigorous measure of hand hygiene behaviour and was used in 14 (74%) of the included studies. In the remaining 5 studies (26%), hand hygiene behaviour was measured via self-reporting. Of the 22 interventions tested across the 19 included studies, 19 (86%) of these were classified as promising interventions (i.e., reported an increased frequency of hand hygiene behaviour). The remaining 3 (14%) interventions did not have a positive effect on hand hygiene behaviour and were classed as non-promising interventions.

3.6. Risk of bias assessment

Only one study (Lewis et al., 2018) was awarded the highest possible overall risk of bias rating of 14 (i.e., was at the lowest risk of bias). The other 18 studies had overall risk of bias ratings ranging from 4 to 11, with a mean of 7.84. Fig. 2 shows the proportion of studies at low, unclear, or high risk of bias (i.e., 'yes', 'partially', or 'no/not applicable',

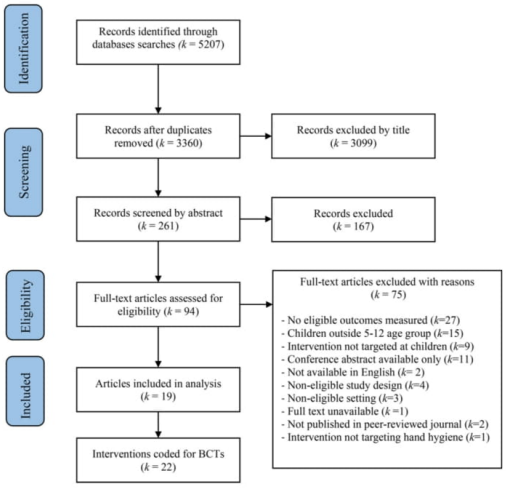

Fig. 1. Flow of studies into the systematic review.

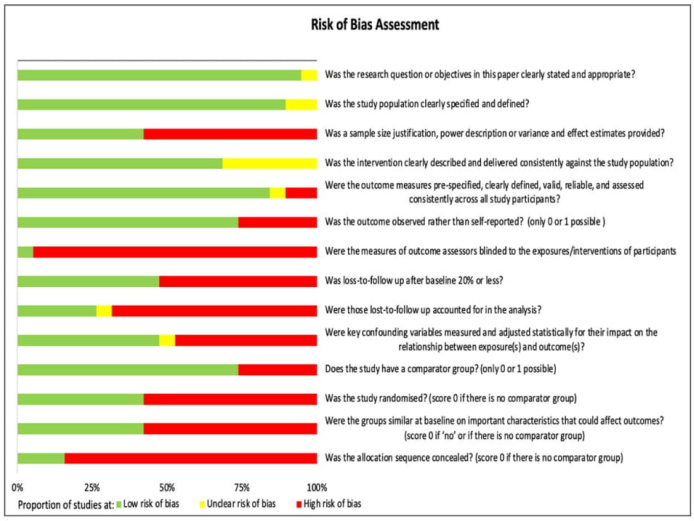

Fig. 2. Risk of bias assessment.

respectively, were the answers to the risk of bias items) for each of the 14 risk of bias items. The full assessment can be found in Appendix S7. Lack of blinding of assessors to the exposures/interventions of participants, no sample size justification, high loss-to-follow-up rates and not accounting for loss-to-follow-up in the analysis were common sources of potential bias across the studies. For controlled studies, a lack of randomisation, baseline imbalance between groups and allocation concealment were also common sources of bias.

3.7. Behaviour change techniques

We identified 32 unique BCTs from the 22 interventions included in this review, belonging to 13 of the 16 hierarchical clusters of the BCTTv1. Inter-coder agreement was almost perfect ($\kappa = 0.87$). Details of the BCTs coded in each intervention can be found in Appendix S8. The most frequently employed BCTs (coded in ≥25% of interventions (Brown et al., 2019)) were 'instruction on how to perform the behaviour' (14 interventions; 64%), 'adding objects to the environment' (13 interventions; 59%), 'demonstration of the behaviour' (12 interventions; 55%), 'information about social and environmental consequences' (8 interventions; 36%), 'prompts/cues' (8 interventions; 36%), 'salience of consequences' (7 interventions; 32%), 'behavioural practice/rehearsal' (7 interventions; 32%), 'restructuring the social environment' (7 interventions; 32%), and 'information about health consequences' (6 interventions; 27%).

The number of BCTs identified in a single intervention ranged from 2 to 16 with a mean of 6.4 (CI 6.2–6.6) BCTs per intervention. Firth's penalized maximum likelihood logistic regression analysis showed that the number of BCTs used in an intervention was negatively associated with the intervention promise rating (i.e., intervention effectiveness) (OR 0.92 $p < 0.01$), however this association was no longer statistically significant when adjusted for risk of bias in studies (OR = 0.98, $p = 0.33$). There was also a significant difference between the mean number of BCTs used in non-promising interventions (7.7 CI 7.0–8.3) and in promising interventions (6.2 CI 6.0–6.4) (Welch's 2-sample t-test (df = 321.6) = 4.3, $p < 0.01$).

It was possible to report promise ratios for 17 of the BCTs identified. The remaining 15 BCTs were excluded from the promise ratio analysis as they were used at too low a frequency across interventions (i.e., used in only one or two interventions). After adjusting for study quality, a total of 8 individual BCTs had a promise ratio of ≥2 and were therefore considered as 'promising', or most likely to enhance effectiveness of interventions to improve hand hygiene among children. The BCTs with the highest promise ratios (i.e., the most promising BCTs) were: 'demonstration of the behaviour' (adjusted promise ratio (aPR) 6.12); 'information about social and environmental consequences' (aPR = 4.31)); 'salience of consequences' (aPR = 3.73); 'adding objects to the environment' (aPR = 3.22); and 'instruction on how to perform the behaviour' (aPR = 3.22).

The 8 BCTs we found to be promising belonged to 6 of the hierarchical clusters of the BCTTv1. 'Natural Consequences' was the cluster with the highest number of promising BCTs (k = 3). The remaining 5 clusters had 1 promising BCT each. Table 1 shows the frequency of occurrence of each BCT identified across the interventions and their promise ratios.

3.8. Sensitivity analysis

Omitting studies without a control group ($k = 5$) in our sensitivity analysis revealed a few disparities between the promise ratio analyses across all studies compared to controlled studies only, but the highest ranked BCTs were similar indicating that including studies without a control group did not substantially change our results (Fig. 3).

3.9. Co-occurrence patterns of promising BCTs

Visual inspection of the co-occurrence network plot of promising BCTs suggests that three of the most promising BCTs, 'demonstration of the behaviour', 'instruction on how to perform the behaviour' and 'adding objects to the environment' all co-occur frequently with one another (Fig. 4). 'Information about social and environmental consequences' also appears to co-occur frequently with the BCTs 'demonstration of the behaviour' and 'instruction on how to perform the behaviour'. No other clear co-occurrence relationships were observable from visual inspection.

Table 1
Behaviour change technique analysis.

Behaviour Change Technique	BCT FAMILY	Total frequency across interventions	Frequency across promising interventions	Frequency across non-promising interventions	Promise ratio*	Mean Quality score	Adjusted Promise ratio**
6.1 Demonstration of the behaviour	Comparison of behaviour	12	11	1	11.00	0.556	6.12
5.3 Information about social and environmental consequences	Natural Consequences	8	7	1	7.00	0.616	4.31
5.2 Salience of consequences	Natural Consequences	7	6	1	6.00	0.622	3.73
12.5 Adding objects to the environment	Antecedents	13	11	2	5.50	0.585	3.22
4.1 Instruction on how to perform the behaviour	Shaping Knowledge	14	12	2	6.00	0.536	3.22
5.1 Information about health consequences	Natural Consequences	6	5	1	5.00	0.583	2.92
3.2 Social support (practical)	Social support	5	5	0	5.00	0.543	2.72
11.3 Conserving mental resources	Regulation	5	4	1	4.00	0.671	2.68
3.1 Social support (unspecified)	Social support	4	3	1	3.00	0.660	1.98
13.2 Framing/reframing	Identity	4	4	0	4.00	0.464	1.86
10.2 Material reward (behaviour)	Reward and threat	3	3	0	3.00	0.595	1.79
1.9 Commitment	Goals and Planning	3	2	1	2.00	0.785	1.57
12.1 Restructuring the physical environment	Antecedents	4	3	1	3.00	0.518	1.55
8.1 Behavioural practice/rehearsal	Repetition & Substitution	7	5	2	2.50	0.612	1.53
12.2 Restructuring the social environment	Antecedents	7	5	2	2.50	0.576	1.44
7.1 Prompts/cues	Associations	8	5	3	1.67	0.607	1.01
8.3 Habit formation	Repetition & Substitution	4	2	2	1.00	0.660	0.66
1.2 Problem Solving	Goals and Planning	1	1	0	L/F	0.643	L/F
1.5 Review behaviour goal(s)	Goals and Planning	1	1	0	L/F	0.643	L/F
13.1 Identification of self as a role model	Identity	1	1	0	L/F	0.428	L/F
15.3 Focus on past success	Self-belief	1	1	0	L/F	0.714	L/F
2.5 Monitoring of outcome(s) of behaviour	Feedback and monitoring	1	1	0	L/F	0.428	L/F
2.7 Feedback on outcome(s) of behaviour	Feedback and monitoring	1	1	0	L/F	0.286	L/F
5.6 Information about emotional consequences	Natural Consequences	1	1	0	L/F	0.714	L/F
6.3 Information about others approval	Comparison of behaviour	1	1	0	L/F	0.714	L/F
9.1 Credible source	Comparison of outcomes	1	1	0	L/F	0.71	L/F
10.1 Material incentive (behaviour)	Reward and threat	2	2	0	L/F	0.68	L/F
1.4 Action planning	Goals and Planning	2	2	0	L/F	0.54	L/F
1.1 Goal Setting (behaviour)	Goals and Planning	2	2	0	L/F	0.46	L/F
2.2 Feedback on behaviour	Feedback and monitoring	2	2	0	L/F	0.43	L/F
2.3 Self-monitoring of behaviour	Feedback and monitoring	2	1	1	L/F	0.64	L/F
2.1 Monitoring of behaviour by others without feedback	Feedback and monitoring	1	0	1	L/F	1.00	L/F

* Promise ratio denotes the number of promising interventions in which a BCT is featured, divided by the number of non-promising interventions in which it is featured.
** Adjusted promise ratio denotes the promise ratio weighted by risk of bias score. An adjusted promise ratio of 2 or above means the BCT can be classed as promising. Rows in green represent the most promising BCTs (promise ratio >3), rows in yellow represent BCTs with a promise ratio between 2-3, and rows in red represent non-promising BCTs.
L/F = low frequency, excluded from the promise ratio analysis.

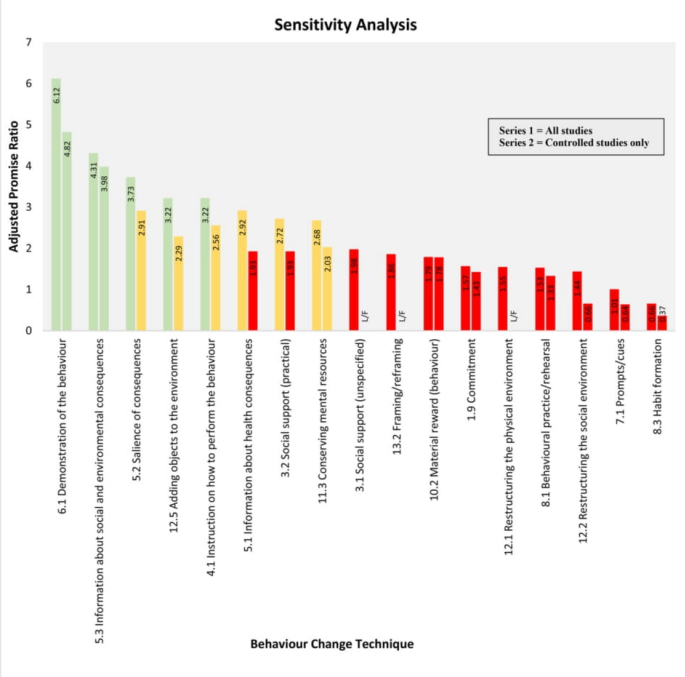

Fig. 3. Sensitivity analysis excluding studies without a control group. *Note.* Adjusted promise ratio denotes the number of promising interventions in which a BCT is featured, divided by the number of non-promising interventions in which it is featured, weighted by risk of bias score. An adjusted promise ratio of 2 or above means the BCT can be classed as promising. Bars in green represent the most promising BCTs (promise ratio >3), bars in yellow represent BCTs with a promise ratio between 2 and 3, and bars in red represent non-promising BCTs. L/F = low frequency, excluded from the promise ratio analysis. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

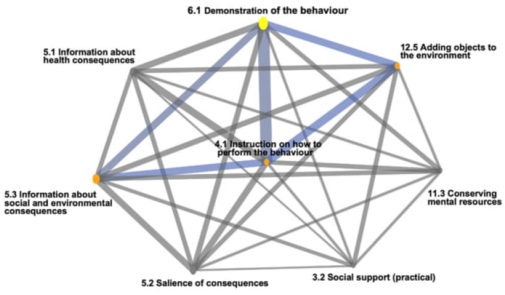

Fig. 4. Co-occurrence network plot of promising BCTs. *Note.* Nodes represent individual BCTs. The size of each node is proportional to the 'promise ratio'. The width of each edge (line joining nodes) is proportional to the total number of co-occurrences of BCTs.

4. Discussion

This is the first systematic review to identify behaviour change techniques used in hand hygiene interventions targeting older children. We identified 22 hand hygiene interventions and found evidence of the use of 32 unique BCTs from the BCTTv1. According to our promise ratio calculations, 8 of these BCTs contributed positively to intervention effectiveness in terms of increasing the frequency of children's hand hygiene behaviour and were classed as 'promising BCTs'.

Among the most promising BCTs were 'demonstration of behaviour', 'instruction on how to perform the behaviour' and 'adding objects to the environment,' such as installing handwashing stations and providing soap. It is clear why these BCTs are important – children need to understand how to perform handwashing and require the right tools to do so – and our visual inspection of the co-occurrence network of promising BCTs indicates that these BCTs are commonly used in combination with one another. Several studies among both children and adults report that even when soap and water are available, handwashing rates are often still low (Biranet al., 2012; Phillips et al., 2015; Watson et al., 2018, 2020), suggesting that while an enabling physical environment is necessary, adding objects to the environment is unlikely to lead to a substantial change in hand hygiene behaviour without complementary BCTs. We therefore recommend that the BCT 'adding objects to the environment' is used in combination with other promising BCTs to achieve the best possible outcome. Consideration should also be given to the placement and design of these objects as this may enhance their use without necessarily requiring additional resources. For example, handwashing stations may themselves serve as behavioural cues if installed in a child's direct path of movement; ensuring taps and soap holders are in easy reach may encourage handwashing by minimising the effort required to perform the behaviour (Neal et al., 2016).

Encouragingly, we found that the three promising BCTs discussed above – 'demonstration of behaviour', 'instruction on how to perform the behaviour' and 'adding objects to the environment' – are also the BCTs that have been employed most frequently in child-targeted hand hygiene interventions. These BCTs should continue to be important considerations for inclusion in intervention design since BCTs with a high overall frequency of use are those most likely to be feasible, acceptable, and fit for purpose (Brown et al., 2019). The fact that these three BCTs were found to frequently co-occur with one another within an intervention further indicates their importance.

Our review also suggests that providing information about the

natural social, environmental, or health consequences of poor hand hygiene and using methods to emphasise these consequences are important techniques to change children's behaviour. Use of these techniques may involve informing children that their peers disapprove of dirty hands (approve of clean hands), visually showing them how dirty hands will lead to a dirty environment (e.g., using glitter), and explaining the link between dirty hands and diseases. Interestingly, our finding that knowledge of health consequences can contribute to a positive change in children's hand hygiene behaviour is contrary to recent studies, primarily among adults, that report health not to be a strong motivator of hand hygiene behaviour change (Biranet al., 2009; Curtis et al., 2009; White et al., 2020). Although a promising BCT, health messaging can be time-consuming and difficult to implement, requiring skilled and trained staff to deliver messages consistently (Contzenet al., 2015b; Greenland et al., 2017). As such, a better use of resources may be to instead provide children with information about social and environmental consequences, particularly since our analysis suggests that this BCT is more promising than providing information about health consequences.

The BCT 'social support (practical) – defined in the BCTTv1 as advising on, arranging, or providing practical help (e.g., from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour – was also found to contribute to intervention promise. Other studies of hygiene behaviour among older children support this suggestion, for example; familial role (i.e. support from family members) was found to be an important determinant of older children's handwashing behaviour in an internally displaced camp in Northern Iraq (Watson et al., 2020). In schools in Bangladesh, after visiting the toilet, the presence of a student reminding their peers to handwash, leading them to the handwashing station, or demonstrating proper handwashing techniques was also found to positively impact older children's handwashing behaviour (Grover et al., 2018b). Hygiene programmes should continue to explore novel and age-appropriate strategies to foster active social support among children for positive hand hygiene behaviours.

We found that the number of BCTs used within an intervention was not associated with the intervention's promise rating, meaning that more BCTs does not necessarily equate to intervention effectiveness. In fact, on average, promising interventions employed fewer BCTs than non-promising interventions. Other reviews of BCTs have reported similar findings (Gardner et al., 2011; Hill et al., 2013; Michie et al., 2009a). An explanation for this may be that intervention quality and fidelity of delivery may be compromised by a large number of techniques. In light of this, when designing interventions to improve hand hygiene, programme designers and implementing organisations should focus time and resources on BCTs that positively contribute to intervention effectiveness, rather than the number of BCTs employed. This is particularly important in low-income settings where resources are scarcer and employing fewer BCTs may have positive effects on intervention feasibility, replicability and ability to be delivered at scale (Michieet al., 2009b).

The decision on which BCTs to employ in an intervention should be informed by the physical, social, and cultural aspects of the specific setting. For example, in contexts where there is already good access to handwashing infrastructure, providing further handwashing stations is unlikely to lead to an increase in handwashing behaviour; however, teaching children how to perform proper handwashing and encouragement and support by peers or family members may be more effective. Robust formative research to further understand the context-specific social, environmental, and behavioural drivers is still needed and can be guided by any number of behaviour change frameworks available (Aungerand Curtis, 2016; Coombes and Devine, 2010; Dreibelbis et al., 2013; Michie et al., 2011; Mosler, 2012).

We found no evidence of 61 (66%) BCTs in Michie's taxonomy being used in child-targeted hand hygiene interventions. In addition, even among the 32 BCTs we identified, almost half of these were used too infrequently to be included in promise ratio analyses. We are therefore unable to determine if these BCTs could contribute to intervention promise, even though many of them were found to be present only in promising interventions. Newer, innovative approaches are less likely to have been widely adopted yet and therefore are more likely to fall into this category of low-frequency BCTs for which promise ratios cannot be calculated. Additionally, innovative approaches are likely to be tested in less rigorous studies, for example in smaller proof-of-concept studies employing simple before-after study designs, likely because funding for evaluation is initially limited for these new approaches. Our weighting by risk of bias will have penalized these approaches due the design of the study in which they are tested and therefore lowered BCT promise ratios (where these could be calculated). Researchers should however not be deterred from further evaluating these newer approaches or from developing their own innovative approaches. Future, more rigorous studies formally evaluating and reporting these unused, low-frequency, and innovative BCTs will shed further light on their ability to change children's hand hygiene behaviour.

Observation was used to measure the behavioural outcome of 74% of the interventions included in this review. For the remaining 26% of interventions, behaviour was assessed by self-report. Self-reported measures are well known to be at high risk of bias; awareness of the social desirability of good hygiene behaviour, coupled with possible courtesy bias, is likely to lead to overreporting of hygiene behaviour (Contzenet al., 2015a). This may contribute to the large proportion of interventions which reported a significant positive change in children's hand hygiene behaviour. We attempted to account for this bias in our BCT analysis by weighting the promise ratio by risk of bias score but nonetheless, care should still be taken when interpreting these results. To aid design of future interventions, practitioners should be encouraged to use observation over self-report wherever possible.

Finally, it should be noted, as found in a previous review of the effect of handwashing promotion targeted at children (Watson et al., 2017), that almost all hand hygiene interventions for children are implemented in a school setting; we found only one study in a non-school setting that met our inclusion criteria. Children spend only about a third of their day in school meaning we are likely missing other opportunities to promote and reinforce good hand hygiene when they are at home or in other community settings. Thus, children out-of-school are clearly a missed subpopulation when it comes to hand hygiene interventions. This may be especially important in low-income settings where children may leave school at an early age, and in humanitarian emergency contexts where schools are not yet established (typically in the early stages of the humanitarian response when camps are first opened and there is a rapid influx of people).

4.1. Limitations

There are number of limitations of our review. First, we made the decision to include studies without a control group in our analysis to increase the depth of information and to reflect the available literature. Although we accounted for this by weighting our promise ratios by risk of bias score, which captured presence or absence of a control group, this study design is at high risk of bias and we cannot know for certain if reported changes in behaviour are bought about by promising BCTs. However, the sensitivity analysis performed indicates that excluding studies without a control group would not change our main results or overall conclusions.

Second, basing our BCT analysis on Gardner's technique (Gardner et al., 2016) allowed us to include heterogenous interventions in our review. This revealed which BCTs likely contributed to intervention effectiveness and their effect relative to other BCTs, but it did not allow quantification of the magnitude of effect of a given BCT. Furthermore, as all interventions employed more than one BCT we can only infer an association and not a causal relationship between an individual BCT and the intervention effect, since the effect of each individual BCT used in the intervention may be masked or modified by the other co-occurring

BCTs.

Third, using the BCTv1 to categorise intervention components and subsequently synthesising results according to Gardener's technique allowed us to account for study quality, as discussed above, but not for the quality of individual BCTs. BCTs can be employed in different ways with varying quality, intensity and duration; however, in our approach, once an intervention component is coded as a specific BCT it is treated as equal to all components across studies that have also been coded with the same BCT label. The most evident example of this in our review was the BCT 'prompts and cues'. Placing a poster above a handwashing facility (Lewis et al., 2018), a teacher verbally prompting students to wash their hands before lunch (Snow et al., 2008), and painting footpaths leading from the toilet to the handwashing station together with handprints on the station (Dreibelbiset al., 2016), were all intervention components we coded as 'prompts and cues'. However, these prompts and cues are all rather different. The painted footpaths and handprints are likely to be much more noticeable than a single poster above a sink and therefore likely to act as a stronger cue to wash hands, and children may feel more compelled or obliged to wash their hands if prompted verbally by a teacher rather than by a simple poster. Beyond this, even the quality of posters, specifically their ability to catch attention and be clearly understood, can widely vary. Similarly, BCTs that have the same format may also be used at very different intensities, for example, the BCT 'information about health consequences' was delivered verbally in numerous interventions but in some it was delivered just in one session and in other interventions it was delivered repeatedly over weeks, months, or even years. In this review, as in others that have used similar approaches, there is a risk that some of our promise ratios may have been skewed. When deciding to employ a specific BCT care should also be taken to ensure the way in which that BCT is employed is of adequate quality and that consideration is also given to the duration and intensity of use.

Accounting for differences in intervention quality and intensity is further compounded by the overall low quality of reporting on the interventions used across the studies included in this review. While standard tools and formats exist for reporting on and assessing study quality (Critical Appraisal Skills Programme, 2019; Downs and Black, 1998; Jadad et al., 1996; National Heart Lung and Blood Institute, 2019; Sterne et al., 2016, 2019; Wells et al., 2019) there are fewer guidelines available for reporting on the specifics of intervention content, delivery mode, intensity, and duration. More standardised reporting of BCTs and intervention delivery and intensity would facilitate future comparisons that account for overall intervention quality. This low reporting quality may have also introduced biases in our own intervention coding. Where information was incomplete or absent with regard to BCTs, there is a risk that BCTs are miscoded or omitted.

The approach we used in this review is designed to identify individual BCTs that contribute to a positive change in hand hygiene. As such, we did not quantitatively assess if specific combinations of BCTs were important for intervention outcome. We did however conduct a visual assessment of the co-occurrence of promising BCTs and this indicated some co-occurrence patterns suggesting that using certain promising BCTs in combination may be important for achieving an overall positive change in behaviour. As mentioned above, in all interventions, BCTs were used in combination so we cannot say for certain if the BCTs we identified as promising would achieve a significant change in hygiene behaviour if used independently. We have however published our data set and welcome further analyses by researchers who are interested in examining these characteristics.

Finally, by including only English language studies we may have missed key hand hygiene interventions published in other languages. There is also a strong risk of publication bias (whereby promising interventions are more likely to be published), indicated by the large proportion (86%) of interventions that were promising in our study, which may have skewed our results. Due to the nature of our analysis, it was not possible to formally evaluate the moderator effects of publication bias and specific methodological features of studies on our results, as is best practice (Johnson and Hennessy, 2019). However, by adjusting promise ratios by risk of bias we attempted to account for this as much as possible. Our protocol was not pre-registered in a standard repository.

5. Conclusion

This systematic review identified 8 promising BCTs for improving older children's hand hygiene behaviour. We recommend that future child-targeted hand hygiene interventions include some of these promising BCTs in combination, particularly those that ensure children understand how to perform the behaviour and its associated consequences and those providing an enabling physical and social environment, which we find to be the most promising BCTs. To further our understanding of the most effective ways to improve the hand hygiene of older children, we also recommend that researchers always publish transparent and comprehensive descriptions of intervention techniques and that observed behavioural outcome measures are used whenever possible. We encourage further research quantitatively evaluating the effectiveness of hand hygiene interventions employing the less frequently used BCTs we have identified in this review in order for their efficacy to also be determined.

Author contributions

Julie Watson: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. Oliver Cumming: Supervision, Conceptualization, Methodology, Formal analysis, Writing – review & editing, Amy MacDougal: Formal analysis, Writing – review & editing, Alexandra Czerniewska: Formal analysis, Validation, Writing – review & editing. Robert Dreibelbis: Supervision, Conceptualization, Methodology, Formal analysis, Writing – review & editing

Declaration of competing interest

None.

AppendixIntervention Characteristics

Study	Study Design	Setting	Country	Behaviour Change Techniques *	Outcome measure	Effect (increased frequency of hand hygiene behaviour)
Al-Delaimy 2014	NRCT (cluster)	Rural schools	LMIC	- 3.1 Social support (unspecified) - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 6.1 Demonstration of the behaviour - 7.1 Prompts/cues - 8.1 Behavioural practice/rehearsal	Self-report	✓

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(*continued*)

Study	Study Design	Setting	Country	Behaviour Change Techniques *	Outcome measure	Effect (increased frequency of hand hygiene behaviour)
				- 12.2 Restructuring the social environment - 12.5 Adding objects to the environment		
Au 2010	RCT	Urban schools	HIC	- 2.2 Feedback on behaviour - 4.1 Instruction on how to perform the behaviour - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 8.1 Behavioural practice/rehearsal - 8.3 Habit formation - 10.1 Material incentive (behaviour) - 10.2 Material reward (behaviour) - 11.3 Conserving mental resources	Observed	✓
Beiri 2013	RCT (cluster)	Rural schools	LMIC	- 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences** - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 5.6 Information about emotional consequences - 6.1 Demonstration of the behaviour - 9.1 Credible source - 12.5 Adding objects to the environment - 15.3 Focus on past success	Observed	✓
Chard and Freeman 2018	RCT (cluster)	Rural schools	LMIC	- 7.1 Prompts/cues - 8.1 Behavioural practice/rehearsal - 8.3 Habit formation - 12.1 Restructuring the physical environment - 12.2 Restructuring the social environment - 12.5 Adding objects to the environment	Observed	×
Dreibelbis 2016	BA	Rural schools	LMIC	- 3.2 Social support (practical) - 7.1 Prompts/cues - 12.1 Restructuring the physical environment - 12.5 Adding objects to the environment	Observed	✓
Early 1998	RCT (multi-arm) ***	Urban school s	HIC	- 3.2 Social support (practical) - 4.1 Instruction on how to perform the behaviour - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 10.2 Material reward (behaviour) - 11.3 Conserving mental resources - 12.2 Restructuring the social environment	Observed	✓
Graves 2011	CBA	Rural schools	LMIC	- 4.1 Instruction on how to perform the behaviour - 7.1 Prompts/cues - 12.5 Adding objects to the environment**	Observed	×
Grover 2018	RCT (cluster) (redefined as two BAs)	Rural schools	LMIC	BA 1) - 1.1 Goal Setting (behaviour) - 1.2 Problem Solving - 1.4 Action planning - 1.5 Review behaviour goal(s) - 1.9 Commitment - 3.1 Social support (unspecified) - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 6.1 Demonstration of the behaviour - 11.3 Conserving mental resources - 12.2 Restructuring the social environment BA 2) - 7.1 Prompts/cues - 12.1 Restructuring the physical environment - 12.5 Adding objects to the environment	Observed	BA 1) ✓ BA 2) ✓

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(*continued*)

Study	Study Design	Setting	Country	Behaviour Change Techniques *	Outcome measure	Effect (increased frequency of hand hygiene behaviour)
Lewis 2018	RCT (cluster)	Rural schools	LMIC	- 1.9 Commitment - 2.1 Monitoring of behaviour by others without feedback - 2.3 Self-monitoring of behaviour - 3.1 Social support (unspecified) - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 7.1 Prompts/cues - 8.1 Behavioural practice/rehearsal - 8.3 Habit formation - 11.3 Conserving mental resources - 12.2 Restructuring the social environment - 12.5 Adding objects to the environment	Observed	×
Pasewaldt 2018	BA	Urban & Rural schools	LMIC	- 1.4 Action planning - 2.5 Monitoring of outcome(s) of behaviour without feedback - 3.1 Social support (unspecified) - 3.2 Social support (practical) - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 8.1 Behavioural practice/rehearsal - 8.3 Habit formation - 12.1 Restructuring the physical environment - 12.2 Restructuring the social environment - 12.5 Adding objects to the environment - 13.1 Identification of self as a role model - 13.2 Framing/reframing	Self-report	✓
Patel 2012	CBA	Rural schools	LMIC	- 4.1 Instruction on how to perform the behaviour - 12.5 Adding objects to the environment	Self-report	✓
Pickering 2013	RCT (cluster, multi-arm)	Urban schools	LMIC	1) - 4.1 Instruction on how to perform the behaviour - 6.1 Demonstration of the behaviour - 12.5 Adding objects to the environment - 13.2 Framing/reframing 2) - 4.1 Instruction on how to perform the behaviour - 6.1 Demonstration of the behaviour - 12.5 Adding objects to the environment - 13.2 Framing/reframing	Observed	1) ✓ 2) ✓
Saboori 2013	RCT (cluster)	Rural schools	LMIC	- 3.2 Social support (practical) - 12.5 Adding objects to the environment	Observed	✓
Snow 2008	RCT (multi-arm)	Urban schools	HIC	1) - 6.1 Demonstration of the behaviour - 7.1 Prompts/cues 2) - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 5.2 Salience of consequences - 7.1 Prompts/cues	Observed	1) ✓ 2) ✓
Solehati 2017	BA	Rural schools	LMIC	- 4.1 Instruction on how to perform the behaviour - 6.1 Demonstration of the behaviour - 12.2 Restructuring the social environment	Observed	✓
	CBA	Urban schools	LMIC	- 1.9 Commitment	Self-report	✓

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(*continued*)

Study	Study Design	Setting	Country	Behaviour Change Techniques *	Outcome measure	Effect (increased frequency of hand hygiene behaviour)
Taware 2018				- 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 6.3 Information about others approval - 8.1 Behavioural practice/rehearsal		
Tousman 2007	BA	Urban schools	HIC	- 1.1 Goal Setting (behaviour) - 2.2 Feedback on behaviour - 2.3 Self-monitoring of behaviour - 2.7 Feedback on outcome(s) of behaviour - 4.1 Instruction on how to perform the behaviour - 5.1 Information about health consequences - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour - 8.1 Behavioural practice/rehearsal - 12.5 Adding objects to the environment - 13.2 Framing/reframing	Self-report	✓
Watson 2019	CBA	Rural households	LMIC	- 4.1 Instruction on how to perform the behaviour ** - 5.2 Salience of consequences - 5.3 Information about social and environmental consequences - 6.1 Demonstration of the behaviour ** - 8.1 Behavioural practice/rehearsal - 10.1 Material incentive (behaviour) - 10.2 Material reward (behaviour) - 12.5 Adding objects to the environment **	Observed	✓
Wichaidit 2019	BA	Urban schools	LMIC	- 1.9 Commitment - 3.2 Social support (practical) - 5.3 Information about social and environmental consequences - 6.3 Information about others approval - 11.3 Conserving mental resources - 12.5 Adding objects to the environment	Observed	✓

HIC = high-income country, LMIC = low or middle-income country, BA = before-after study, CBA = controlled before-after study, RCT = randomised controlled trial, NRCT = non-randomised controlled trial.
1) and 2) represent different intervention arms within a trial. Where an RCT has been redefined as two separate BA studies, BA 1) and BA 2) represent these separate studies.
* Employed in the intervention group/s.
** BCT also features in the control group and therefore was excluded from the analysis.
*** Only one intervention arm targeted the behaviour of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.114090.

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CHAPTER 4

Research Paper 2: Child handwashing in an internally displaced persons camp in Northern Iraq: A qualitative multi-method exploration of motivational drivers and other handwashing determinants

The following research paper addresses research objective 2): identify the motivational drivers and other determinants of handwashing behaviour among older children in a humanitarian emergency context.

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RESEARCH ARTICLE

Child handwashing in an internally displaced persons camp in Northern Iraq: A qualitative multi-method exploration of motivational drivers and other handwashing determinants

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Abstract

Background

Children in humanitarian situations are particularly vulnerable to diseases such as diarrhoea. Handwashing with soap can greatly reduce transmission but handwashing rates are often low and traditional interventions ineffective. To aid future intervention design, this study aims to understand the determinants of child handwashing and the key motivational drivers of children's behaviour within a specific humanitarian setting.

Methods

In an internally displaced persons camp in Northern Iraq we conducted a series of 36 friendship-paired interviews with children aged 7–12 years, six semi-structured caregiver interviews, and three semi-structured hygiene promoter interviews. Perceived determinants of child handwashing were explored qualitatively, and motivational drivers were explored quantitatively with children in a rating exercise. Qualitative data were analysed thematically, using an inductive approach, and logistic regression analyses of motive rating data were performed to determine the predicted probabilities of motives being rated as important.

Results

Access to soap and water was perceived to be high across all participant groups. Children, caregivers and hygiene promoters all perceive the determinants of child handwashing to be associated with familial role, environmental factors pertaining to location and quality of handwashing materials and facilities, and level of exposure to hygiene promotion, and children also attribute their handwashing to social norms. We find that children in this context are motived most by play and nurture.

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Conclusions

Provision of soap and water alone is not sufficient to encourage children to practice handwashing with soap in a humanitarian context. Our findings suggest that equal consideration should be given to the quality and location of handwashing materials and facilities and social norms could be leveraged to promote and enhance child handwashing. Motive-based interventions targeting play or nurture may be a promising approach and are likely most effective when used in conjunction, along with other motivational drivers such as affiliation and love.

Introduction

Practising handwashing with soap at key occasions is a fundamental tool for the prevention of infectious disease. Handwashing with soap interrupts the transmission of infectious agents and can reduce the risk of diseases such as diarrhoea and acute respiratory infections by up to 23% and 21%, respectively [1, 2]. It has also been linked to the reduction of certain neglected tropical diseases with high disease burden in children, such as trachoma [3] and soil-transmitted helminths [4, 5], as well as lead to improvements in school attendance [6–8].

Despite the clear benefits of handwashing, rates are low; 81% of the global population fail to wash their hands with soap after defecating [1]. Though no official estimate of the handwashing rate among the global child population exists, age-segregating the studies comprising this overall estimate indicates that rates are even lower among children. Lack of handwashing is especially problematic in humanitarian emergencies where conditions such as overcrowding, unclean water and sanitation facilities, poor healthcare and environmental contamination leave people at high risk of disease [9, 10]. Diarrhoea can be responsible for up to 40% of all deaths in the immediate aftermath of an emergency [10]. Children in these contexts are particularly vulnerable, with diarrhoea and pneumonia being two of the leading causes of death in persons age fourteen and under [11].

The Sphere Handbook sets out minimum standards for hygiene promotion in humanitarian response [12] and most response agencies include handwashing promotion to both children and adults as part of their humanitarian response protocols. Multiple studies have documented that handwashing promotion approaches typically rely on a combination of communicating the health-related risks associated with poor hygiene and providing soap and water [13–16]. However, research from stable settings suggests that knowledge does not translate into practice and health is often not an effective motivator of behaviour change [13, 17, 18]. Though there is a paucity of research in this field from humanitarian settings, in refugee camps it has been shown that even when soap and water are present and handwashing is promoted via health-based messaging, rates of handwashing with soap are low [15].

To achieve success, behaviour change interventions must effectively identify and address the determinants (factors that influence behaviour) of the behaviour in question [19]. There have been a number of formative studies of the determinants of handwashing in stable settings [17, 20–22] however, these have largely focused on adult populations and to a lesser extent, children in schools [23–25]. There are as yet no published studies on the determinants of children's handwashing behaviour in a humanitarian context.

Some behavioural theories place a strong emphasis on motives as determinants of behaviour and motivations have been explored in a number of the existing studies on handwashing determinants [17, 21]. According to the Evo-Eco theory [26], the theory at the centre of the

Behaviour Centred Design (BCD) approach to designing and evaluating interventions [27], there are fifteen innate human motives that drive all human behaviour and have evolved to fulfil evolutionary important goals such as finding food or a long-term mate. Motivation-based handwashing interventions have shown promising results in stable settings, such as the SuperAmma campaign in India which used nurture, disgust, affiliation and status to motivate handwashing through animated film, skits and public pledging [28]. Until recently, however, motivation-based handwashing not been tested among children in humanitarian emergency settings.

Data presented here are part of a larger mixed-method study exploring the determinants of handwashing behaviours among children in an internally displaced persons (IDP) camp in Northern Iraq. In parallel to the study presented here, we tested the hypothesis that handwashing behaviour among children in this population could be determined by motivational drivers, as described in the Evo-Eco theory. We implemented a handwashing intervention organised around two specific motives—play and curiosity—and assessed its effect on children's handwashing with soap in a proof-of-concept study. This study showed a large increase in rates of handwashing with soap among children [29].

Play and curiosity motives were selected *a priori* as primary drivers of children's behaviour due to their intuitively assumed importance among this age group; however, it remains unknown whether these two motives are indeed the most important behavioural drivers among these children. An exercise of motive exploration could reveal which are the most important drivers of children's behaviour and which could be most effectively targeted to produce robust behaviour change interventions in humanitarian settings.

In this multi-method study, we qualitatively explore the determinants of children's handwashing behaviour in an IDP camp from the perspective of children, caregivers and hygiene promoters residing in the camp and we quantitively explore the most important motives driving children's handwashing behaviour within this population.

Methods

Study site

The study took place in Sharia camp, an IDP camp located in the Dohuk Governorate of the Kurdistan Region of Iraq. This camp is managed by the Board of Relief and Humanitarian Affairs (BRHA)–a governmental body within the Dohuk government structure. At the time of this study, Save the Children were the organisation leading the water, sanitation, and hygiene (WASH) response in the Sharia camp. IDPs in the camp are exclusively from the Yezidi community, originating from the Sinjar region of Northern Iraq and most entered the camp in 2014 when the Islamic State of Iraq and the Levant (ISIL) entered Sinjar. Sharia camp has a population of approximately 17,000 people, over 37% of whom are children under the age of 12 [30]. The camp population is accommodated in tents with access to communal latrine blocks, shower units, and a consistent water supply at shared water points, though many families have purchased water tanks to store water in or near their tent. A previous study has shown that the rates of handwashing with soap among children after the five key moments (after using the toilet, before eating, before preparing food, after handling another child's faeces, and before serving food to others) in this camp range from 13% to 32% [29].

Participants and recruitment

72 children between the ages of seven and twelve participated in this study. They completed semi-structured interviews in 32 gender-segregated friendship pairs to encourage participation [31] (Table 1). In addition, we conducted semi-structured interviews with six female primary

Table 1. Child friendship-paired interviews conducted with 72 IDP children.

Age group	Gender	Number of friendship-paired interviews
7–8	Female	6
7–8	Male	6
9–10	Female	6
9–10	Male	6
11–12	Female	6
11–12	Male	6

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caregivers of children age 5–12, and semi-structured interviews with three camp-based hygiene promoters employed by Save the Children (one male, two female). All participants, including the hygiene promoters, were IDPs residing in the Sharia camp at the time of the study.

The Sharia camp is divided into five blocks (A—E). Primary caregivers and child participants were only selected from blocks not taking part in the concurrent proof-of-concept study (blocks A, C, and E) [32]. Two caregivers were recruited from each of the three eligible blocks. Each caregiver was recruited by randomly selecting a row of tents within one of the blocks (each block consisted of approximately 12–14 rows of tents) after which the lead author (JW) and local translator approached the first tent in this row. If the caregiver was not home or was ineligible, we moved on to the neighbouring tent, and so on until a caregiver was recruited from the row. All eligible caregivers we approached opted to participate. After written consent was obtained, the lead author and caregiver agreed a suitable time to conduct the interview. Interviews took place inside of the caregiver's own tent for convenience and safety. The enrolled caregiver, lead author, and the local female translator, who provided translation for all interviews, were the only adults inside the tent during the interviews, although the young children of the household were sometimes also present.

Three hygiene promoters (two females, one male) were randomly selected from the group of six working in the Sharia camp. The lead author enrolled the hygiene promoters face-to-face and explained that she was in no way evaluating their abilities as hygiene promoters or working on behalf of their employer. All three hygiene promoters opted to participate, and interviews proceeded following written consent. Interviews took place in private in the Save the Children mobile office located in the Sharia camp.

Hygiene promoters assisted with recruitment of child participants, identifying households with at least one child age 7–12. For each friendship-paired interview, one child was recruited and then asked to nominate a friend of a similar age to join the interview. Assent and consent were sought respectively from both the children and their caregivers before proceeding with the interview. All nominated friends opted to participate, and all caregivers gave consent. Interviews took place in a private room within Save the Children's child-friendly space in the camp in the presence of the lead author and translator. Children were guided to the room by Save the Children hygiene promoters who remained nearby on the premises to ensure safety.

Sample size was based on preliminary assumptions about the heterogeneity of the target population, housing and access to facilities, and logistical feasibility. We pre-defined six gender/age groups and completed a total of six interviews in each to reach assumed theoretical saturation [33]. As there were only six hygiene promoters working in the Sharia camp, theoretical saturation was expected within three interviews (i.e. 50% of this population).

Data collection

All interviews were conducted between January 2018 and March 2018. Via the translator, all interviews were conducted by the lead author (a female academic researcher) who received

Table 2. Participatory methods for friendship-paired interviews with IDP children.

Activity	Description	Purpose
Word associations	Handwashing-related words are called out and children describe what they associate this word with	To situate the conversation around handwashing and to understand the mental associations children have with handwashing and associated domains
Function of handwashing behaviour	Children list reasons for washing hands and then choose those most important to them, giving reasons	To understand the function handwashing serves from the perspective of the child
Routine scripting	Children recall their daily routine with the aid of picture cards and conversation is elicited around handwashing	To understand how handwashing features in daily routines and to identify barriers to practicing handwashing with soap
Pictorial vignettes of critical handwashing junctures	Pictorial vignettes depicting children in different handwashing scenarios are shown and children describe how they and others view the child, the reasons the child has washed/not washed their hands, and what may change the outcome	To explore social norms and barriers to handwashing
Ideal handwashing facility	Children describe their ideal handwashing facility and explain how it differs from their current facility	To elicit environmental barriers to practicing handwashing with soap
Perceived social norms	Children are given ten counters to represent children in the camp and are asked to estimate, giving reasons, how many have soap in their house, practice handwashing after using the toilet, etc.	To understand social norms around handwashing

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training from colleagues and collaborating researchers. The lead author had no relationship with the participants prior to study commencement. Potential participants were informed about the nature of the study both informally and through a standardized document explaining that the study aim was to understand children's handwashing behaviour in the camp and that data may ultimately help to shape future handwashing interventions. Interviews lasted between thirty minutes to one hour and were audio recorded, transcribed and translated verbatim. Following transcription and before analysis, each transcript was checked for accuracy against the original recordings by the lead author and translator.

Interview guides, specifically developed for each participant group by the authors and pilot tested prior to data collection, were used to guide the discussion on the topic of child handwashing in each interview. All interview guides can be found in S1 Appendix. Caregiver and hygiene promoter interview guides consisted of a series of semi-structured questions and child interview guides detailed a number of participatory tools which were used to elicit conversation around handwashing. An overview of these participatory tools is given in Table 2. A motive rating exercise was also undertaken with the child participants during the friendship-paired interviews and is detailed below.

To determine potentially important motivational drivers of children's behaviour within this population, a motive sorting and rating exercise, was undertaken during the child friendship-paired interviews. Each child was presented with cartoon pictures depicting 14 of the 15 human motives from the Evo-Eco theory (the lust motive was deemed to be inappropriate for this age group and was excluded) [26]. The motive rating exercise was piloted prior to data collection using a number of different pictures and those pictures we felt were best understood were selected for use in the study. In addition, simple terms were consistently used to describe the pictures to the children in each interview (motive pictures and terms can be found in S2 Appendix). In the first phase of the motive rating exercise, each child was first asked to select the pictures that they felt were important to them with no restriction on the number they could choose. In the second phase, children were asked to select which motives were the most important to them. This staged process allowed all motives to be placed in one of three categories—not important, important, and very important.

Data management and analysis

All interview transcripts were imported into QSR Nvivo 11 [34] to aid analysis. The lead author (JW) conducted a thematic analysis of all of the interview transcripts following the six stages described by Braun and Clarke: (i) becoming familiar with the data, (ii) generating initial codes, (iii) searching for themes, (iv) reviewing and naming themes, (v) defining themes, (vi) interpreting and reporting [35]. An inductive approach to coding was used to allow unexpected themes and concepts to emerge from the information provided by the participants. Codes identified features of the data considered to be of relevance to the research question. The coding structure can be found in S3 Appendix.

Statistical analysis of motive rating data generated from the child friendship-paired interviews was undertaken in Stata Version 14 [36]. The data violated the proportional odds assumption of ordered logistic regression so outcomes were dichotomised as 'not important' and 'important or very important' and a logistic regression analysis was undertaken for each motive to: (i) determine the predicted probability of the motive being rated as 'important or very important', adjusting for clustering within the child pairs (here, predicted probabilities translate to the predicted proportion of children who would rate a motive as 'important or very important'), (ii) assess the association between motive rating and gender, controlling for age and adjusting for clustering within the child pairs, and (iii) assess the association between motive rating and age group, controlling for gender and adjusting for clustering within the child pairs.

Final predicted probabilities of motives being rated as 'important or very important' were then used to identify the smallest set of motives that could motivate the largest proportion of children. To do this we firstly identified the motive with the highest predicted probability of being rated as 'important or very important' (i.e. the motive that motivated the highest proportion of children). We then recalculated the predicted probabilities of motives being rated as 'important or very important' among only the children who had rated the previously identified motive as 'not important' and again we identified the motive with the highest predicted probability among this group (i.e. the motive that motivated the second highest proportion of children). These two motives were grouped, and the process continued until we had a set of motives with the potential to motivate nearly all children and where adding a further motive made little difference to proportion of children covered (i.e. motivated).

Ethical considerations

The study was reviewed and approved by the London School of Hygiene and Tropical Medicine Ethics Review Committee (Ref: 14483) and the Hawler Medical University Ethics Review Committee in Erbil, Iraq (Ref: 1/16). The study was also approved by the Board of Relief and Humanitarian Affairs (Ref: 365) and the Directorate of Preventive Health Affairs in Dohuk Province (Ref: 7787). Written informed consent was obtained from all adult participants and caregivers of child participants and verbal assent was obtained from child participants.

Results

Perceived handwashing determinants

Four key themes emerged from the interviews describing the perceived determinants of child handwashing in the Sharia IDP camp. Three of these themes (familial roles, environmental barriers and hygiene promotion exposure) were common across respondent groups and so results were combined. The fourth theme (prescriptive social norms) was specific to the child friendship-paired interviews. All themes are detailed below.

1. Familial roles. Across all three respondent groups, parental role was a key determinant of child handwashing. Lack of handwashing was seen as a reflection of poor parenting, and particularly attributed to a lack of care by mothers. Mothers were believed to carry the greatest responsibility because, as one hygiene promoter explained, *"she spends most of her time with them"*. Caregivers typically felt a lack of handwashing in the home was not due to a lack of resources but to family practices. One caregiver stated,*". . .everything is available for the children and people in general, so I think it is something that depends on the family itself*."

Caregivers and hygiene promoters believed that families with a large number of children find it harder to oversee their children's handwashing. One hygiene promoter explained: *"I think the reason for this neglect may be the large number of children in the family. The father is not always at home and the mother remains busy with domestic work"*. This view was corroborated by caregivers:

"*Actually, as I see it, some of my neighbours have many children so it is hard to make them all wash their hands. Sometimes, when I see her children, I send them home and tell them to wash their hands*."

Children also felt strongly about the familial role in child handwashing. The appearance of dirty hands was thought to be a reflection of poor parenting and a lack of handwashing in the home was attributed to parenting ability rather than resources. One child said *"Everything is available, but it depends on their parents. This boy's family is good and tells him to wash his hands, so he does but others do not wash their hands. There is nobody taking care of them."*

In addition to the parental role, some children also felt that they played an important role in the handwashing of younger siblings. These children felt they acted as role models and should therefore demonstrate good handwashing so that younger siblings followed suit.

2. Environmental barriers. Across respondent interviews, the common view was that availability of handwashing materials (soap, water and a handwashing station) was not an issue within the home. Most children (mentioned in 24 out of 36 friendship-paired interviews) and four caregivers reported having soap and water available in their home. Financial restraints were not a significant barrier to purchasing soap; only two caregivers and one child reported difficulties in affording soap in their households.

At the latrines however, respondents felt that many environmental barriers to child handwashing existed. One of these barriers was the availability of handwashing materials; water supply was reported to be intermittent at the handwashing stations within the latrine blocks and soap rarely available. Lack of lighting at the latrines was also a barrier to children practicing handwashing in the night. One child explained that, *". . .some nights there is no electricity or water at the latrines, we are frightened to go to wash our hands, so it is hard for us to wash our hands."* One caregiver also raised the lighting at the latrines as a concern and explained that she would have to accompany her children there because they felt frightened at night.

Other environmental barriers to children handwashing with soap were related to the conditions at the latrine blocks. In particular, dirtiness was perceived to be a significant environmental barrier to children practicing handwashing with soap there (although most reported that children would return home to wash their hands after using the latrines) and is also a psychological determinant, evoking the motive of disgust—a negative motivational driver for handwashing in this context. One child explained, *"we wash our hands at home because the latrines are dirty and also the water is dirty too"*. Another child said, *"if they (the latrines) are dirty I do not wash my hands in the latrines, I use latrines when they are clean"*. Caregivers also agreed that the dirtiness of the latrines was a problem and one gave the following account: *"Nobody can wash hands in the latrine because they are very dirty. Whoever enters will be dizzy because of the disgusting smell"*. In the instances where soap and water were available at the latrines, some children explained that they considered the soap to be too dirty to use because it

was communal and kept in the unclean latrine block. They also complained that the water was too cold to use for handwashing, especially in the winter.

Most respondents attributed the dirtiness of the latrines to their communal nature and both children and caregivers believed that children's handwashing would improve if households were provided with private latrine facilities. Private latrines were also desired because distance to the communal latrines presented a barrier to use of the handwashing stations there. One caregiver explained that, *"if they (latrine blocks) were closer, almost all of the children would be encouraged to wash their hands anytime they need to"*.

3. Hygiene promotion exposure. Exposure to hygiene promotion among children in the camp was high; five of the six caregivers said that their children were exposed to hygiene messages and this was evident through the common knowledge of the seven steps of handwashing (mentioned in 18 of the 36 friendship-paired interviews) which are taught by hygiene promoters in schools, kindergartens and child-friendly spaces and the high awareness of disease. Both children and caregivers demonstrated knowledge of specific diseases that occurred in the camp, including cholera and mumps, and of disease transmission pathways. One child explained, *"we should wash our hands well because dirtiness goes under nails, so when we eat food, germs go into our body and we will be sick"*.

Avoidance of sickness and disease was stated as one of the most important reasons for practising handwashing in all of the child friendship-paired interviews. One child said, *"handwashing is so important for us to avoid cholera. We should wash our hands using soap. If we do not wash our hands, we will be sick"*. Children believed that knowledge of why and how to wash hands was an important determinant of handwashing and that hygiene promoters and parents should dispense this knowledge. Looking at a pictorial vignette depicting a child who did not wash her hands after using the toilet, one child stated that, *"if there is a CFS (child-friendly space) and they teach her the seven steps about handwashing she will know how to wash her hands"*. They felt that they also had a duty to impart knowledge to other children and another child explained, whilst looking at a pictorial vignette of a group of children with dirty hands: *"If we tell them all about handwashing, how handwashing is important and if you wash your hands you will be healthy, they will wash their hands"*.

Caregivers also believed that handwashing promotion was a key determinant of child handwashing. One caregiver said, *"if the hygiene promoters, CFS, and school tell them about handwashing they will wash their hands more because they like it and they will listen to you (hygiene promoters) more than us"*. Most agreed that their children enjoyed hearing messages from promoters and complained that household visits were decreasing, and NGOs were no longer doing enough to encourage children to wash their hands.

Hygiene promoters too felt that giving awareness was key to children's handwashing. They believed that children's handwashing in the camp had improved after Save the Children began operating in the camp and hygiene promoters believed that children who did not attend kindergartens and schools (and hence did not receive hygiene awareness there) were washing their hands less.

4. Prescriptive social norms. Children expressed that a strong motivation for handwashing was to avoid social stigma. Normative importance of proper hygiene was a theme in 29 child friendship-paired interviews. One child said, *"if my hands smell good, people will not try to avoid me, and I will have lots of friends."* Another explained, *"we want our hands to be clean and look to nice, so other children do not laugh at us"*. Talking about a child who does not wash his hands, another child said, *"if he is not clean people will always joke about him and his family"*. Children felt the reason that they or others would be avoided if they did not wash their hands was due to fear of catching disease. When shown a pictorial vignette of a child not

washing their hands one child said, *"her friends will say to her 'you are sick, so we cannot play with you or we will be sick like you'"*.

The idea of being stigmatised for not handwashing also extended to stigmatisation of the child's family since handwashing was considered to be a reflection of the rest of the family's cleanliness and social standing. When looking at a picture of a boy washing his hands, one child said, *"people will say he is clean, and he came from a clean family so maybe if you are clean it means your family is clean and asking you to be clean."*

Children also washed their hands simply because their parents told them to and in order to gain their parents' approval. One child said, *"our parents are proud of us when we wash our hands, they always encourage us to wash our hands."*

All children in the friendship-paired interviews gave an estimate of the proportion of children in the camp that they believed would wash their hands with soap after using the toilet and the average estimate was 70%. Two of the hygiene promoters estimated the proportion of children practising handwashing with soap to be between 50%-60%. The other hygiene promoter did not give an estimate and neither did any of the caregivers.

Motive analysis

Each child rated between two and eleven of the fourteen motives as 'important' or 'very important' (typically between two and five). Between zero and five motives were rated as 'very important' (typically one or two). Play had the highest probability of being rated as 'important' or 'very important' (56%), followed by nurture (54%), affiliation (47%) and comfort (46%). Predicted probabilities of each motive being rated as important or very important are shown in Table 3.

Females had three times higher odds of rating the motive love as 'important or very important' compared to males, controlling for age ($p<0.05$; see Table 4). Controlling for gender, the odds of the motive love being rated as 'important or very important' were ten times higher for children in older age groups, 9–10 and 11–12, than for children age 7–8 ($p<0.05$). The oldest age group (ages 11–12) were at three times higher odds of rating the motive justice as 'important or very important' compared to the youngest age group (ages 7–8).

Table 3. Predicted probabilities of motive rating using logistic regression.

Motive	Predicted Probability of 'important' or 'very important' rating
Play	0.56
Nurture	0.54
Affiliation	0.47
Comfort	0.46
Hunger	0.40
Attract	0.38
Love	0.36
Create	0.36
Justice	0.28
Curiosity	0.31
Disgust	0.21
Fear	0.22
Hoard	0.21
Status	0.08

Analyses are all adjusted for clustering within the child pair.
N = 72 IDP children

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Table 4. Logistic regression analysis relating gender and age group to an 'important' or 'very important' motive rating.

Motive	Gender (Female vs. Male)		Age group 9–10 (vs. 7–8)		Age group 11–12 (vs. 7–8)	
	OR	P value	OR	P value	OR	P value
Play	1.25	0.62	1.13	0.84	0.99	0.99
Nurture	1.41	0.51	1.38	0.61	2.04	0.24
Affiliation	1.98	0.16	0.83	0.77	0.87	0.80
Comfort	1.75	0.23	0.81	0.69	0.42	0.15
Hunger	0.56	0.27	1.62	0.46	1.79	0.38
Attract	0.70	0.48	2.34	0.19	1.58	0.46
Love	2.99	0.01	10.89	<0.01	10.02	<0.01
Create	0.78	0.63	1.30	0.68	0.71	0.55
Justice	1.01	0.99	5.29	0.06	6.00	0.03
Curiosity	0.77	0.67	1.26	0.76	2.41	0.24
Disgust	2.42	0.14	0.10	0.05	1.42	0.56
Fear	1.98	0.29	1.48	0.66	3.35	0.07
Hoard	0.42	0.13	0.63	0.46	1.10	0.87
Status	0.88	0.88	0.41	0.31	1.00	1.00

Logistic regression controlling for age (in gender analysis) and controlling for gender (in age group analysis). Analyses are all adjusted for clustering within the child pair. N = 72 IDP children

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A combination of the four motives: play, nurture, affiliation and love, were considered motivational by 96% of the children sampled (i.e. 96% of these children rated least one of these motives as important or very important) (Table 5).

Discussion

This is the first study of which we are aware to explore the determinants of child handwashing and the motivational drivers of child behaviour in a humanitarian emergency context. We found that children, caregivers and hygiene promoters in an IDP camp in Northern Iraq all perceived the determinants of child handwashing to be around familial role, environmental factors—including location and quality of handwashing materials and facilities, and level of exposure to hygiene promotion, and that children also perceive social norms to be an important determinant. We also found that children in this context are motived most by play and nurture.

Across all three interviewee groups, availability of soap and water at the household level was thought to be high and not a barrier to handwashing. This corroborates the high prevalence of handwashing stations, with soap and water present, observed in households during the baseline data collection activities of the concurrently implemented proof-of-concept study [29]. These handwashing stations were generally located next to the kitchen area, however tents in the Sharia camp are small and there was little distance between the handwashing station and

Table 5. Motivation coverage across 72 IDP children.

Motive Combination	Predicted proportion of children motivated
Play only	56%
Play and Nurture	82%
Play and Nurture and Affiliation	91%
Play and Nurture and Affiliation and Love	96%

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any area within the household. In line with previous handwashing studies among adults in humanitarian settings [15, 37], our study suggests that providing a sufficient supply of soap and water during humanitarian emergencies, as there was in the Sharia camp, is not enough to achieve good handwashing practices among children.

We find that the quality of communal handwashing materials and facilities, and their location, are important determinants of child handwashing. These environmental determinants, particularly the dirtiness of materials and facilities (a key theme across the interviews), may be most relevant in humanitarian settings where latrines and their associated handwashing stations are often far from households, and difficult to maintain; however in stable settings, studies have also shown an association between washroom cleanliness and adult handwashing [38]. In the Sharia camp we found that dirtiness evoked the emotion of disgust, driving children to avoid the dirty area (the latrine blocks), and hence handwashing there. An abundant literature from stable settings supports disgust as a key motivator of handwashing [17, 21, 28, 39, 40] but our study highlights that when the source of disgust is the handwashing facility or it's environment, as is likely in most humanitarian settings, this motive can also have the opposite behavioural effect. Furthermore, disgust of the environment and facilities may be a stronger behavioural driver than disgust of dirty hands. We note the discrepancy between this finding and the motive rating exercise—disgust was not rated as a particularly important motivational driver of behaviour. While we can't say for certain, this may be in part because when thinking about behaviours, children have a tendency to think more of those with a positive association and because the disgust emotion stems from the automatic part of the brain, and when consciously considered with the executive brain, it is not recognised as a very important behavioural driver [21, 26].

To encourage children to practice handwashing with soap, we should ensure handwashing facilities are clean, have a consistent supply of water that is warm and soap that appears clean, are well lit, and are located close to latrines. Alternatively, providing private latrines in camps where households have their own handwashing stations of acceptable quality may also lead to improvements in post-latrine child handwashing practices. Though no previous studies have assessed the effect of latrine location on children's handwashing in a humanitarian setting, having a handwashing station within 10 paces of the toilet was associated with an increase in adult handwashing in a stable context [20].

We find participants of this study hold a strong expectation that families, especially mothers, should take responsibility for children's handwashing. This may have been accentuated by the camp setting; families live in close proximity within tents and extended family members often occupy neighbouring tents giving them ample opportunity to oversee the behaviour of others. Living in close proximity to others and sharing communal WASH facilities also likely strengthened the influence of social norms on children's handwashing behaviour; children reported that they performed handwashing to appear clean in order to avoid social stigma of themselves and their families by their community and so that other children would play with them. Similarly, in a school environment in Bangladesh, the presence of another person, particularly another child, was found to increase children's handwashing, and shame and stigma are also drivers of hygiene behaviour among adults [41]. These social norms may be a useful tool in future handwashing promotion interventions for children living in camp settings.

Children also felt that they could play an important role in the handwashing of their younger siblings, and they rated nurture (applied to themselves, not their parents) as one of the most important motives. This may be because children in the Sharia camp often take on caregiver roles; in the friendship-paired interviews, nine children reported a role in caring for younger siblings. The camp setting likely perpetuates this duty of care—children share a small living space with their siblings, spend more hours in the home than they did prior to

displacement (due to less time in school), and some have lost a parent due to displacement-related causes. Thus far, nurture has only been used in motive-based behaviour change interventions for adult caregivers in stable settings [28, 42]. Our study suggests that, in humanitarian emergencies, the nurture motive could be useful to drive children's handwashing behaviour. This may also be true in stable settings; Grover et al (2018) observed children in schools assisting younger children in handwashing and modelling handwashing techniques for other students [43].

Our study also adds support for the use of play in motive-based handwashing interventions for children in humanitarian emergencies. Children rated play as the most important motive in this study and this was one of two motivational drivers used in the concurrently-implemented proof-of-concept study [29]. It is noted that curiosity was also used as a motivational driver in the intervention study but was not rated as very important in our study. This may be because the intervention motivated children to wash their hands through play alone, or because curiosity was inaccurately conveyed in our pictures, a possibility given the notion of curiosity is more abstract than play. Not all children are highly motivated by the same drivers and, to have the greatest impact, motive-based interventions should consider using a set of motives. We find that in the Sharia camp an intervention targeting a set of four motives—play, nurture, affiliation and love—has the potential to motivate almost every child.

Perceived rates of handwashing with soap among children in the camp (50%-60%) were notably higher than actual rates measured in the concurrently-implemented proof-of-concept study (13%-32%) [29]. This disparity is likely attributed, in part, to the fact that perceived rates pertain to handwashing after toilet use, whereas actual rates pertain to handwashing at five key occasions. Nonetheless, perceived rates were high and may reflect the norms around social stigma discussed above—children believe that handwashing is occurring in private at the household more frequently than it is. Though we didn't measure the actual handwashing rates of each child in the paired interviews, studies have found a positive correlation between perceived peer handwashing frequency and own behaviour [44]. Rates may be improved by further enhancing the perception that other children are frequently practising handwashing and thus appealing to the motive of affiliation—a motive rated among the most important by children in our study.

In close alignment to some of the leading frameworks developed to describe the determinants of handwashing, the determinants we have identified in this study span multiple domains. The BCD framework puts forth that three domains of the environment—the physical, social and biological domain—determine behaviour (by acting as stimuli for an individual's brain, causing a change in their psychology and thereby in their behaviour) [27]. Similarly, the IBM-WASH framework organises determinants into three dimensions—the contextual, psychosocial and technological dimension [45]. The determinants we report here span the physical environment (access to handwashing technology, ease of use, etc.), the biological environment (e.g. environmental dirtiness inducing feelings of disgust) and the social environment (social norms, expectations, perceptions, stigma, etc.), and we find that the humanitarian context influences each of these domains, as well as dictating other factors falling slightly outside of their scope, such as exposure to hygiene promotion—a modification of the community context which is better described under the contextual dimension of the IBM-WASH framework. Recognising the diverse nature of handwashing determinants, humanitarian actors should look to multi-pronged approaches which alter the physical, social and biological environment in ways which both enable and motivate handwashing behaviour.

Our study had various limitations. Though friendship-paired interviews encourage participation, they bring the risk that children may influence each other's thoughts and responses [46]. In these interviews, we asked children to rate motives using cartoon pictures. We cannot be

certain that our depiction of the motives was interpreted as intended; this may be especially true for the more abstract motives such as curiosity, justice and status. However, there are currently no other tools available to measure these motives and we are encouraged by the alignment between emergent themes in the interviews and many of the motive ratings. Future studies may consider using video clips or real-life scenarios to portray motives and should check the understanding of each motive by asking participants to feedback their interpretation of each.

Another limitation related to the motive rating exercise was the qualitative sample size used in this study. Whereas logistic regression was useful in understanding how the different motives were rated among the study participants, it cannot be used to make population-wide inferences because this was a qualitative sample.

We report the perceived determinants of child handwashing. Discrepancies may exist between perceived and actual determinants. There was evidence of this in our study; most respondents believed that knowledge of disease and the benefits of handwashing are strong determinants of children's handwashing and that increased messaging would improve handwashing rates. However, it was apparent that handwashing promotion exposure was already very high in this camp and an increase is unlikely to impact children's handwashing rates. A study among adults in refugee camps similarly found that high exposure to hygiene messaging is not associated with high rates of handwashing with soap [37]. Despite this, we are confident that there is some alignment of perceived and actual determinants as we find convergence in the perceived and actual access to handwashing materials.

Finally, our study was limited to one camp, with a largely homogenous population, in one humanitarian context and thus, our findings may not be generalisable beyond this context. The humanitarian sector would benefit from similar studies in different humanitarian camps to determine if children's handwashing determinants and motivational drivers are common across these contexts, or to what extent handwashing interventions must be tailored to each context.

Conclusion

This is the first study of handwashing determinants among children in a humanitarian context. Future handwashing interventions for children in humanitarian emergency contexts should go beyond just the provision of basic soap and water facilities and hygiene messaging and give equal consideration to their quality and location. Besides infrastructural improvements, interventions should harness existing social norms and consider using a set of motivational drivers to improve rates of handwashing with soap among children living in humanitarian settings.

Supporting information

S1 Appendix. Interview guides.
(PDF)

S2 Appendix. Motive pictures and terms.
(PDF)

S3 Appendix. Coding structure.
(PDF)

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CHAPTER 5

Research Paper 3: Child's play: Harnessing play and curiosity motives to improve child handwashing in a humanitarian setting

The following research paper addresses research objective 3): to test the use of play and curiosity-based motives in a rapidly deployable HWWS intervention for older children in an emergency context.

As mentioned in the introductory chapter, the initial idea of embedding a toy inside of a bar of soap to improve children's handwashing in an emergency setting was conceived by Save the Children, following the HIF's call for proposals to design and test innovative handwashing interventions in emergencies. At the request of Save the Children, I agreed to lead this research and write the funding proposal and a partnership was formed between LSHTM and Save the Children, as well as Field Ready - a NGO that manufactures, supplies, and repairs equipment used in humanitarian emergencies. Field Ready's role was to support the design and manufacture of a soap product which was culturally appropriate, appealing, and attractive to the children living in Sharia IDP camp.

I supported Field Ready in holding a series of rapid prototyping workshops with a group of 15 children in Sharia camp - a Yazidi displacement camp in Northern Iraq - to understand the children's preferences in terms of the toy embedded inside of the soap as well as the soap's size, shape, colour, and smell. Based on the children's preferences, Field Ready produced several toy-in-soap prototypes (using 3D printing to rapidly create different toys) which were presented to the children for feedback, after which they were refined and presented again. This iterative process continued until the final product was agreed – a colourful, translucent, round bar of soap with different toy animals, of various colours, embedded inside. The below photographs show an example of 3D printed penguin toys, the toys embedded inside the soap, and the final packaged toy-in-soap product, now known as 'Surprise Soap'.

Figure 5: Photographs of Surprise Soaps

We decided that the Surprise Soap should be delivered at the household level so that it was inclusive of both children in and out of school. I led the design of the household session in which it was delivered. Given the need for interventions in emergency settings which are rapidly deployable, the session was designed to be delivered in under ten minutes and activities were kept simple to keep training requirements to a minimum. As we wanted to test an intervention based on the motives of play and curiosity, and given that evidence suggests health is not a strong motivator of behaviour change, the session omitted any health-based messaging and instead focussed on incorporating a fun-based activity – a glitter game depicting germs spreading between children's hands. A demonstration was also given to ensure that children understood how to wash hands with soap correctly.

This intervention was tested in a controlled before-after study for which I led the design, implementation, analyses, and reporting. The results of this study are presented in the published research paper attached below.

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Child's play: Harnessing play and curiosity motives to improve child handwashing in a humanitarian setting

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ABSTRACT

In humanitarian emergency settings there is need for low cost and rapidly deployable interventions to protect vulnerable children, in- and out-of-school, from diarrhoeal diseases. Handwashing with soap can greatly reduce diarrhoea but interventions specifically targeting children's handwashing behaviour in humanitarian settings have not been tested. Traditional children's handwashing promotion interventions have been school-focused, resource-intensive and reliant on health-based messaging. However, recent research from non-humanitarian settings and targeting adults suggests that theory-based behaviour change interventions targeting specific motives may be more effective than traditional handwashing interventions. In this proof-of-concept study we test, for the first time, the distribution of a modified soap bar, designed to appeal to the motives of play and curiosity, in a household-level, rapidly deployable, handwashing promotion intervention for older children in a humanitarian setting - an internally displaced persons camp in Iraqi Kurdistan. Out of five total blocks within the camp, one was assigned to intervention and one to control. 40 households from each assigned block were then randomly chosen for inclusion in the study and the practice of handwashing with soap at key times was measured at baseline and four weeks after intervention delivery. Children in intervention households received transparent soaps with embedded toys, delivered within a short, fun, and interactive household session with minimal, non-health-based, messaging. The control group received plain soap delivered in a short standard, health-based, hygiene promotion session. At the 4-week follow-up, children in the intervention group were 4 times more likely to wash their hands with soap after key handwashing occasions than expected in the counterfactual (if there had been no intervention) based on the comparison to children in the control group (adjusted RR = 3.94, 95% CI 1.59–9.79). We show that distributing soaps with toys embedded inside, in a rapidly deployable intervention, can improve child handwashing behaviour in a humanitarian emergency context. Further studies are needed to determine the longer-term behavioural and health impact of such an intervention when delivered at a greater scale in a humanitarian context.

1. Introduction

Handwashing with soap (HWWS) is one of the most cost-effective public health interventions (Jamieson et al., 2006) and reduces the risk of both diarrhoeal and respiratory disease by over 20% (Aiello et al., 2008; Freeman et al., 2014). Most deaths from diarrhoeal disease and acute respiratory infections (ARIs) occur in children under five (GBD Diarrhoeal Diseases Collaborators, 2017; Liu et al., 2015), but their disease burden is also substantial in older children (Institute for Health Metrics and Evaluation, 2016), categorized as ages 5–14 by the Global Burden of Disease studies (GBD, 2016 Causes of Death Collaborators, 2017). Globally, diarrheal diseases and ARIs account for 12% of all deaths among children ages 5–14 and rank among the leading causes of mortality in this age group (Institute for Health Metrics and Evaluation, 2016). Children are particularly vulnerable in humanitarian emergencies where there is a heightened risk of disease transmission due to compromised public health infrastructure, crowded households, environmental contamination, and limited access to basic water and sanitation facilities (Connolly et al., 2004; Kouadio et al., 2012). It is estimated that 201 million people across 134 countries are in need of

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international humanitarian assistance (Development Initiatives, 2018).

Despite the well-known benefits of HWWS, handwashing rates remain low in both stable and humanitarian emergency contexts (Biran et al., 2012; Freeman et al., 2014; Phillips et al., 2015). There is limited evidence for effectiveness of handwashing promotion interventions targeting children in general, but particularly in humanitarian emergencies (Watson et al., 2017). Historically, existing handwashing promotion interventions have focused on caregivers of young children. Those that have specifically targeted children have been predominantly school-based, failing to reach out-of-school children and inappropriate for implementation in the early stages of emergencies when schools and child-friendly spaces have yet to be established (McCambridge et al., 2014; Vujcic et al., 2015).

Traditional handwashing promotion interventions in both stable and emergency settings have also focused on messaging around the health-related risks associated with germs (Biran et al., 2009; Ejemot-Nwadiaro et al., 2015; Phillips et al., 2015; Vujcic et al., 2015), however studies have shown that health is often not an effective motivator of behaviour change (Biran et al., 2009; Curtis et al., 2009) and health-based interventions have had mixed success in a number of emergency settings, including refugee camps in South Sudan, Thailand, Kenya, and Ethiopia (Biran et al., 2012; Phillips et al., 2015). Furthermore, these traditional interventions use education-based and knowledge-based messaging which requires skilled health workers to deliver the messages, who are typically overstretched or undersupplied in emergency settings, so that the messages are difficult to deliver consistently (Contzen et al., 2015; Greenland et al., 2017; Rajaraman et al., 2014). They are therefore not amenable to the rapid deployment necessary in humanitarian response. Hygiene promotion that is less reliant on skilled and trained health workers delivering messages repeatedly may have more success in large scale interventions.

Recent research from stable settings has demonstrated success in handwashing promotion using motivational rather than health-based messages (Biran et al., 2014). The use of motives in behaviour change interventions is supported by the Evo-Eco theory which postulates that 15 latent human motives have evolved to drive behaviour in all human experiences and solve evolutionarily important goals, for example, finding food or a long-term mate (Aunger and Curtis, 2014). In particular, 'disgust', 'nurture' and 'social affiliation' have been used within multiple interventions to change handwashing behaviour in stable settings (Biran et al., 2014). The explicit use of motives to improve children's HWWS behaviour, however, has not yet been implemented in a humanitarian emergency setting. Two of the motives presented in the Evo-Eco theory which seem intuitively relevant for use in handwashing promotion interventions targeting children are 'play' and 'curiosity' (Perry et al., 2000). Play is essentially concerned with learning new skills in relatively low-risk contexts (for example, playing with dolls can teach nurturing skills), while curiosity is about actively seeking out new information that may prove helpful in solving a variety of future problems. Many handwashing interventions targeting children have involved some elements of play and curiosity, but no previous studies have formally focused on these motives as a mechanism of behaviour change.

In resource scarce environments, education or knowledge-based messaging, whether focussed on health or other motivational drivers, face a number of limitations, as we discuss above. There have, more recently, been some approaches to delivering hygiene promotion that do not rely on this traditional messaging, for example, the modification of tools or hardware to 'nudge' children to wash their hands (Dreibelbis et al., 2016). However, though promising, these alternative approaches have been tested in very controlled and limited settings and were largely theoretical in their application (Dreibelbis et al., 2016). Whether the modification of hardware and tools to drive handwashing behaviour can be considered an effective behaviour change technique (Michie et al., 2015) in handwashing promotion for children in emergency settings is yet to be determined.

In this proof-of-concept study we test the hypothesis that a rapidly deployable and simple household intervention, designed to appeal primarily to the motives of play and curiosity using a modified bar of soap delivered in a fun and interactive session, can increase handwashing at key occasions by older children in a humanitarian emergency setting. Our intervention is specifically designed to require little formal training of implementers and is targeted at the household level to reach in- and out-of-school children, both of which are important in the acute and recovery phase of an emergency where schools and child-friendly spaces may not yet be established. Our intervention consists of the distribution of a specially designed soap product - a bar of soap with a toy embedded inside, hereinafter referred to as 'toy soap'- which, theoretically, should incentivize children to wash their hands with the soap in order to reach the toy. A recent trial of a similar a toy-in-soap product in a non-emergency context suggested that improvements in child handwashing may be associated with the distribution of these modified soaps but some their results lacked statistical power (Burns et al., 2018). Our intervention, led by hygiene promoters, is delivered within a 5–10 min interactive session with a number of children in the household. This session also aims to incorporate play and curiosity using a 'glitter game' to demonstrate how germs are transmitted from one hand to another, after which toy soap supplies are handed out.

2. Material and methods

2.1. Study setting

The study took place in Sharia Camp, an Internally Displaced Persons (IDP) camp located in the Dohuk Governorate of the Kurdistan Region of Iraq, a part of the country with a relatively stable security situation. Sharia Camp is easily accessible by road and is managed by the Board of Relief and Humanitarian Affairs (BRHA) – a governmental body within the Dohuk government structure. IDPs in this camp are exclusively from the Yezidi community, originating from the Sinjar region of Northern Iraq. Most have resided in Sharia Camp since 2014 when the Islamic State of Iraq and the Levant (ISIL) entered Sinjar. The camp has a population of over 17,000 with over 37% of this population comprising children under the age of 12 (Duhok Governorate Board of Relief and Humanitarian Affairs, 2016). The camp population is accommodated in tents with access to communal latrine blocks, shower units, and a largely consistent water supply at water points, though many families have purchased water tanks to store water in or near their tent. With the addition of a bucket these water tanks also act as handwashing stations in the home.

2.2. Study design and eligibility criteria

We used a controlled before-and-after (CBA) study design to test the hypothesis that a short and rapidly deployable handwashing intervention which appeals to the motives of play and curiosity can improve the handwashing of older children between the ages of 5 and 12 (primary school-age) in a humanitarian emergency context. The study site was selected in coordination with Save the Children as the IDP population in Sharia camp was stable and access to water and sanitation was consistent.

Sharia Camp was divided into 5 blocks, A-E. Block B and D were selected for participation in this study to minimise intervention contamination as these blocks are the furthest distance apart. Block D was randomly assigned to the intervention group and block B to the control group using a coin toss. Field workers recruited households in each section using a list of household numbers generated with a random number table which included all household numbers in each section. Eligible households had a least one child between the age of 5 and 12 who would likely be at home during a 3-h observation period (9AM-12PM). This observation period was appropriate to capture both school-going and non-school-going children since children in Sharia camp

attend school either in the morning or in the afternoon according to assignment by camp management, which varied between households within each block. At the time of this study, Save the Children were delivering hygiene promotion in schools, child-friendly spaces, and during household visits. Exposure to all past and current hygiene promotion activities was the same across all camp blocks.

2.3. Sample size

A total of 80 households (40 households per study arm) were recruited to the study. As a proof-of-concept study, its main objective was to determine the behavioural impact of the intervention, and specifically whether such an intervention *could* change handwashing behaviour. As such, the sample size of 80 households was not determined through a formal power calculation but by taking in to account population diversity, and budgetary and time constraints. As the entire camp population are of a single ethnicity and since this is a single camp setting, social and environmental factors were anticipated to be similar across households. The sample size was thus deemed sufficient to reflect the range of socio-economic and household dynamics within the study area. We calculated, *a priori*, that 40 households in each study arm would result in a minimum detectable effect (MDE) equivalent to a risk ratio (RR) of 1.45–3.6 for baseline handwashing rates ranging from 10% to 60%, 80% power, and 5% significance.

2.4. Intervention content and delivery

The intervention was delivered over one weekend when children were most likely to be in the home. Hygiene promoters who were already active in the camp with Save the Children were trained to deliver the intervention. In pairs, hygiene promoters delivered five toy soaps to each intervention household. Toy soaps were transparent, and all five soaps featured a different toy animal inside (a photograph is available in the supplementary material). The shape and volume of the toy soap was selected to make breaking the soap open as difficult as possible. Hygiene promoters visited each household and played a glitter game with the children to demonstrate how germs are spread: one child's hands were covered with petroleum jelly and glitter and they were asked to 'high five' other children, transferring the glitter from hand-to-hand, followed by a demonstration of how to remove the glitter 'germs' from their hands using the toy soap and seven steps of handwashing. No health-based messages were given. Children were not instructed on which key occasions to hand wash, but hygiene promoters explained that the more they washed their hands with the soap the faster they would reach the toy. At least one adult of the household, usually a caregiver, was present during intervention delivery but they were not instructed in any way about the use of these toy soaps. All soaps for the study were designed and manufactured in Kurdistan by Field Ready (UK) using insights generated in a prototyping workshop with children from Sharia camp. Children who participated in the insight study were not part of this study. As the toy soaps were previously unknown to the children in the intervention households, the assumption was that presentation in this way would inspire curiosity to learn more about them (for example, to find the toy through use). Similarly, the toy inside the soap signifies to children that the soap can be part of their play activities, which would also stimulate use.

We employed an active control where households received five plain soaps which were identical to the toy soaps in colour, size, shape, volume, and quality except that they did not contain a toy inside. To control for the effects of household delivery, these plain soaps were also distributed to children in the control households by hygiene promoters who delivered a standard Save the Children handwashing promotion session lasting 5–10 min and consisting of standard health-based messages on disease risks associated with germs, the key moments for handwashing, and a demonstration of the seven steps of handwashing. These messages were the same as those given during existing handwashing promotion activities taking place in the camp at the time of the study. Children in control households did not play the glitter game.

2.5. Outcomes of interest

The primary outcome for the study was the proportion of key handwashing occasions that were accompanied by handwashing with soap (both hands) for children age 5–12. The five key occasions specified were: (i) after using the toilet, (ii) before eating, (iii) before preparing food, (iv) before serving food to another person and, (v) after cleaning another child's faeces.

Three secondary outcomes served as indicators of intervention compliance and included the proportion of households reporting 'toy cheats' (households in which children broke one or more soaps to retrieve the toy); the proportion of households which had used at least one soap; and the proportion of households with toy soap that was wet on inspection from those households with at least one toy soap remaining at follow up.

2.6. Data collection

All data collection was undertaken by field workers, recruited from the Sharia camp, who received formal training in the relevant data collection techniques. After enrolment, participating households completed a brief socio-demographic survey and, during the two weeks before intervention delivery, fieldworkers collected baseline data on child handwashing in the household through structured observations. To minimise the risk of bias, households were informed that the field workers would be observing all household activities around water use and did not reveal that they were specifically observing handwashing. Field workers conducting the observations had no involvement in the intervention and households belonging to family or immediate neighbours of the field workers were excluded from participating in the study. No further blinding of study participants was possible. Observations lasted for 3 h (9AM-12PM). Field workers positioned themselves in an unobtrusive location in or near the household tent with a view of the handwashing station or area. One index child between the age of 5 and 12 was selected at random at the time of data collection. Data were collected on all key occasions for handwashing observed and reported whether the child washed hands with soap, just water, or did nothing at the appropriate moment associated with each key occasion.

Four weeks after intervention delivery, field workers returned to the households to conduct an endline structured observation of handwashing for another index child selected at random. Directly after the endline structured observation, field workers recorded information on 'toy cheat' events where children had broken the soap bars to get to the toy.

2.7. Data analysis

Data was cross-checked by the field supervisor on a daily basis. All statistical analysis was undertaken using Stata Version 14 (StataCorp, 2015, USA). As this was a proof-of-concept study, we conducted a per-protocol analysis to estimate the effect of the intervention on handwashing (Hernan and Robins, 2017). To estimate effect, we calculated a risk ratio (RR) using a difference-in-differences (DID) analysis via a multilevel mixed effects Poisson model (Stata command: *meqrpoisson*) to account for within-subject correlation due to repeated measures and clustering at the block level (Austin et al., 2018). Adjusted RRs along with corresponding 95% confidence intervals were calculated to control for the potential confounders determined *a priori* (age, sex, number of children age 5–12 in the household, and number of people earning in the household).

2.8. Ethics statement

The study was reviewed and approved by the London School of Hygiene and Tropical Medicine Ethics Review Committee (Ref: 14,483) and the Hawler Medical University Ethics Review Committee in Erbil (Ref: 1/16). The study was also approved by the Board of Relief and Humanitarian Affairs (Ref: 365) and the Directorate of Preventative Health Affairs in Dohuk Province (Ref: 7787). Written informed consent was sought from all participating households. Control households received the toy-based intervention after completion of the study.

3. Results

3.1. Participants and baseline data

The study ran from March–April 2018. 40 households were enrolled in the control arm and 40 households in the intervention arm. Five households were lost-to-follow-up because they left the camp and two households did not receive the intervention due to failure to locate the correct households during intervention delivery. A further two households were excluded from the analysis because none of the five key handwashing occasions were observed to occur at follow-up. Complete data was obtained from 33 households in the intervention group and 38 households in the control group. Characteristics of the index children observed are shown in Table 1. Household characteristics were similar between groups at baseline (Table 2).

3.2. Intervention compliance

Field workers measured the number of toy cheats and indicators of soap use in the intervention group at the end of the study. Only 3% (n = 1) of intervention households reported toy cheats; all others reported that the children reached the toys via handwashing. At the four-week follow up, 97% (n = 32) of households had finished at least one soap, 61% (n = 20) of households still had some toy soap remaining and, of those households, 85% (n = 17) had toy soap that was wet on inspection.

3.3. Handwashing with soap

Baseline prevalence of handwashing after key handwashing events was 24% (95% CI, 14%–36%) in the intervention group and 32% (95% CI, 23%–42%) in the control group. At endline, the prevalence of HWWS at key events in the intervention group increased by 16 percentage points to 40% (95% CI, 29–53%) and decreased by 19 percentage points to 13% in the control group (95% CI, 8%–21%). After adjustment, children in the intervention group were 4 times more likely to wash their hands with soap after key handwashing occasions compared to the counterfactual represented by children in the control group after adjusting for baseline handwashing rates (adjusted RR = 3.94, 95% CI 1.59–9.79; Table 3).

Table 1
Index child characteristics.

Group	Baseline		Endline	
	Age (mean)	Sex (male)	Age (mean)	Sex (male)
Intervention (n = 33)	8	45%	8	55%
Control (n = 38)	8	50%	8	42%
P value	0.3[a]	0.7[b]	0.4[a]	0.3[b]

[a] Poisson Regression.
[b] Pearson Chi-square test.

4. Discussion

This is the first study to evaluate the use of a novel toy-in-soap product to motivate HWWS behaviour in a humanitarian setting. This proof-of-concept study provides evidence that targeting motives of play and curiosity using a toy soap delivered in a short and rapidly deployable handwashing promotion intervention can improve children's handwashing behaviour in a long term IDP camp. Children receiving our intervention were four times as likely to wash their hands with soap after key events one month after intervention delivery compared to the counterfactual, represented by children in the control group.

Importantly, our study adds to the limited evidence base for WASH interventions in emergencies (Blanchet et al., 2017). The evaluated intervention is rapidly deployable, does not require intensively trained hygiene promoters for implementation, and can reach children outside of schools and child-friendly spaces. These features are important in emergency settings where the risk of disease transmission is high and there is a large influx of people and minimal public health infrastructure, necessitating rapidly deployable and scalable hygiene interventions, especially in the acute phase of an emergency. Our intervention may be more suitable for use in emergency settings than traditional message-based approaches which require highly trained hygiene promoters who are difficult both to find and to sustain in emergency settings, limiting the speed at which the intervention can be deployed and scaled (Phillips et al., 2015; Vujcic et al., 2015).

Thus far, most handwashing promotion interventions for children have relied on education or knowledge-based messaging and didactic informative transfer (Watson et al., 2017). Our findings complement those of a recent cluster-randomised trial preceded by a proof-of-concept study which showed that a non-message-based 'nudge' intervention can improve children's handwashing behaviour and is as efficacious as a high-intensity hygiene education intervention (Dreibelbis et al., 2016; Grover et al., 2018a). That intervention combined infrastructural improvements with environmental nudges, including paved pathways connecting latrines to handwashing stations and footprints and handprints on infrastructure, without any other handwashing promotion activities or messages. While our toy soap intervention is incentive-based rather than a 'nudge', our results also suggest that innovative design and hardware intervention components together, when combined with minimal, interactive, non-didactic messaging, may achieve large increases in HWWS behaviour among children.

Our findings also add to existing evidence (Aunger et al., 2010; Biran et al., 2009, 2014) that the use of motivational drivers - primarily nurture and disgust (Curtis et al., 2009) - can support successful handwashing promotion interventions, although there are also examples where such interventions have had limited success (Greenland et al., 2016). Here we show that a toy-in-soap intervention that aims to appeal to the motives of play and curiosity can be effective in changing child handwashing behaviour in an emergency setting and may be well suited to hygiene interventions specifically targeting children.

Previous research on the use of motivational drivers in handwashing promotion has come from interventions predominantly targeted at caregivers of young children (Biran et al., 2014; Greenland et al., 2016). While not the target of our intervention activities, caregivers may have also had an important role to play in the success of this intervention. Our intervention was delivered to children in the household in the presence of their caregivers and these caregivers may likely have encouraged children to use the toy soap and prevented them from breaking the soap to reach the toy inside; only one household in our study reported 'toy cheats'. Though this very low number of toy cheats presumably reflects a degree of response bias, it is likely the number would have been substantially higher in the absence of caregiver supervision. Delivering our handwashing intervention at the household level may have enhanced or even determined the effectiveness of the intervention via the additional caregiver input.

Five toy soaps were distributed to each intervention household at

Table 2
Household characteristics at baseline.

Variable	Intervention (N = 33)	Control (N = 38)	P Value
Number of household members earning	0.4	0.4	0.7[a]
Household head education level (score)	0.2	0.3	0.8[b]
Total number in household	7.2	7.7	0.5[a]
Number of < 5 children in household	1.0	1.1	0.8[a]
Number of children 5–12 in household	2.4	2.8	0.3[a]
Length of time in the camp (months)	38.6	39.7	0.4[a]
Soap present in household (%)	88	79	0.3[c]
Water available in household (%)	97	100	0.3[c]
Handwashing station in the household (%)	97	97	0.6[c]
Handwashing prevalence (%)	24	32	0.3[c]

[a] Poisson Regression.
[b] Two-sample Wilcoxon rank-sum test.
[c] Pearson Chi-square test.

Table 3
Effect of the intervention on handwashing with soap.

	HWWS Prevalence			DID analysis		
	Baseline	Endline	Difference	Risk Ratio[a]	95% CI	*P*-value
Intervention	24%	40%	+16%	3.94	1.59–9.79	0.003
Control	32%	13%	−19%			

Difference-in-difference analysis via multilevel mixed effects Poisson model.
[a] Adjusted for age, sex, number of children age 5–12 in the household, and number of household members earning an income.

the start of the study. At the four-week follow-up, 97% of intervention households had finished at least 1 bar of toy soap, indicating that nearly every household had engaged to some extent with the intervention. 39% of households had finished all 5 bars of soap. Of the intervention households who did have toy soap remaining, 85% had a bar of toy soap that was wet on inspection indicating at the four-week follow-up households were still engaging with the intervention.

We report a large behavioural impact four weeks post-intervention delivery; however, we did not assess whether these behaviours were sustained beyond this. It is unclear how long children's interest in the toy soap would continue, the duration of which is likely the key determinant of the intervention's behavioural and health impact. If interest in the toy soap proves to be short-term, this intervention is likely to be most useful in the acute and recovery phase of a humanitarian emergency (typically the first six months) when disease transmission is highest, resources are stretched, and before basic public health infrastructure, such as adequate drinking water and sanitation, may have been established (Connolly et al., 2004). An alternative hypothesis that warrants investigation is that frequent use of the toy soap may lead to habit formation such that the targeted behaviour of HWWS might be sustained after the toy soap is finished and/or after the children have lost interest in the toy soap. Future trials might adjust analysis for soap remaining at endline to assess if the increased HWWS behaviour seen in this study continues after toy soap is finished.

Our study has important limitations. Although our groups appeared well balanced, there was a differential drop-out rate in the intervention (7/40) and control (2/40) groups that may reflect some underlying difference between these two groups that may bias our results. We used structured observations to measure handwashing. While this is considered to be the 'gold standard' of measuring handwashing behaviour (Biran et al., 2008) it is still at risk of social desirability bias (Ram et al., 2010) and observer bias, especially as blinding of observers and participants was not possible. The 'Hawthorne Effect' (McCambridge et al., 2014) is also a risk; children may modify their behaviour in response to their awareness of being observed (Grover et al., 2018b; Ram et al., 2010). The HWWS prevalence in both groups recorded at baseline was relatively high (32% control, 24% intervention). At endline, HWWS prevalence in the control group was significantly lower at 13% (−19 percentage points) which suggests some degree of reactivity bias observed in our baseline data then dissipating at endline. Future studies may benefit from multiple observations prior to the intervention period to better assess reactivity in baseline observations. We hypothesize that our intervention effectively targeted the motives of play and curiosity in this context; however, we were unable to develop specific measurements of these latent, complex constructs. This is a common limitation of motive-based interventions (Biran et al., 2014) and highlights a need for better measurement systems that allow individual motives to be tested.

Our proof-of-concept study was limited to 71 households in just one IDP camp with an entirely Yezidi population, and in one humanitarian context. Trials with a larger number of households and across different humanitarian contexts are needed to validate the findings and ascertain the generalisability of our intervention to different humanitarian emergency populations. Furthermore, this intervention was purposefully conducted in an IDP camp where water supply was consistent and plentiful. In some humanitarian emergency settings where water is scarcer, use of the toy soap may be less frequent, potentially altering the impact of our intervention. In Sharia camp, the setting for our intervention, children were also receiving health-based handwashing messages from hygiene promoters in school and child-friendly spaces at the time of our intervention. More research is needed to determine if our intervention can standalone or if its success is interlinked with the presence of other handwashing promotion activities.

5. Conclusions

Our study demonstrates that the use of a theory-based hygiene intervention designed to target both play- and curiosity-based motives through innovative hardware and software components is associated with increases in handwashing with soap among older children. Our results provide evidence that this readily deployable intervention may be effective at increasing child handwashing practices in a humanitarian setting while facilitating rapid implementation in an often chaotic humanitarian emergency context. We argue that hardware intervention components should no longer be viewed as distinct from software 'behaviour change' components, as has been the tradition in handwashing interventions, especially in emergency settings (Vujcic et al., 2015). This approach should be considered an effective behaviour change technique in handwashing promotion for children. Our positive findings provide justification for future efficacy studies to assess the effect of such an intervention on handwashing behaviours and related health outcomes (such as diarrhoea) when delivered at greater scale and in the context of a humanitarian response.

Conflicts of interest

The authors declare no conflict of interests.

Acknowledgements

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ijheh.2018.09.002.

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CHAPTER 6

Research Paper 4: Practitioner's perspectives on the challenges and solutions to changing handwashing behaviour in older children: a qualitative study

The following research paper addresses research objective 4): understand NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children.

As per the journal's requirements, US spelling is used.

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Primary Supervisor	Dr. Robert Dreibelbis		

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Practitioner's perspectives on the challenges and solutions to changing handwashing behaviour in older children: a qualitative study

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Role of Authors

JW conceived of the study, conducted the interviews, analysis and interpreted the data, and led the writing of the manuscript. RD contributed to the study design, analysis and interpretation of the data and was a major contributor to writing the manuscript. OC contributed to the study design, interpretation of the data, and was a major contributor to writing the manuscript. All authors read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

Practitioner's perspectives on the challenges and solutions to changing handwashing behaviour in older children: a qualitative study

Abstract

Background: Increasing handwashing with soap (HWWS) among older children (age 5-14) can achieve a significant public health impact. However, HWWS interventions targeting older children have had mixed success and it is unclear what determines their effectiveness. Recent research has attempted to quantitatively identify effective intervention techniques; however, intervention success is likely also influenced by the wider context of implementation. This study explores NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children to enhance understanding of what is required, beyond just intervention content, for these interventions to be effective.

Methods: We conducted, in-depth, semi-structured interviews in 2020 with 25 practitioners employed across 11 NGOs and involved in HWWS interventions targeting older children in development and humanitarian settings. Purposive and snowball sampling were used to recruit participants holding global, national/regional, and local-level roles. Interviews were audio recorded, transcribed, and thematically analyzed to identify challenges and solutions to HWWS interventions targeting older children. Results were organised according to program development cycle stages.

Results: 12 themes relating to perceived challenges emerged: (i) lack of prioritization; (ii) funding inconsistency; (iii) insufficient formative research; (iv) demand on resources; (v) unengaging intervention content ; (vi) non-enabling physical environments; (vii) availability of skilled implementers; (vii) reaching out-of-school children; (ix) community mistrust (x) lack of coordination (xi) lack of evaluation rigour; and (xii) failure to assign older children's HWWS as a primary outcome in evaluations of hygiene interventions. Recommended solutions were at the intervention level, e.g., designing low-cost interventions, the organization level, e.g., building implementer capacity, and the sector level, e.g., standardizing implementation tools.

Conclusion: Intervention design and delivery are important for the success of HWWS interventions for older children but are not the only factors. Wider contextual factors such as the availability of human and material resources and level of coordination within and beyond the NGO sector should also be considered. NGOs need to prioritize HWWS promotion among older children and resource programs accordingly.

Teaser Key Messages

Older children's handwashing behaviour has long been overlooked by the NGO sector and should be made a top priority. Changes throughout the programme cycle, including designing lower-resource, more engaging interventions, building implementer capacity, and ensuring better inter and intra-sectoral coordination, are necessary to improve intervention success.

Key Findings

- We report NGO practitioner's perspectives on the challenges to changing older children's handwashing behaviour and find that older children are often overlooked in existing hygiene programs.
- Practitioners report that most handwashing with soap (HWWS) interventions targeting older are too resource-heavy, unengaging, and are implemented within non-enabling physical environments, and there is little evidence of success.
- Lack of coordination with and between sectors creates major challenges to the implementation of HWWS interventions targeting children.

Key Implications

- The NGO sector should make improving older children's handwashing behaviour a top priority and resource programs accordingly.
- NGO Practitioners should balance resource needs against using evidence based, engaging approaches that address the drivers of handwashing among older children.
- NGOs should foster better intra- and inter-sectoral coordination to overcome challenges related to the integration of HWWS promotion within existing educational institutions, the standardization of implementation tools, and the sustainability of interventions.

Introduction

Handwashing with soap (HWWS) at critical times is one of the most effective ways to reduce the spread of infectious disease. Meta-analyses suggest that HWWS can lead to reductions in diarrhoeal disease by 23%-43% (1-3) and acute respiratory infections (ARIs) by 21%-23% (4, 5) . HWWS has also been associated with reductions in neglected tropical diseases such as trachoma (6) and some soil transmitted helminth infections (7).

While the largest burden is borne by children under-5 diarrhoea and ARIs account for over 14% of mortality among older children (age 5-14) and are the 3rd and 4th leading causes of death respectively in this age group (8). Improving HWWS among older children has significant public health potential. Not only does HWWS reduce disease transmission, but it is also associated with reduced rates of school absenteeism (9-13) which may lead to improved academic attainment (14, 15) and associated economic and health benefits later in life (16). Keeping children is schools is also important for access to vaccination and nutrition programs, access to mental health and psychosocial support services, and child protection risks (17-19).

The responsibility for younger children's HWWS usually falls to the caregiver and thus interventions aimed at reducing infectious disease transmission among young children are typically targeted at the caregiver-level. However, older children are more independent; they may be joining or are already in school and have more agency over the cleanliness of their own hands. Habits are formed during older childhood which may persist into adulthood (20-22). Older children may also act as agents of change among their peers, encouraging others to practice HWWS (23-28).

Wide-scale HWWS programs targeting older children are typically a major component of an outbreak response, specifically school-based programs designed to improve handwashing behaviours to prevent the spread of respiratory and gastrointestinal infections between students and to the broader community (10, 11, 29-31). Recently, programs aimed at encouraging older children to perform regular HWWS in school have been central to safe school-reopening strategies and for preventing school closures (32).

Despite the clear need for effective interventions targeting HWWS practices among older children, there is a dearth of evidence on how best to design and deliver these interventions. HWWS interventions targeting older children are predominantly school-based or focused on child-friendly spaces (CFS) - safe places set up in an emergency-affected community which help children return to a normal routine by offering activities, games and informal education - and are implemented by teachers or hygiene promoters (33-35). Health education and health-related knowledge transfer

largely drive these interventions and have had mixed success (34-36). In a recent systematic review, some specific intervention techniques that may be effective in increasing older children's hand hygiene were identified, however, this review did not consider the wider context of implementation which may influence effectiveness (34).

Non-governmental organizations (NGOs) are often engaged in HWWS programs in development and humanitarian emergency settings (33). NGO practitioners can therefore offer invaluable insights into the challenges facing HWWS interventions targeting older children and make pragmatic recommendations to improve effectiveness. Prior research exploring NGO practitioner's perspectives on challenges to hygiene promotion have been limited to humanitarian context only and have not focused on HWWS interventions targeting older children (37, 38). In this study we qualitatively explore the challenges to HWWS interventions targeting older children and recommended solutions from the perspective of NGO practitioners involved in the design, coordination, implementation, or evaluation of child-targeted HWWS interventions.

Methods

Study Design

A qualitative study involving in-depth, semi-structured interviews followed by inductive thematic analysis was undertaken to provide a nuanced and detailed account of the participants' perceptions of challenges to HWWS interventions for older children and recommended solutions related to these challenges.

Participants and Sample Selection

Participants were NGO practitioners involved in designing, coordinating, implementing, and/or evaluating HWWS interventions targeting older children in development and humanitarian settings. This was the only eligibility criterion.

Purposive sampling was used to recruit information-rich participants via several channels. Firstly, we directly contacted eligible individuals within our existing network to seek their consent to participate (n = 6). Concurrently, additional participants were recruited through the Global WASH Cluster – a global network of humanitarian water, sanitation, and hygiene (WASH) agencies - via an advertisement inviting interested network members to participate. Individuals who made contact were assessed for eligibility (n=11) and those found to be eligible invited to participate (n=8). Additional

participants were recruited via referral from those already enrolled in the study (n=11). All communications prior to interview were via email.

To capture a broad range of views and achieve theoretical saturation, we aimed to recruit a minimum of 18 practitioners employed across 6 or more NGOs, with at least 6 practitioners working at a global level, 6 at a regional or national level, and 6 at a local level. This initial target sample size of 18 was guided by previous similar research (39-43) but we continued recruitment until data reached theoretical saturation.

Data collection

In-depth, semi-structured interviews were undertaken remotely via the Zoom virtual meeting platform (Zoom Video Communications, Inc., San Jose, California) between April and November 2020. All interviews were conducted in English by the lead author (JW) – a female academic researcher experienced in conducting and analysing qualitative research. Interviews lasted between 45 and 90 minutes and were audio recorded using the Zoom recording function. An interview guide developed and piloted by the authors was used to facilitate the discussion towards the challenges and solutions to HWWS interventions for older children but did not mandate rigid adherence to the questions, or the order in which they appeared in the guide. Participants were encouraged to consider the determinants of older children's handwashing behaviour, discuss approaches to HWWS promotion they had experienced in the past, and give recommendations for future interventions. The full interview guide can be found in Supplementary File 1.

Data management and Analysis

Audio recordings were transcribed verbatim, transcripts were imported into QSR Nvivo 12 for analysis, and a thematic analysis of the transcripts was undertaken by the lead author following the six-stage approach suggested by Braun and Clarke (44). This approach entails 1) becoming familiar with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining themes, and 6) writing up. An inductive approach to coding was adopted to avoid making preliminary assumptions and to allow themes to emerge from the data. Emergent themes related to challenges and related solutions, were then organized along 4 key stages of the program development cycle – stage 1: funding acquisition, stage 2: design, stage 3: delivery, and stage 4: evaluation (45). The coding structure can be found in Supplementary File 2. Direct representative quotations of the participant's opinions are presented to support our analysis, however, to protect participants' identity we only attribute the quotation to the participant's gender and the level of their role in the organization (global, regional/national, or local).

Ethical Approval

Ethical approval for this study was granted by the London School of Hygiene and Tropical Medicine Ethics Review Committee (ref. 14483) prior to contacting participants. Participants were provided with a Participant Information Sheet detailing the study prior to giving written consent via email, and subsequent verbal consent at the start of the interview.

Results

Participants

A total of 25 participants were interviewed from across 11 different NGOs operating in both development and humanitarian settings. 10 of these were international NGOs and one was a national NGO. 36% of participants interviewed held a global level position [n=9], 24% held a regional or national level position [n=6], and 40% of participants held a local-level position [n=10]. Table 1 presents details of the positions held by participants within their organizations. To maintain anonymity, details of the participants' affiliated NGOs are omitted from the table.

Table 1: Participant Characteristics

#	Position	Gender	Level of Role	Current Professional Location
1	Global WASH Advisor	F	Global	India
2	National WASH Advisor	M	National	Philippines
3	Program Officer for School and Nutrition	F	Local	Philippines
4	Global WASH Advisor	F	Global	Belgium
5	Global Public Health Promotion Advisor	F	Global	UK
6	Public Health Team Leader	M	National	Tanzania
7	Senior Innovation Officer (Public Health Promotion)	F	Local	Bangladesh
8	Senior WASH Advisor	M	Global	USA
9	WASH Project Manager	M	Local	Uganda
10	Senior Behaviour Change Advisor	F	Global	Canada
11	Senior Behaviour Change Advisor	F	Local	Madagascar
12	WASH Program Officer	F	Local	Madagascar

13	Senior WASH Advisor	M	Global	UK
14	Organization Founder and Director	M	Local	Cameroon
15	WASH Technical Advisor	F	Global	UK
16	Health Promotion and Community Engagement Specialist	M	National	Pakistan
17	Health Promotion and Community Engagement Advisor	F	Global	Netherlands
18	Hygiene Promoter Supervisor	M	Local	Pakistan
19	WASH Consultant	F	Global	UK
20	Hygiene Promoter	F	Local	Nigeria
21	Hygiene Promoter Manager	M	Local	Nigeria
22	WASH Technical Working Group Head	M	National	Myanmar
23	Hygiene Promoter	F	National	Lebanon
24	WASH Regional Advisor	M	Regional	Lebanon
25	Public Health Promotion Officer	M	Local	Bangladesh

Challenges and Recommended Solutions

Themes describing the perceived challenges to HWWS interventions targeting older children in development and humanitarian contexts and related solutions are presented below, organized into the 4 stages of the program cycle. A total of 12 themes emerged across these 4 stages which interacted and influenced one another in various ways. We elaborate on the relationships between themes in the discussion. The 12 themes are summarised in Table 2.

Table 2: Summary of Themes

Program Cycle Stage	Theme
1. Funding Acquisition	Lack of prioritization
	Funding inconsistency
2. Design	Insufficient formative research
	Demand on resources
	Unengaging intervention content
	Non-enabling physical environments
3. Delivery	Availability of skilled implementers
	Reaching out-of-school children
	Community mistrust
	Lack of coordination

4. Evaluation	Lack of evaluation rigour
	Failure to assign older children's handwashing as a primary outcome in evaluations of hygiene interventions

Stage 1: Funding Acquisition

2 major themes related to funding acquisition emerged from participant interviews: lack of prioritization and funding inconsistency. The theme 'lack of prioritization' emerged predominantly from interviews with global level participants whereas funding discontinuity was reflected across all levels of participant.

Lack of prioritization

Participants reported that HWWS interventions targeting older children do not receive sufficient funding, reflecting a low prioritization of older children's HWWS within the NGO sector. Particularly in humanitarian settings, participants believed that with numerous competing priorities, HWWS promotion is often de-prioritized. Participants called for the sector to recognize the potential to achieve a large public health impact by targeting HWWS interventions at older children and to design more HWWS interventions for this specific age group.

> *"It does always feel a little bit like working with children specifically and understanding their specific needs is something that is a bit like 'well that can come later', it's not something to focus on at the beginning……If it's not in the budget then, not only do we then not have the resources to be able to do it, but I think sometimes in the busyness of an initial response it can quite often get forgotten because it's not listed down as a deliverable in the budget or in the proposal."*
> [Female, global level]

Funding inconsistency

Where HWWS interventions targeting older children are funded, participants felt that funding changes throughout the program cycle - cuts in budget and short-term funding - and the resultant discontinuity in which organization is responsible for the program, made sustaining interventions difficult. Referring to a past program, one participant explained:

"What we learned is that sustainability is very important because, unfortunately, not long afterwards it was the end of the (financial) year and [organization redacted] was not selected to continue as WASH lead in these camps. We are currently operational partner but not WASH lead and what that means is … we are no longer able to do these competitions in schools, we have to go through another partner and that brings a bit of complications."
[Male, national level]

Stage 2: Design

4 major themes related to intervention design emerged from participant interviews: insufficient formative research, demand on resources, unengaging intervention content, and non-enabling physical environments. Insufficient formative research was a theme that emerged only from global and regional-level participants. The other 3 themes were reflected across all levels of participant.

Insufficient formative research

Participants reported that formative research is rarely undertaken to inform HWWS interventions targeting older children. Many recommended consultations with children to ensure interventions are appealing, appropriate, and acceptable and to allow messages to be customised to settings. Involving children in the design of HWWS interventions was considered a good way for them to engage and take more ownership of associated activities and handwashing facilities.

"*I urge none of the organizations to design hygiene behaviour anecdotally… it has to be more evidence based, it has to be informed based on formative research, the package has to be designed through a creative process so that at least the package is attractive, engaging, emotional to the school students*"
[Male, global level]

Demand on resources

Existing HWWS interventions targeting older children were perceived to be too resource-intensive to be very effective in resource-poor settings. Interventions were said to require numerous props, materials, and supplies which are not always affordable. They also often require health messages to be delivered consistently which relies on highly skilled and motivated implementers; skillsets that are

often difficult to find at the local level. Integrating intensive HWWS interventions into the school or CFS curricula was also perceived to be a challenge as they present a demand on teachers and CFS managers, yet the education sector considers this as outside its responsibility. As time is already stretched within school curricula, additional hygiene activities are not prioritized. Where teachers are expected to deliver the HWWS intervention, participants noted a lack motivation as it is an additional responsibility on top of their heavy workload. Activities such as hygiene clubs were identified as particularly resource intensive.

> *"I think challenges are there in terms of feasibility… when you have a school calendar which doesn't support some of the activities which you want to do…it creates a challenge where some of the activities are not prioritized. For example, it's the first term and you want to talk about school health clubs, yet schools are concentrating on athletics. So, you won't get that support"* [Male, national level]

Participants emphasised the need for 'low-resource' interventions that require fewer skilled implementers, less time, and less money than resource-intensive interventions. They explained that not only would these interventions be more feasible to implement but they would also be easier to sustain after external implementers and funds are withdrawn. Participants also reported that shorter intervention sessions in general would better hold children's attention and make attendance easier for children with competing commitments**.** **'**Nudging' was an example of what practitioners perceived to be a low-resource intervention.

> *"I don't think we go through a menu of different approaches to decide but rather, say what gets us that outcome that we're looking at most effectively, efficiently, and often times it's, you know, the cost of it. So, a nudge is easier for example, and a routine is easier than doing hygiene promotion education sessions because that requires alignment with school, the class calendar, timetable and, and getting that slot, training people, it's a heavy lift."* [Female, global level]

In contrast, though, some participants also recommended that intervention frequency should be high, i.e., they believed that the intervention should be repeated numerous times to reinforce the messages and behavioural adoption. One-day events, e.g., plays or parades, were thought to be ineffective because children have difficulty recalling the messages they hear after the event ends.

> *"The more that you're working with those children or adults, or whoever you're working with, the more influence you will have on them to be able to learn the*

appropriate behaviours that you're trying to get them to adapt. If you go in there, and you do like a one-hour session, once a month, or once a week or something like that, yeah, I wouldn't expect any behavioural change on that, I think you're just checking the box" [Male, national level]

Unengaging intervention content

In addition to shorter and more frequent HWWS promotion activities, participants felt that more engaging content was required for effective HWWS promotion. Existing HWWS interventions targeting older children do not engage and motivate them sufficiently; focusing primarily on health messaging, delivered via a didactic approach, which participants believed to be ineffective. While most participants believed that health messaging is necessary to ensure older children understand why they are being asked to wash their hands, they felt that existing approaches are ineffective because they are not engaging, nor do they create a link between HWWS and health that older children find tangible.

"*Children do not want you to push things down on them… if you're going to teach them, lecture them like their parents and teachers do, they are going to be disconnected. So, you need to do it in a participatory manner, use play and let them express, don't restrict them to verbal exchange."* [Female, local level]

Participants believed that older children learn through play and so making sessions fun and interactive would better hold their interest and make messages more memorable. Playing games, role-playing, using superheroes and cartoons, using puppets, and singing songs were all recommended. Demonstrating HWWS to children and having them subsequently demonstrate HWWS to their peers for feedback was also an interactive technique recommended by participants. Specifically, multiple participants felt that the glitter game – where glitter is used to represent germs and is passed around children's hands before being washed off with soap and water – is a good example of an interactive and fun way to teach older children about the importance of HWWS and makes outcomes more tangible.

"Having fun is the most important thing that you need to encourage during the hygiene promotion sessions because if you only encourage messaging and information sharing, the children are going to retain it, of course, because they are a sponge that absorbs everything that you say, but there is not going to be change in the behaviour" [Female, global level]

Participants also recommended interventions using positive 'feel-good' motivational drivers to increase older children's HWWS. For example, linking HWWS to a 'bright future' - doing well in school (due to fewer illness-related absences), completing higher education, and going on to secure a high-paid, high-status job.

> *"If you wash your hands, you'll be topping your class, you'll be one of the model students, you will be getting higher marks and subsequently you will not be absent in your class because if you wash your hands you will be protected from the diseases, and then therefore the regular attendance into the class, and then also the cognition development"* [Male, global level]

Material incentives, for example placing toys and games near handwashing facilities were also thought to encourage older children to practice HWWS by making the behaviour memorable. Incentivising children to perform handwashing via competitions or with verbal encouragement, for example, praise from caregivers, were also perceived to be good approaches.

Another common recommendation was to leverage social norms within the peer group. Older children were said to spend much of their time with their peers, especially in humanitarian settings, and thus participants believed they were easily influenced by peers and responsive to peer pressure. A 'peer-to-peer 'approach, for example, creating 'peer champions' in hygiene clubs (where a select number of children are trained to promote handwashing to their peers), or having a student monitor at the handwashing facility to encourage maintenance and use, were suggested ways of creating social norms that encourage HWWS. Installing group handwashing facilities and scheduling group HWWS sessions was also an approach participants believed would promote consistent HWWS as a socially desirable behaviour and encourage children to conform to this norm.

> *"It is the idea of creating that element, that peer pressure within the same age groups to say, kids will listen to what other kids say or they will understand if a demonstration is done by their peers. Or, if those people in this school health club act as role models, such that other children also see that 'oh, we can also do the same'. Then, also, understanding that kids spend most of their time together as kids, even at school or outside the school."* [Male, national level]

Non-enabling physical environments

Participants felt that the lack of an enabling physical environment often hinders the success of HWWS interventions targeting older children. They explained that in settings where handwashing facilities with soap and water are lacking, if provision of handwashing hardware is not part of the intervention children are unable to properly practice what they have learned from HWWS promotion.

As well as providing handwashing hardware where needed, participants also felt that the hardware should be designed and positioned to act as a visual cue to HWWS. Strategically placing handwashing facilities at the entrance to the classroom was an example of using hardware to act as a visual cue. Nudges were commonly referenced as a good approach - painting footsteps leading from the toilets to handwashing points frequently quoted. Participants also felt it was important to make facilities attractive and inclusive for older children. Suggestions included making facilities colourful, using cartoons or painting murals on or around facilities, and adding mirrors. Attractive handwashing facilities were thought to nurture children's sense of ownership of the facility and encourage use. Making facilities child-friendly was also viewed as important as children do not want to spend much time and effort on HWWS. Participants recommended ensuring taps are easy to operate and the height of facilities is adjusted so that children can easily reach them. Multiple participants also mentioned the need to make facilities inclusive of children with disabilities. The location of handwashing facilities was also deemed important. In schools, participants recommended installing facilities as close to the school building as possible so that busy children can easily reach them.

> *"It's important a hand washing station is easy to use and easy to access. If it's going to take a lot of time, or the children need to actually focus on hand washing, it's not going to happen because the kids are going to be thinking about other things and they're going to be looking for their friends and going out or going to school. So…it's important that a hand washing station is something easy and simple for the children just to make it automatic*" [Female, global level]

Stage 3: Delivery

4 major themes related to intervention delivery emerged from participant interviews: availability of skilled implementers, reaching out-of-school children, community mistrust, and lack of coordination. The first 3 themes were reflected across all levels of participant whereas lack of coordination emerged predominately from interviews with global, regional, and national level participants.

Availability of skilled implementers

Recruiting people with the necessary skills to promote HWWS to older children was reported as a common challenge. Working with older children in particular requires a specific skillset which is difficult to master, even for existing hygiene promoters. Transitioning from working with adults to working with children was thought to be difficult for hygiene promoters due to more informal interactions and the focus on fun and participatory strategies (for example, singing songs and playing games), which they may find uncomfortable. Many participations also reported that teachers often lack the skills to deliver hygiene messages to older children in a participatory manner. As such, building the capacity of those involved in intervention delivery was believed to be of fundamental importance.

> "*There is naturally resistance from adults not wanting to be like children, even though they want the job they don't want to be like children and play like children"* [Female, local level

Reaching out-of-school children

Reaching children outside of schools or CFSs with HWWS interventions was perceived to be a challenge. Some children do not attend these institutions due to an insufficient number of spaces or because of work or household duties. Participants explained that attempts to reach these 'out-of-school' children are mostly via one-off activities in the community which lack effectiveness and have low attendance because these children find them uninteresting or because of the competing demands on their time.

> *"You will compete with their time ... they will not join at the start or become interested in any hygiene or health discussion because they have different interests now, because they are out-of-school. So, there's no environment that actually motivates them and, at the same time, supports them, for them to be able to participate in any hygiene or health education."* [Male, national level]

Designing more HWWS interventions within the community, particularly at the household level, was recommended to reach these out-of-school children. Participants also felt that household-level interventions benefit from reaching caregivers in addition to the children, who may support and encourage children to practice handwashing at home.

Community Mistrust

Participants believed that caregivers often lack trust in hygiene promoters and hygiene promotion activities and frequently withhold permission for their children to attend hygiene promotion sessions. Mistrust of hygiene promotion was said to be especially high when delivered outside of existing structures like schools or CFSs and where sessions are 'child-only' – i.e., caregivers were not invited to attend. Hygiene promoters also report feeling uncomfortable when approaching children outside of these structures.

> *"I think if you're trying to do something that doesn't kind of have that structure around it, it's a little bit more difficult and it's a little bit less acceptable perhaps from a parent's point of view, in terms of just organising, like, them not knowing who you are and not knowing what the activity is etc."* [Female, global level]

To overcome this challenge, participants recommended consulting the community to gain their buy-in and to secure parental consent for child participation.

> "*I feel organizations need to build a stronger constituent with the community. Number one, the community are the gatekeepers. The communities will grant you access to their children, the community reinforce your messages, they grant you access to their children…"* [Female, local level]

Lack of coordination

Participants felt a lack of standardized tools, for implementing both formative research and specific interventions, within the NGO community hindered the effectiveness of HWWS interventions. They explained that even when there is evidence to support a specific intervention, replicating it without standardized tools is a challenge. For example, one participant referenced the difficulties in replicating a nudge intervention that was successful in a school in Bangladesh without the support of a standardized tool.

> *"Other countries, one or two that I know of, have implemented it but not with any sort of global tools to support them, so they've gone about doing it in very different ways, and with different levels, degrees of success."* [Female, global level]

A more coordinated approach to child-targeted HWWS promotion within and across sectors was recommended to encourage the sharing of evidence and tools. For school-based interventions in

particular, participants believed that coordination between the education sector and the community is needed so that they can better support HWWS interventions.

> *"So basically, the knowledge management part, sharing of best practices, sharing of resources in some pools, these actually are essential for you to be able to better help the schools and teachers to promote habit, and also stimulate the social environment part in a school setting"* [Male, national level]

Stage 4: Evaluation

2 major themes related to evaluation emerged from participant interviews: lack of evaluation rigour and failure to assign older children's handwashing as a primary outcome in evaluations of hygiene interventions. Both themes emerged predominately from interviews with global, regional, and national level participants.

Lack of evaluation rigour

Participants felt that rigorous evaluation of HWWS interventions targeting older children is lacking resulting in limited evidence to assess impact, which could also encourage prioritization of older children's HWWS, and limited evidence to inform the design of future interventions. They were concerned that much of the evidence gathered by the NGO sector is anecdotal. For example, several participants described how photographs of children performing HWWS shared by parents and hygiene promoters were used as evidence that an intervention was working.

> *"I think one of the clear issues that we have is that we don't measure enough the impact of what we are doing. So that's a bit problematic. Like not measuring makes it hard to know what works and what doesn't."* [Male, regional level]

Knowledge, attitudes, and practice (KAP) surveys were also frequently used to evaluate HWWS interventions. Participants recognized this as a flawed methodology because practices are often measured via self-report and a control group is usually lacking, and they expressed concerns about relying on data from these surveys given their lack of rigour. They explained that adherence to protocols can be a problem, for example baseline KAP surveys are sometimes undertaken after the start of intervention implementation and 'ethics obstacles' were blamed for hindering KAP survey improvements, for example the addition of a control group.

"The baseline usually isn't done in the very beginning, it's done a couple months into it because of the time constraints and rolling out and doing it and so it's not really a good indicator of behavioural change, or knowledge, or practices and things like that." [Male, national level]

Failure to assign older children's handwashing as a primary outcome in evaluations of hygiene interventions

Participants partly attributed the lack of rigorous evaluations of HWWS interventions targeting older children to older children's handwashing behaviour rarely being designated as a primary outcome in evaluations of hygiene interventions in general. Where handwashing behaviour is measured and reported, it was said to be usually that of caregivers rather than children. Evaluations were also said to be overlooked because of the difficulties associated with measuring handwashing, particularly by observation. Where an evaluation is undertaken, knowledge of HWWS, rather than handwashing practice, is typically the outcome measured.

Participants called for more rigorous evaluations of HWWS interventions targeting older children to be undertaken and for organizations to commit to sharing these findings across the sector to grow the evidence base and lead to better informed intervention design.

Discussion

This study offers an insight into NGO practitioner perspectives on the challenges to HWWS interventions targeting older children and related solutions to improve effectiveness. Practitioners identified challenges to each stage of the program cycle. These included a lack of prioritization of older children's HWWS, funding inconsistency, insufficient formative research, demand on resources, unengaging intervention content, non-enabling physical environments, availability of skilled implementers, reaching out-of-school children, community mistrust, lack of coordination, lack of evaluation rigour, and failure to assign older children's HWWS as a primary outcome in evaluations of hygiene interventions. Recommended solutions related to these challenges and included making changes at the intervention level, the organization level, and the sector level.

Many of the challenges identified by the practitioners align with those reported in assessments of hygiene promotion interventions in school-based settings in low- and middle-income countries. These assessments find that schools often lack an enabling physical environment - functional handwashing

facilities and consistent access to soap and water (46-51). They also report that inadequate funding, time, technical capacity, and competing classroom priorities, impede the feasibility, acceptability, and adherence of hygiene promotion interventions and, like practitioners, they call for coordination within and between sectors.

The challenges identified by practitioners also align with broader social-ecological perspectives on health and health behaviour and highlight the need to consider not only older children's handwashing behaviour within a multi-level context but also the programs designed to address this behaviour. For example, the IBM-WASH (the Integrated Behaviour Model for WASH) Framework (52) categorizes WASH determinants across three domains: psychosocial factors, technological factors, and contextual factors that operate across multiple levels of influence (individual, interpersonal, communal, and social). The challenges reported by practitioners in the design and delivery of HWWS interventions targeting older children span all three of these conceptual domains and levels of influence: engaging content and delivery, for example, impacts individual-level psychosocial determinants among children and interventions are often delivered poorly due to limited capacity by front line workers to foster supportive interpersonal relationships that older children respond to, while the retention and training of staff are limited by larger contextual factors like short funding periods and lack of coordination across the sector. HWWS programs will not achieve the desired behavioural outcome in the absence of robust hardware, which in turn can be used to trigger individual-level determinants. Applying the lens of multi-level theories to the funding, design, delivery, and evaluation of HWWS programs will help further explore how the challenges described are inter-related and mutually reinforcing.

Despite the alignment we find between perceived challenges and theoretical models of behaviour, such as above, none of the practitioners explicitly referred to or suggested using theoretically-informed approaches to guide intervention design or delivery. Theoretically-informed interventions are thought to lead to better outcomes (53-57), however practitioners' failure to connect theory and practice was evident. Although practitioners emphasised the need for low-resource interventions they also recommended various approaches (e.g., interventions using motivational drivers, leveraging social norms, and implementing nudges) without considering the associated resource burden. This suggests that practitioners struggle to apply their contextual knowledge to intervention design or selection. Practitioners may benefit from using theoretical models to guide intervention design. By systematically linking HWWS determinants to specific intervention approaches in this way, they may better ensure that interventions are contextually appropriate and that they address the most salient determinants in their operational context, ensuring efficient allocation of resources. Many theoretical models, however, are not operationally feasible, and this is likely the reason for their low uptake by practitioners (58). They typically address barriers and enablers but do not provide guidance on selecting relevant approaches to influence them.

Theoretical models of behaviour recognize the importance of individual characteristics and their broader social relationship systems. Gender for example, has implications for expectations and norms around behaviours such as handwashing (59-62). Practitioners, however, only touched on social inclusion within the context of infrastructure, and this was largely limited to recommending that facilities were accessible to children with disabilities. None of the participants mentioned gender, and broader engagement on the topic of inclusion was largely absent. When designing and implementing HWWS programs for older children, it is important to apply a gender and social inclusion lens not only to the infrastructure component but to the program as a whole. It is also important that practitioners consider gender implications when designing messages and deciding how, where, and when interventions are delivered and evaluated.

Practitioners made recommendations both to employ low-resource interventions and to have high intervention frequency. Resource-intensive interventions, even when effective on a small scale, present a challenge for wide-scale implementation. For example, the motivation-based SuperAmma intervention achieved a large increase in HWWS in a trial in rural Indian households (63), but the intervention's scalability is limited due to its high demand on resources (64). Low-resource interventions are more feasible to implement at scale and there is evidence suggesting that they can be as effective as resource-intensive interventions (65). Evidence also indicates that high intervention frequency is also important (64, 66-69). Although these recommendations are seemingly contradicting, the potential for 'low-dose, high frequency' interventions has been explored in various aspects of public health programming and may be a potential innovation to bring to HWWS promotion generally, and to HWWS interventions targeting older children specifically (70-73).

While evidence suggests that a combination of hardware and software is necessary for behaviour change (59, 64, 74), in resource-scarce settings it may prove more challenging to meet both of the above recommendations with software-heavy interventions, which are reliant on human resources. Interventions skewed towards hardware could more feasibly meet both recommendations – high frequency is reached via repeated exposure to the hardware without requiring much human resource. One way this may be achieved, and an approach recommended by practitioners, is via environmental nudges – small changes to the environment that cue and trigger HWWS. Specific environmental nudges that have been shown to increase children's HWWS include painting brightly coloured footprints leading children from the toilet to handwashing facilities (75, 76), placing toys inside of transparent soap to incentivise soap use (77), and tying soap onto a piece of rope which acts as a hall pass and reminds children to HWWS after visiting the toilet (78). Strategically designing, and positioning handwashing facilities so that they cue behaviour, for example altering the appearance of facilities to make them attractive, positioning the facilities so that they are directly in a child's path, or

ensuring they are highly visible to heighten perceptions of social pressure to perform HWWS, are also forms of environmental nudges. Not every nudge will be contextually appropriate, so it is imperative that practitioners are able to apply contextual knowledge when designing nudge-based interventions. Nudging HWWS is only appropriate within a physically enabling environment and where children understand how to perform HWWS. In the absence of this, the intervention design would need to include other techniques such as the provision of handwashing hardware and demonstrations of HWWS technique.

There is also evidence to support the use of social norm-based interventions using motivational drivers. Social norms have been found to be a strong determinant of handwashing behaviour, including among children (62, 79-82). Evidence relating specifically to children's handwashing includes a study in Bangladesh reporting that children are more likely to practice HWWS after visiting the toilet when in the presence of a peer monitor (83) and a study in Kenya which found hand cleaning rates were higher when at least one other person was present at the handwashing station (84). The evidence base around using motivational drivers in HWWS interventions is made up mostly of interventions targeting adults (63, 64, 66, 85), but recently there is evidence to suggest this approach can also be successful at increasing children's HWWS (36, 77, 86), but interventions should target the drivers relevant to children, such as 'play', 'curiosity' and 'nurture' (36, 77).

Practitioners believed that existing approaches to health messaging lack effectiveness, concurring with various studies reporting health to be a poor motivator of HWWS (87-90). However, whereas most of these studies go on to dismiss this approach in favour of alternatives, practitioners felt that health messaging is still an important inclusion if designed in a way that creates a tangible link between HWWS and health. There is evidence to support the inclusion of health messaging and health education in HWWS interventions targeting older children; a recent systematic review found that providing 'information about health consequences' contributes to a positive change in children's hand hygiene behaviour (36) and other studies find knowledge to be a necessary precursor for HWWS among children (36, 91).

Globally 59 million primary school-age children are out of school (92). Given that the overwhelming majority of HWWS interventions targeting older children have been implemented in schools (11, 34, 93), it is evident that this vulnerable group has been historically overlooked. Though schools are an important setting in which to implement HWWS interventions for children, there also needs to be community-based interventions, including at the household-level, to reach out-of-school children. Household-level delivery may also help to ease the mistrust by allowing caregivers to oversee activities which may encourage caregivers to support children in sustaining new handwashing habits. Given that a likely deterrent to organizations adopting household-level HWWS interventions is the

concern that they are more resource intensive than school-based interventions, the need for low-resource interventions is even more apparent.

Respondent's call to build the evidence base around HWWS promotion among older children is well founded. Multiple systematic reviews of handwashing interventions reveal that most published studies focus on adult-targeted interventions and are not of high quality (11, 34, 35, 59, 93). This hinders the ability to draw conclusions as to the best approaches for targeting older children. A study of humanitarian perspectives on the Ebola WASH response in Liberia also reported that organizations mostly focussed their monitoring on inputs and outputs, and none systematically monitored outcomes related to hygiene knowledge, awareness, or behaviour (38). Understandably, practitioners were concerned that older children are not prioritized when it comes to HWWS interventions and that this hampers efforts to improve their HWWS behaviour. Building the evidence base will hopefully demonstrate the value of improving older children's HWWS behaviour, influence policies and standards, and encourage donors and NGOs to ringfence more funding and resources for HWWS interventions targeting older children. Practitioners must, however, also engage with the existing evidence base given there have been some rigorous trials of school-based HWWS interventions. Some of the responses given by practitioners in this study suggest this is not always the case. Group handwashing, for example, was often proposed as an effective approach yet evidence suggests it is unlikely to achieve behaviour change, especially outside of a larger behaviour change intervention package (69, 94, 95). The gap between research and practice is a long-standing problem and calls for better ways of disseminating the evidence so it is accessible to practitioners (96). Rather than relying only on scientific publications, additional channels are needed to reach practitioners for example via policy briefs, one-on-one meetings, workshops, and seminars.

Finally, participants called for better coordination within the NGO community to encourage sharing of best practices and the development and access to standardized tools which aid the implementation of formative research and of specific interventions that are simple, rapid to employ, and reflective of the local context. The need for a well-coordinated approach to achieve effective and sustainable HWWS interventions has also been identified by others (37, 97) and extends beyond just coordination within the NGO community. Organizations should also create stronger links with national governments to understand their policies on hygiene and help to formulate new contextually appropriate strategies, donor agencies to secure sufficient and dedicated funds, educational institutions to firmly integrate HWWS promotion within the curriculum, and academia to support rigorous evaluation and the upstream flow of information from within the organization to policy makers and other key actors. To achieve long term impact, it is also necessary to engage the community to plan how the intervention will be sustained beyond the withdrawal of the implementing organization.

There are some important limitations of our study. Firstly, given that both the researchers and the participants work in the field of WASH, there were instances where participants already knew of the researchers and their work, and the lead researcher had prior professional relationships with three of the participants. This may have biased data collection and analysis, as well as influenced participants' responses, subjecting our findings to social desirability bias. Secondly, although most participants spoke openly, it seemed that some were hesitant to express personal views outside of their organization's official stance. We tried to minimise this by emphasising to participants at the start of the study that we were interested in both positive and negative views, and by ensuring only non-leading questions were posed, nonetheless some of the responses may not have been truly representative of the participants' personal views. Thirdly, due to the qualitative nature of our study, findings cannot be generalised to all NGO practitioners nor to all NGOs.

Conclusions

This study identifies a range of challenges facing those concerned with designing and implementing effective HWWS interventions targeting older children but also solutions related to these challenges from the NGO practitioner perspective. Beyond tailoring intervention design and delivery so that interventions are engaging, motivating and simple to implement, and creating an enabling physical environment, practitioners believe the NGO sector should make children's handwashing a top priority. Practitioners strongly advocate for better intra- and inter-sectoral coordination to overcome challenges related to the integration of HWWS promotion within existing educational institutions, the standardization of implementation tools, and the sustainability of interventions. We also recommend that practitioners engage more with theory when designing interventions to support application of their contextual knowledge to intervention design.

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CHAPTER 7

General Discussion

The aim of this thesis was to identify potentially effective approaches to HWWS promotion interventions targeting older children with a focus on older children in humanitarian emergency contexts. The four specific objectives were to: 1) review the current behaviour change techniques used across hand hygiene interventions targeting older children and assess their relative effectiveness (Research Paper 1); 2) Identify the motivational drivers and other determinants of handwashing behaviour among older children in a humanitarian emergency context. (Research Paper 2); 3) test the use of play and curiosity-based motives in a rapidly deployable HWWS intervention for older children in an emergency context (Research Paper 3); and 4) Understand NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children (Research Paper 4). This final chapter summarises the main findings across the thesis, organised by objective, and goes on to synthesise these findings and make recommendations for future approaches to HWWS interventions targeting older children in emergency settings. The chapter later discusses the limitations of this thesis as a whole and proposes an agenda for future research.

Main Findings

Objective 1: Review behaviour change techniques used across hand hygiene interventions targeting older children and assess their relative effectiveness

The first objective was addressed in Research Paper 1 in which I systematically reviewed the literature to identify individual behaviour change techniques used in hand hygiene interventions targeting older children and assessed their contribution to intended behavioural change (1). The review included experimental studies evaluating hand hygiene interventions targeting children, and quantitively reporting hand hygiene behaviour. Each intervention was categorised as 'promising' or 'non-promising' according to whether it led to a positive change in hand hygiene behaviour. 32 unique BCTs were identified across the interventions using a standard taxonomy and a novel promise ratio calculated for each (the ratio of promising to non-promising interventions featuring the BCT), reflecting the BCTs likely contribution to an increase in children's hand hygiene behaviour. The review found eight BCTs to be 'promising' – where the promise ratio ≥ 2. These were, in descending order of promise: 'demonstration of the behaviour', 'information about social and environmental consequences', 'salience of consequences', 'adding objects to the environment', 'instruction on how to perform the behaviour', 'information about health consequences', 'social support', and 'conserving mental resources'. This review also found that promising interventions employed, on average, 1.5 fewer BCTs than non-promising interventions (i.e., those resulting in no or a negative change in hand

hygiene behaviour) ($p < 0.01$). However, findings also indicate that promising BCTs should be used in combination; three of the most promising BCTs, 'demonstration of the behaviour', 'instruction on how to perform the behaviour' and 'adding objects to the environment' (i.e., installing handwashing stations and providing soap) were found to frequently co-occur in interventions and 'information about social and environmental consequences' also co-occurred frequently with the BCTs 'demonstration of the behaviour' and 'instruction on how to perform the behaviour'.

Previous reviews of WASH interventions targeting children have been unable to perform metanalyses due to high heterogeneity across studies. This means that they have also been unable to make conclusive recommendations for future intervention approaches (2-4). Research Paper 1 overcomes this issue by using a standard taxonomy to identify individual BCTs used across hand hygiene interventions targeting older children and subsequently employing a novel promise ratio analysis technique to enable quantitative synthesis of heterogenous studies. The study further innovates on the analysis by weighting promise ratios by study quality to account for the different study designs, reporting and analysis. Unlike past studies, this novel analysis technique allowed recommendations to be made on specific approaches to HWWS interventions for older children.

Objective 2: Identify the motivational drivers and other determinants of handwashing behaviour among older children in a humanitarian emergency context

The second objective was addressed in Research Paper 2, which presents the results of a multi-method study exploring the perceived determinants of children's handwashing behaviour, conducted in an IDP camp in Northern Iraq (5). In this study, friendship-paired interviews were undertaken with children and in-depth semi-structured interviews with caregivers and hygiene promoters. In addition to exploring perceived determinants of children's handwashing behaviour, a rating exercise was conducted in the friendship-paired interviews to determine the relative importance of different motivational drivers among the children. All participants lived in the camp and hygiene promoters also worked there. A thematic analysis of the interviews found the perceived key determinants of children's handwashing behaviour to be the influence of child's the family, particularly their mother, environmental factors pertaining to location and quality of handwashing facilities and materials, i.e. soap and water (although the availability of materials was not perceived to be an issue), level of exposure to hygiene promotion, and social norms related to the community's perception of an individual's handwashing practices. A quantitative assessment of the motive rating exercise indicated that children in this context are motived most by play (play had a 56% probability of being rated as 'important' or 'very important') and nurture (54%), and that a combination of the four motivational

drivers: play, nurture, affiliation, and love, has the potential to motivate 96% of children (i.e., 96% of these children rated at least one of these motives as important or very important).

A number of these findings are consistent with the broader literature around HWWS and its determinants. Past research has shown that exposure to hygiene promotion influences hygiene behaviour (6). Strong associations between social norms and children's HWWS behaviour have also been reported. For example, studies show that the presence of another person at the handwashing station is associated with significantly higher rates of HWWS among children (7, 8) and perceived social norms around handwashing are strongly associated with an individual's behaviour (9). The fact that soap and water availability was not thought to be an issue yet rates of HWWS among older children in the camp were low (10) also adds to evidence suggesting that access to soap and water alone is often not sufficient to drive HWWS behaviour (11). Finally, although evidence on the motivational drivers of older children's behaviour is limited, in line with this study, nurture has also been indicated as an effective motivator of older children's HWWS elsewhere (12).

This was the first study to explore the determinants of older children's handwashing behaviour in an emergency setting. It demonstrates both the value in engaging older children to better understand their behaviours and the feasibility of doing so in complex settings and will hopefully encourage more formative research activities to be undertaken with this age group.

Objective 3: Test the use of play and curiosity-based motives in a rapidly deployable HWWS intervention for older children in an emergency context

The third objective was addressed in Research Paper 3, which presents the results of a proof-of-concept study undertaken in the same IDP camp as Research Paper 2 (2). In this study I tested an intervention targeting the motives of play and curiosity, involving the delivery of 'Surprise Soap' – a transparent soap with a toy embedded inside of it – within a short, fun-based household session among children living in the camp. At baseline, most households in the study had a handwashing station (97%) with soap (84%) and water (99%) available, yet rates of HWWS after key occasions among the children were low (between 24-32%). Four weeks after receiving the Surprise Soap intervention, children were four times more likely to practise HWWS after key occasions compared to children in the comparison group after adjusting for baseline HWWS rates (risk ratio = 3.94, 95% ci 1.59–9.79). Intervention compliance was high; at the four-week follow up, 97% of households had finished at least one bar of soap, 61% of households still had some toy soap remaining and 85% of households with toy soap remaining had soap that was wet on inspection, showing it had recently been used. These results indicate that play and curiosity can motivate children to practice more

frequent HWWS in emergencies. Surprisingly, only 3% of intervention households reported 'toy cheats' - i.e., children who broke open the soap to reach the toy inside - indicating caregivers may have played a role in maintaining intervention compliance.

This proof-of-concept study shows that targeting older children with HWWS interventions may be worthwhile. It also adds to the growing body of evidence that suggests that interventions targeting behavioural motives are effective at improving handwashing behaviour (11-15). However, it is the first to specifically test the use of play and curiosity as motivational drivers and it is the first to test a motivation-based HWWS intervention targeting older children in an emergency setting. The study also demonstrates that low-resource, rapidly deployable HWWS interventions targeting older children can be effective in emergencies and that such interventions can be evaluated relatively easily while still providing robust evidence.

Objective 4: Understand NGO practitioner's perspectives on the challenges and solutions to HWWS interventions targeting older children

The fourth objective was addressed in Research paper 4, a qualitative study in which in-depth interviews were undertaken with 25 NGO practitioners working in emergency and development settings. While the rest of the thesis looks specifically at handwashing behaviour among older children, understanding the broader context in which HWWS programmes targeting older children operate is critical in order to understand what is needed, across the programme cycle, to ensure that they are effective. Practitioners were encouraged to share their experiences of HWWS interventions targeting older children and to think about the challenges to effectiveness, as well as to propose solutions to improve the effectiveness of future HWWS interventions. The overall aim was to gain a holistic understanding of what is required for successful HWWS interventions for children, beyond just intervention content. A thematic analysis of interview transcripts revealed perceived challenges to pertain to twelve themes: (i) lack of prioritisation; (ii) funding inconsistency; (iii) insufficient formative research; (iv) demand on resources; (v) unengaging intervention content; (vi) non-enabling physical environments; (vii) availability of skilled implementers; (viii) reaching out-of-school children; (ix) community mistrust; (x) lack of coordination; (xi) lack of evaluation rigour; and (xii) failure to assign older children's HWWS as a primary outcome in evaluations of hygiene interventions. Solutions proposed by the participants related to these challenges and included making changes at the intervention level, the organisation level, and the sector level. Specific recommendations included undertaking formative research to inform intervention design, consulting children in the design process and consulting the community to gain their buy-in, designing low-resource interventions, building the capacity of implementers to enable them to better engage and

interact with children, ensuring interventions are fun and interactive, using positive motivational drivers, using material incentives, leveraging social norms, creating an enabling physical environment that also serves to cue handwashing, undertaking more rigorous intervention evaluations, and coordinating within and across sectors to encourage sharing of evidence and tools, and to build support for interventions.

These findings are consistent with research on handwashing interventions in schools in stable settings and hygiene interventions for adults in humanitarian settings, suggesting that handwashing interventions for children in humanitarian settings are faced with much of the same challenges. Common challenges across these studies include time and labour requirements, low technical capacity, competing priorities, inadequate funding, and poor coordination and management (6, 16-21). While the barriers are similar, this study goes further to identify specific actionable solutions to overcome these challenges, as described above.

Synthesis of Findings

Below I synthesise research findings, firstly to address the question as to whether explicitly targeting motives, particularly the motives of play and curiosity, is effective, and subsequently to identify other approaches that may be effective.

Targeting Motives

In Research Paper 3, the results of the proof-of-concept study indicate that interventions explicitly targeting motives can be effective in increasing children's HWWS behaviour. This particular intervention aimed to appeal to the motives of play and curiosity. Adding support for using the motive of play, Research Paper 2 found children rated play as the most important motive. Research Paper 4 adds further support for the use play as NGO practitioners believed children to be motivated most by fun, interactive, play-based interventions. Curiosity, however, was not identified as important by NGO practitioners nor was it among children's top ranked motivational drivers. I hypothesise that this is due to one of three reasons: 1) curiosity involves high-level cognitive processes compared to play, which is practice-oriented, and hence children are unlikely to recognise it as important, 2) curiosity was not accurately depicted in the pictures used for the motive rating exercise, 3) curiosity is not an important motive for children. It is also unclear if the Surprise Soap intervention did in fact appeal to the motive of curiosity. Despite the success of this intervention, the exact motives the intervention appealed to are open to interpretation. More research is needed to better understand how motives inform children's behaviour to ensure future interventions accurately target motives that will drive HWWS among older children. Research is also needed to measure these specific motives and to

assess if they are indeed influenced by these interventions and lead to behaviour change, for example using mediation analysis (22, 23).

Besides play, another motive that this thesis research suggests may be useful for HWWS interventions targeting older children is nurture. Children rated nurture as the second most important motive and some practitioners perceived it to be a strong motive for children in relation to their siblings. Nurture has also been employed as a motivational driver in adult-focused interventions in stable settings (11, 15) and has recently been used in a wider school-based intervention (12). However, it has yet to be formally tested among older children in emergency settings, highlighting a research gap for future studies to address. Play and nurture are both 'positive' motives, in the sense of emphasising reward rather than punishment. Practitioners recommended using positive motives in HWWS interventions targeting older children, rather than negative motives such as disgust, the most often used motive in HWWS interventions to date.

The Surprise Soap proof-of-concept study met the inclusion criteria of the systematic review reported in Research Paper 1. The BCTs featured in the Surprise Soap intervention were therefore coded using Michie's taxonomy. However, this taxonomy does not specifically include codes for the motivational drivers described in the Evo-Eco theory, and so the distribution of Surprise Soap was coded as both a 'material incentive' (of behaviour) and a 'material reward' (of behaviour). Although 'material reward' was not found to be a promising BCT, it was not possible to determine if 'material incentive' was promising as this BCT was employed too infrequently across interventions to undertake a promise ratio analysis. However, given that the other three research papers in this thesis indicate that motive-based interventions are effective, and NGO practitioners believed incentives to be a good approach, it seems plausible that 'material incentive' would be a promising BCT if it truly reflected the use of motivational drivers to incentivise behaviour. Future revisions of the existing taxonomy may be necessary to better reflect the scope of motivational drivers for change and how they are utilised in public health interventions.

Health-based Messaging

In recent years health messaging has been discredited by a number of behavioural scientists as an effective way to improve HWWS (24-27). In contrast, this thesis suggests that health messaging linked to a specific, tangible, outcome can play an important role in HWWS promotion targeting older children. My systematic review found that providing 'information about health consequences' was a promising BCT, i.e., health messaging contributes to an increase in HWWS among older children. Research Paper 2 found that exposure to hygiene promotion was perceived as a key determinant of children's handwashing behaviour in the Sharia camp and, at the time of the research, these children

were exposed to Save the Children's hygiene promotion programme which was predominantly health-based messaging. It was clear that children had received health-based messaging as they demonstrated good knowledge of diseases and disease transmission pathways related to handwashing. NGO practitioners also believed that health messaging, when designed carefully, should be included in HWWS interventions targeting older children. They believed that even if not a motivation for HWWS, health messaging can serve both to satiate a child's need to know why they are performing a behaviour and to act as a reminder to perform the behaviour. Although my systematic review did not differentiate between different health-messaging techniques, interviews with NGO practitioners highlighted the importance of how health-messages are designed and delivered. Practitioners explained that health messaging that is not engaging and which fails to create a tangible link between HWWS and a specific health outcome, will not be effective. The frequency and intensity at which health messages are delivered are also likely to play an important role in their success and so, when deciding to employ this technique, it is crucial that careful consideration is given to both the design and delivery of the messages.

Health messaging might be an important BCT in HWWS interventions for older children, but this research also suggests it may be necessary to combine it with other BCTs to achieve lasting change in children's HWWS behaviour. For example, despite older children possessing health-related knowledge of handwashing in the Sharia camp, their baseline rates of HWWS were low. This suggests that additional BCTs should be employed alongside health messaging. Although the Surprise Soap intervention purposefully avoided health messaging, it was delivered in a context where exposure to hygiene promotion was high. It may be that the intervention effect was enabled or enhanced by children's health-related knowledge of handwashing.

When to include health messaging is likely context dependant. In settings where exposure to hygiene promotion is low (i.e., health-related knowledge of HWWS is low), including health messaging as part of the intervention may be essential. To determine if it is necessary to include this BCT, formative research is required to assess the existing levels of health-related knowledge of HWWS. If health messaging is to be included, the key, according to NGO practitioners, is that is delivered via fun, interactive, non-didactic methods, and that it creates a tangible link between handwashing and health. An important limitation of the systematic review was that it did not account for the quality of individual BCTs - BCTs of any quality were grouped and assigned the same promise ratio. Health messaging can be delivered in many ways, for example from posters to didactic lectures, to interactive games, and the delivery method alone can influence its effectiveness. When deciding if to include heath messaging it is equally important to carefully design the method of delivery.

Environmental Cues

Ensuring that there is a physically enabling environment (i.e., 'adding objects to the environment') was a particularly important finding across this thesis. Of course, in settings where the availability of soap and water are a barrier to handwashing, the provision of these materials is paramount. In environments where soap and water are already available, adding more soap and water is unlikely to lead to a change in behaviour (28). Adding objects to the environment, however, encompasses more than merely providing soap and water. It also encompasses the provision or adaptation of handwashing facilities and materials so that children find them attractive and easy to use, and the design of facilities and materials so that they, themselves, serve as an environmental cue to practice HWWS (24, 29). In Sharia camp, for example, nearly all households had a handwashing facility with soap and water available. Rather than simply the provision of soap, the provision of soap that was attractive, surprising, and novel, and which contained an incentive, was therefore the likely mechanism of change for the Surprise Soap Intervention.

Environmental cues (referred to also as 'nudges') were identified as a good approach to HWWS interventions targeting older children by the NGO practitioners. Practitioners believed this to be a good approach because they tend to be simple, low-cost interventions which are easy deployable, require little resources to implement, and are therefore easy to standardise. Further, given that evidence suggests, and NGO practitioners agree, intervention repetition is important, environmental cues may be the most feasible way to achieve this in low-resource settings, such as humanitarian emergencies. This may be another reason why the Surprise Soap intervention led to a change in behaviour. Having this product in the home may have visually cued HWWS. Hypothetically, each time it was viewed there was a natural repetition of the intervention, i.e., the child was cued to HWWS again. Hardware-based interventions like this may offer a more feasible approach to promoting HWWS in humanitarian settings than software-based interventions that require more resources to achieve high repetition.

Social Norm-based Interventions

Leveraging social norms to influence children's HWWS was also a consistent theme across this thesis. In the systematic review, 'information about social and environmental consequences' was found to be a promising BCT, and NGO practitioners believed that leveraging peer group social norms should be used in HWWS interventions targeting older children. Among the children, caregivers, and hygiene promoters interviewed for Research Paper 2, social norms were also perceived to be a strong determinant of children's handwashing behaviour, particularly in terms of the family's influence, and especially that of the mother. In the Surprise Soap intervention, the

surprisingly low number of ‘toy cheats’ (children who broke open the soap to reach the toy inside) may have reflected this. It is likely that children refrained from breaking the toy inside due to caregivers influencing how they use of the soap.

Combining BCTs

Beyond ‘material reward’ and ‘material incentive’, the motive-related BCTs employed in the Surprise Soap Intervention, according to Michie’s taxonomy, six other BCTs were also employed– ‘instruction on how to perform the behaviour’, ‘salience of consequences’, ‘information about social and environmental consequences’, ‘demonstration of the behaviour’, ‘behavioural practice/rehearsal’, and ‘adding objects to the environment’. All but one of these BCTs (behavioural practice/rehearsal) were found to be promising. This supports the recommendation made by Research Paper 1 to employ a combination of promising BCTs; perhaps HWWS interventions for children using motivational drivers are enabled by the presence of other BCTs. The glitter game used in the Surprise Soap intervention, for example – a way of demonstrating the social and environmental consequences of not practising HWWS, as well as the salience of consequences - was also independently identified by NGO participants as a popular and effective game to encourage children’s HWWS.

Synthesis of this thesis research indicates that a combination of the three BCTS: ‘demonstration of behaviour’, ‘instruction on how to perform the behaviour’ and ‘adding objects to the environment’ may be an important starting point when designing HWWS interventions for older children. As well as being employed together in the Surprise Soap intervention, Research Paper 1 found that these three promising BCTs are used in combination in many other hand hygiene interventions targeting older children. NGO practitioners also emphasised the need for a physically enabling environment (i.e., adding objects to the environment) and recommended HWWS demonstrations (i.e., demonstrating behaviour and proving instruction on how to perform the behaviour), giving weight to these BCTs being important inclusions within interventions. As in the Surprise Soap intervention, future HWWS interventions targeting older children may consider, as standard, combining this package of three BCTs with their other BCTs of choice.

Broader Reflections on the Thesis

In my thesis I engaged with different theories to both guide and analyse my research. I found that no one theory met the needs of this research in its entirety and instead took a pragmatic approach to the application of theory. This was largely related to the sequence of my research; I started the research process with an initial set of questions and subsequently identified the best methods to address each

question. The theoretical models I selected were those I felt were best aligned with my aims and objectives. Though it is recommended that practitioners apply theory to intervention design, they should not necessarily find that one theoretical approach will fit different needs. There will often be multiple questions posed within a single project and varying resources available to address each question (30). Practitioners therefore may also find it useful to engage with theory in this pragmatic way to account for real-life complexities. They should be encouraged to view theoretical models and frameworks as organisational tools to simplify complex relationships rather than static, linear models, and feel able to select the 'tools' that aid them in meeting project objectives. Practitioners are more likely to engage with theory if presented in this way.

This thesis focussed on understanding older children's handwashing behaviour and finding approaches to change it in the context of an emergency setting. However, the differentiation between emergency and stable or development settings may be an artificial one. It was clear from interviews with NGO practitioners that many work across stable and emergency settings but their views on operational challenges and solutions varied little between the two settings. Funders also typically provide grants across both settings. The systematic review I undertook included studies from almost entirely stable settings, yet findings closely aligned with my research in an IDP camp. It is also likely that children are motivated by play across all settings. This thesis research indicates that the scarcity of studies on older children's handwashing in emergencies is predominantly a reflection of the complexity of undertaking research in these settings and does not necessarily reflect fundamental behavioural differences between stable and emergency settings. Until there is more evidence around older children's handwashing specifically in emergencies, it is reasonable for practitioners to apply knowledge from stable settings to inform the design of HWWS interventions targeting older children in emergencies.

This thesis used a range of research methods, none of which are considered the 'gold standard' of public health research, i.e., a RCT (31). However, in their entirety, the methods used produced new evidence that makes a valuable contribution to the literature. While RCTs are often considered as the most rigorous study design for established causal evidence, they are not often possible in emergency settings. There are issues both with the feasibility and ethics of conducting RCTs in these settings (32). The methods I use in this thesis are reflective of real-world complexities in undertaking research in difficult settings. I used innovative techniques in my systematic review to enable the inclusion and synthesis of lower quality data and to draw conclusions and make recommendations. I used a controlled before-after study design to test the Surprise Soap intervention which was also able to generate evidence of value to the field and I used qualitative research that added a depth of understanding not possible with quantitative methods. Triangulating data from each of these studies

added validity to the findings. My thesis work demonstrates that research does not need to involve a RCT to be of value; less rigorous methods can also contribute in a valuable way.

Notably, issues of gender and social inclusion were largely absent in practitioner's discussion about HWWS promotion for older children. Practitioners mentioned making handwashing facilities disability inclusive but did not engage with the topic further and they did not discuss larger structural issues like gender disparities and household dynamics. Gendered behaviour begins to emerge among older children, for example girls start to take on more responsibilities in the home, collecting water, and caring for younger siblings – responsibilities mentioned by children during interviews in the IDP camp. Handwashing programmes do not sufficiently take this into consideration. Understanding that children are a diverse group with specific needs and trajectories and designing HWWS programmes accordingly is important. During prototyping of the Surprise Soap, we identified different stated toy preferences between girls and boys. Girls favoured dolls and boys favoured toy cars, however their preferences converged around animals. We purposefully selected a range of animals to include in the final Surprise Soap product in order to appeal to both genders. It is important to understand gender preferences, but this work shows it is also possible, with sufficient formative research, to find shared preferences. Of course, not all programmes would be able to do this as easily. A key question to consider is how we implement HWWS interventions for older children at scale while addressing the requirements of various sub-groups with this population. In the two RCTs of the Surprise Soap intervention, ongoing in Sudan and Somalia, we are collecting data around gender and disability to assess if this has an impact on how the Surprise Soap intervention is adopted and on its effectiveness.

Conclusions and Recommendations

This thesis research suggests that there are a number of approaches that may be effective at increasing children's HWWS behaviour in humanitarian emergency settings, including using positive motivational drivers, creating environmental cues, and interventions that leverage social norms. HWWS interventions targeting children in emergency settings should be simple and rapidly deployable, requiring as few resources as possible. The approach should be attractive to children and engaging, focussing on fun though play, and delivered in a non-didactic manner. Beyond the design of the intervention, fundamental changes to the contextual factors around HWWS promotion for children are necessary. Knowledge of the operational context should always be applied by NGO practitioners when designing these interventions. The NGO sector should make HWWS promotion for children in emergency settings an organisational priority, new interventions should be evaluated to as high a rigour as possible to build the evidence base, and approaches that prove successful should be

standardised and shared. To achieve the above, coordination within and between sectors is of fundamental importance.

Aimed at WASH practitioners at all levels, the following recommendations are made for future HWWS interventions for children in emergency settings:

1. Undertake formative research to determine existing access to handwashing facilities and materials, existing levels of health-related knowledge about handwashing, and existing social norms, and use the results to inform intervention design, for example the inclusion of health-based messaging or the provision of handwashing materials.

2. Balance resource needs against using evidence based, engaging approaches that address the drivers of handwashing among older children.

3. Engage with a theoretical framework to aid in applying specific contextual knowledge to intervention design.

4. Incorporate a standard package of BCTs into the intervention which includes providing instruction on how to properly perform HWWS, demonstrating HWWS, providing handwashing facilities and materials where necessary (guided by formative research), and enhance effectiveness by using handwashing facilities and materials to cue handwashing behaviour where possible.

5. Consider employing theory-based HWWS interventions that explicitly target positive motives, and in particular the motive of play, and interventions that leverage social norms to improve handwashing.

6. Design more household-level interventions which can reach out-of-school older children.

7. Undertake evaluations of interventions with the maximum rigour possible to build the evidence base around approaches to HWWS interventions for children in emergency settings

and disseminate findings across the sector and beyond to establish children's HWWS behaviour in emergencies as a global priority.

8. Build capacity of the organisation, local actors, and the community to ensure the availability of implementers skilled in delivering HWWS promotion to children and people who have the technical skills to sustain intervention activities and handwashing hardware after the exit of external organisations.

9. Actively coordinate within the sector to share best practices and produce standardised HWWs promotion tools which are available to all WASH actors and can be quickly and easily deployed in emergency settings to enable them to be more effective in their operations.

10. Create stronger links with national governments to understand their policies on hygiene and help to formulate new contextually appropriate strategies, donor agencies to secure sufficient and dedicated funds, educational institutions to firmly integrate HWWS promotion within the curriculum, and academia to support rigorous evaluation and the upstream flow of information from within the organisation to policy makers and other key actors.

Thesis Limitations

There are some important limitations to this thesis research as whole related to the generalisability of findings, scope of the research, and my positionality as a researcher. Below I discuss these limitations in more detail.

A lack of generalisability of findings from stable settings to emergency settings may be a limitation of this thesis. In my systematic review the limited number of published studies of hand hygiene and hand hygiene interventions in emergency settings required including studies from stable settings. Additionally, most NGO practitioners interviewed in Research paper 4 worked across both types of settings, meaning that not all views expressed would have been specific to emergencies. This presents a risk that some of the conclusions and recommendations made in this thesis may be more relevant to stable settings. In a recent review of HWWS determinants, authors were not able to ascertain if determinants differed between stable and humanitarian settings (24). However, HWWS determinants have been found to differ between different post-conflict displacement settings (33). The authors

found HWWS determinants in post-conflict settings to be linked to disruptions to a person's physical, psychological, social, and economic circumstances. Given these disruptions emerge after displacement, it is plausible that HWWS determinants would differ between stable and emergency settings. However, none of this research focused on children and, depending on length of displacement, children may have no recollection of life before displacement. Given that findings across my four research papers are highly consistent, if HWWS determinants among children do differ across stable and emergency settings, this appears to have had little impact on the conclusions drawn as to which HWWS intervention approaches targeting children in emergency settings may be effective.

Another limitation related to generalisability is that I was only able to conduct field research in one emergency setting - an IDP camp in Northern Iraq. This camp had specific characteristics, such as hosting a relatively stable, entirely Yezidi population with a high exposure to hygiene promotion. There are a range of different humanitarian settings, from formal or informal camps to collective centres, urban settlements, rural self-settlements, and host families. Each humanitarian population has different characteristics. Thus, findings from this one IDP camp may not be generalisable to other humanitarian settings. In follow-on work to this thesis, however, I will be addressing this limitation by conducting further trials of the Surprise Soap intervention in two different, more complex humanitarian settings. This work is discussed in more detail below and full protocols for these studies are included in this thesis in Appendix E. Depending on the outcome of these new trials, further assumptions can be made about the level of generalisability of my findings.

It was beyond the scope of this thesis to conduct cost-effective analyses. This is a limitation of the thesis as this type of analysis is important for ensuring that valuable resources are being allocated in the best possible way, especially in humanitarian emergency settings. Whereas this thesis does recommend that chosen approaches are as low cost as possible, it cannot say which of the approaches recommended are the lowest cost or the most cost-effective. Cost data required to perform cost-effective analyses are rarely available in publications of HWWS interventions for children. To promote these types of economic analyses future studies should be encouraged to publish detailed cost data along with the intervention evaluation. Cost data was not reported in the Surprise Soap publication. This is because, for the purpose of this small-scale study, the soap was hand-produced via a resource-intensive process which would not be adopted if producing on a wide scale. There is ongoing research by Field Ready into how these soaps can be mass produced if the next phase of trials show that the Surprise Soap intervention can work if different humanitarian settings.

Finally, I acknowledge that my positionality as a researcher may have had some influence on my research findings. As a relatively young female from a stable high-income country, working and

pursuing a PhD at a prestigious academic institution, and ultimately, as an outsider to Sharia IDP Camp, I am aware that my position as a researcher in the camp was one of privilege, power, and disconnect, which may have influenced how research participants behaved, shared information, and expressed their views. Further, being associated with Save the Children - an NGO delivering aid - while I worked in the camp likely further compounded the power imbalance between researcher and research participants. My positionality may have also influenced the way I handled and analysed data. Having developed my own handwashing habits in a context with few physical barriers to HWWS, and with my own preconceptions around handwashing determinants and children's motives, I may have unintentionally viewed the data through a non-neutral lens and introduced bias to my analyses.

Agenda for Future Research

Priorities for future research have been identified throughout the four research papers in this thesis. Several stand out as being particularly important.

Firstly, regarding the Surprise Soap intervention, further research is needed to determine if this intervention can be effective in different, more challenging emergency settings, and if changes in handwashing behaviour can be sustained beyond 4 weeks. I have secured and lead a new grant from the donor agency, ELRHA, to address these questions. Under this grant I am currently leading a multi-site evaluation of the Surprise Soap intervention as deployed by two new agencies in two challenging humanitarian settings and with an increased follow-up of 16 weeks. This involves parallel RCTs in humanitarian sites in Somalia and Sudan in which the populations are highly unstable, children have low prior exposure to hygiene promotion, and political instability or conflict affects site access. This study been granted ethical approval from LSHTM, the Somali Federal Republic Ministry of Health and Human Services, and the Research Directorate at the Federal Ministry of Health, Sudan. The approved protocol can be found in Appendix E.

Secondly, there is need to test more approaches that may be effective in HWWS interventions targeting older children. For example, given that play appears to effectively motivate older children's HWWS behaviour, it would also be useful to evaluate the effectiveness of other motivational drivers in changing older children's handwashing behaviour. This thesis indicates that nurture may be an important motive for children and interventions using nurture, as well as disgust and affiliation as motivational drivers, have had success among adults in stable settings. It would be useful to test the use of these motivational drivers in HWWS interventions for older children in emergencies using proof-of-concept studies, similar to the Surprise Soap study. Further studies are also needed to

understand how motives inform children's behaviour in order to guide the design of motive-based HWWS interventions for children.

Leveraging social norms was also a recommended approach to HWWS interventions for older children. Social norm-based HWWS interventions should be developed and evaluated among children to be able to validate this recommendation.

Thirdly, cost-effective analyses of different HWWS interventions for older children need to be undertaken. Where available, cost data related to past evaluated interventions should be published and future interventions should accurately record and share associated costs to enable these analyses.

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APPENDICES

Appendix A: Supplementary Materials for Introduction Section

A. Watson et al, 2017 systematic review

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Systematic Review

Does targeting children with hygiene promotion messages work? The effect of handwashing promotion targeted at children, on diarrhoea, soil-transmitted helminth infections and behaviour change, in low- and middle-income countries

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Abstract

OBJECTIVES To synthesise evidence on the effect of handwashing promotion interventions targeting children, on diarrhoea, soil-transmitted helminth infection and handwashing behaviour, in low- and middle-income country settings.

METHODS A systematic review of the literature was performed by searching eight databases, and reference lists were hand-searched for additional articles. Studies were reviewed for inclusion according to pre-defined inclusion criteria and the quality of all studies was assessed.

RESULTS Eight studies were included in this review: seven cluster-randomised controlled trials and one cluster non-randomised controlled trial. All eight studies targeted children aged 5–12 attending primary school but were heterogeneous for both the type of intervention and the reported outcomes so results were synthesised qualitatively. None of the studies were of high quality and the large majority were at high risk of bias. The reported effect of child-targeted handwashing interventions on our outcomes of interest varied between studies. Of the different interventions reported, no one approach to promoting handwashing among children appeared most effective.

CONCLUSION Our review found very few studies that evaluated handwashing interventions targeting children and all had various methodological limitations. It is plausible that interventions which succeed in changing children's handwashing practices will lead to significant health impacts given that much of the attributable disease burden is concentrated in that age group. The current paucity of evidence in this area, however, does not permit any recommendations to be made as to the most effective route to increasing handwashing with soap practice among children in LMIC.

keywords hand washing, systematic review, children, behaviour change, diarrhoea, helminth

Introduction

The global burden of disease associated with poor water, sanitation and hygiene (WASH) is concentrated among children and thus promoting the practice of handwashing with soap (HWWS) among children presents an important public health measure [1].

Pneumonia and diarrhoea are two of the leading causes of child mortality globally and account for over 900 000, and 500 000 deaths per year in children under five years, respectively [2], many of which may be preventable with improved hygiene [3–5]. Systematic reviews have consistently shown that HWWS is effective at reducing diarrhoeal disease, and can reduce the risk of diarrhoea by up to 48%, [1, 6–8], with the current best estimate believed to be around a 23% risk reduction [9]. In fact,

[a]This article is dedicated to the late Dr. Jeroen Ensink. As a researcher, and as a teacher, Jeroen made a huge contribution to the field of environmental health. His wisdom, patience and good humour are much missed by his many collaborators and friends around the world.

it has been argued that HWWS is one of the single most cost-effective of all public health interventions [10]. HWWS acts as an important barrier in the transmission of diarrhoea-causing aetiological agents via the faecal–oral pathway by preventing faeces from entering, and being transmitted in the domestic environment [11].

In 2015, the sustainable development goals (SDGs) were launched and the target set for SDG 3.2 was to end, by 2030, the preventable deaths of newborns and children under five years [12]. With pneumonia and diarrhoea among the leading causes of deaths in these age groups, WASH interventions represent one of the most cost-effective methods to help achieve this goal [10]. HWWS is a key part of the integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea (GAPPD) framework, which proposes a cohesive approach to ending preventable pneumonia and diarrhoea deaths [13].

Children also are the population most vulnerable to soil-transmitted helminth (STH) infection, with prevalence and intensity peaking between the ages of 5 and 14 [14]. STHs are parasitic intestinal nematodes passed to humans through contact with soil contaminated with infected faeces and are one of the most common human infections worldwide, with a disproportionate burden in the poorest and most deprived populations [15]. STH infection is recognised as one of the most important causes of stunting in children and can also lead to long-term effects on cognitive development and educational achievement, which may hinder future economic development [14].

Whilst, historically, there has been less research assessing the relationship between HWWS and STH than between HWWS and diarrhoea, a recent systematic review also found handwashing interventions to be an effective measure to prevent the transmission and reduce the infection intensity of *Ascariasis lumbricoides*, a common STH. Handwashing can reduce the risk of *A.lumbricoides* infection by up to 62% [16].

No previous systematic reviews seem to have assessed the effectiveness of targeting handwashing promotion at children in LMICs. A recent Cochrane review of handwashing promotion to prevent diarrhoea did assess the effect of handwashing promotion on preventing diarrhoea, however, results were stratified by setting before being stratified by age, and, within these settings, the author did not analyse the effect of targeting handwashing promotion at children but only the effect of *any* handwashing promotion on diarrhoeal episodes in children [1]. The purpose of this systematic review is to assess if handwashing promotion, targeted at children in LMICs, is effective at increasing handwashing behaviour and consequently reducing diarrhoea and STH infection among children and their families. Handwashing behaviour is a primary outcome of interest in this review as this is the proposed mechanism to achieve reductions in communicable disease. Diarrhoeal disease is also a primary outcome of interest as this outcome is commonly used to measure the effectiveness of hygiene interventions and the link between diarrhoea and WASH is well known [8, 9]. Including STH infection as a primary outcome offers a measure which potentially has a lower risk of bias because diarrhoea is often measured by self-report, whilst STH can be measured objectively through standard diagnostic tests, such as the commonly used Kato–Katz method and the more sensitive FLOTAC method [17]. Although there is only evidence that handwashing reduces *A. lumbricoides* infection, this helminth is commonly grouped together with the helminths *Trichuris trichuria* and hookworm, and referenced as 'STH'.

Methods

Search strategy

Searches were carried out in July 2016, using eight bibliographic databases: MEDLINE, EMBASE, Global Health, CINAHL Plus, Scopus, IBSS, Africa-Wide Information and Web of Science. The search strategy incorporated terms related to: (i) children; AND (ii) handwashing promotion; AND (iii) (diarrhoea OR soil-transmitted helminths, OR behaviour). The search strategy was originally developed for MEDLINE (MESH terms were identified), before being adapted for use in bibliographic databases using database-specific controlled vocabulary terms and search filters. Reference lists of included studies were hand-searched for additional relevant citations. A full description of the search strategy and search terms for the MEDLINE database can be found in Appendix S1.

Screening and inclusion criteria

Studies were eligible for inclusion if they were published in a peer-reviewed journal, on any date up until 7 July 2016, and available in English. Qualitative studies and studies that were published as conference abstracts or posters were excluded. Eligible study designs included: randomised controlled trials (RCTs), non-randomised controlled trials (NRCTs) and controlled before–after (CBA) studies (with a concurrently enrolled control group). These study designs were selected to limit the risk of bias.

After screening, articles needed to meet five criteria to be included: (i) the study evaluated a clearly described hygiene promotion intervention including, or exclusively focussed on, messages around handwashing; (ii) the evaluated intervention targeted children between the ages of five and eighteen; (iv) the study was conducted in a low- or middle-income country, as defined by the World Bank [18]; (v) the study reported an effect on one or more of the outcomes of interest (detailed below). We excluded studies in which water, sanitation or other health interventions (with the exception of soap provision) were implemented concurrently, unless the study was able to report the effect of the hygiene promotion component targeting children separately. Similarly, studies in which children were not the only main targets of the intervention were excluded unless the effects of a distinct intervention component targeting only children could be clearly stratified.

Intervention

We included interventions that promoted handwashing (with or without soap) at any specified key moment, for example: after toilet use (defecation or urination), before preparing or handling food, before eating, after sneezing and coughing, upon arriving at school, after playing with soil, and during bathing. Intervention activities could include, for example: hygiene education, posters, group discussions, theatre, peer-monitoring, teacher monitoring, handwashing pledges, videos, comic books, songs, poems, games, drawing, puppet shows, mascots, rewards, competitions and environmental cues.

Outcomes

The primary outcomes of interest were the following: [1] handwashing behaviours (cleansing hands with water, with soap and water, or with hand sanitiser, at any key moment as listed above); [2] diarrhoea morbidity [prevalence or incidence] or mortality [regardless of aetiology and case confirmation]; and [3] one or more soil-transmitted helminth[1] infection [including prevalence and/or intensity]. Any reported change in knowledge with regard to handwashing with soap was a secondary outcome of interest. For all outcomes of interest, we included measurements taken at an individual or cluster level, and for either the target children or their families, since evidence suggests children can be effective agents of change [20]. For the handwashing behaviour outcome, we included studies using either direct measures of handwashing behaviours or soap consumption as a proxy measure.

[1]The main species that infect humans are roundworm (Ascaris lumbricoides), whipworm (Trichuris trichuria), and hookworm (Necator americanus and Ancylostoma duodenale) [19].

Study selection, data extraction and analysis

All results retrieved from database searches were exported into Endnote X7.1 (Thomson Reuters, New York, USA) and duplicates removed. Results were screened by title and abstract, by a single reviewer (JW), and non-eligible studies excluded. The full text for eligible studies was then independently reviewed by two reviewers (JW and OC), and a final decision on the inclusion of studies was reached by consensus.

Data were extracted into a pre-specified data extraction table, recording the following information: (i) study authors and publication date, (ii) intervention content, (iii) intervention methods, (iv) control group, (v) setting, (vi) study design, (vii) intervention length/intensity (intervention intensity was graded as 'low' if intervention activities were implemented at one point in time and 'high' if intervention activities were implemented at multiple points in time over the length of the intervention), (viii) outcomes, (ix) participants, (x) soap provision, (xi) results. A quantitative meta-analysis was not conducted due to the limited number of studies, and the heterogeneity in study interventions and outcomes, and instead a narrative synthesis of results was undertaken. Studies were grouped by outcome measure (behaviour change, diarrhoea and STH infection) and by secondary outcome (knowledge) to allow for qualitative comparison.

The review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA guidelines) [21]. A PRISMA checklist can be found in Appendix S2.

Quality assessment

Two reviewers (JW and OC) independently assessed the risk of bias in studies selected for inclusion in the review using the Cochrane 'Risk of Bias' Assessment Tool [22]. This tool is designed to assess if adequate steps have been taken to reduce bias across five domains by assessing sources of bias in each domain. 'Risk of bias' judgements were categorised as 'high risk', 'low risk', or 'unclear risk'. Table 1 outlines the assessment undertaken for each domain.

To assess the quality of NRCTs and CBAs, two additional criteria were included, as used in a recent relevant Cochrane Review [23]:

Table 1 Tool for assessing risk of bias

Domain	Source of bias	Assessment
Selection bias	Random sequence generation	Studies were categorised as 'low risk' if method used to generate allocation was sufficient to produce comparable groups
	Allocation concealment	Studies were categorised as 'low risk' if concealment of allocation before assignment was sufficient to ensure intervention allocations could not have been foreseen before or during enrolment
Performance bias	Blinding of participants and personnel	Studies were categorised as 'low risk' if trial participants and researchers were blinded from knowledge of which intervention a participant received and if intended blinding was effective
Detection bias	Blinding of outcome assessment	Studies were categorised as 'low risk' if outcome assessment was blind from knowledge of which intervention a participant received and if intended blinding was effective
Attrition bias	Incomplete outcome data	Studies were categorised as 'low risk' if outcome data were complete for each main outcome, including attrition and exclusions from the analysis. The reviewers assessed if attrition and exclusions were reported, the numbers in each intervention group (compared with total randomised participants), if reasons for attrition or exclusions were reported, and any re-inclusions in analyses for the review
Reporting bias	Selective reporting	Studies were categorised as 'low risk' if publication of outcomes measured, or of analyses performed, was complete

(i) comparability of baseline characteristics – studies were categorised as 'low risk' if baseline characteristics were similar between the intervention and control groups.
(ii) contemporaneous data collection – studies were categorised as 'low risk' if data were collected at similar points in time in the intervention and control groups.

Results

Search results

A total of 2,827 studies were identified from MEDLINE (349), EMBASE (494), Global Health (390), CINAHL (183), Africa-Wide Information (125), Scopus (865), IBSS [19] and Web of Science (402). One further study was identified from reference-list scanning and was also included in the final analysis. After deduplication, 1300 studies were screened by title and abstract and 43 studies selected for full-text screening. Applying the pre-defined inclusion criteria, eight studies were selected for inclusion in the final analysis [24–31]. The flow diagram in Figure 1 outlines the results of the database searches and the screening process, according to PRIMSA guidelines [21]. Appendix S3 lists the reasons for excluding the 35 studies on full-text screening.

Characteristics of included studies

Full details of the characteristics of included studies can be found in Appendix S4.

Settings and participants

Studies were conducted across six different countries: Malaysia [1], Peru [1], India [1], Egypt [1], China [2] and Kenya [2]. All studies targeted children of primary-school age, between the ages of five and twelve. Seven of the studies selected for inclusion were implemented in primary schools [24–28, 30, 31] and the one remaining study (Nicholson, 2014) [29] was implemented in communities, but targeted five-year-old children attending the first grade of a primary school.

Study design and length

Of the eight included studies, seven were cluster-RCTs [25–31] and one was a cluster-NRCT [24]. No eligible CBAs were identified. Six of the cluster-RCTs used schools as the unit of randomisation [25–28, 30, 31] and the other used low-income communities [29]. The NRCT used schools as the unit of allocation [24]. The intervention length of the included studies ranged from eight to forty-one weeks and intervention intensity was graded as 'high' in the six of the studies [24–26, 28, 29, 31].

Intervention

Of the eight included studies, four employed interventions focussed exclusively on handwashing promotion [26, 27, 29–31] and three studies employed interventions that promoted general hygiene messages around STH

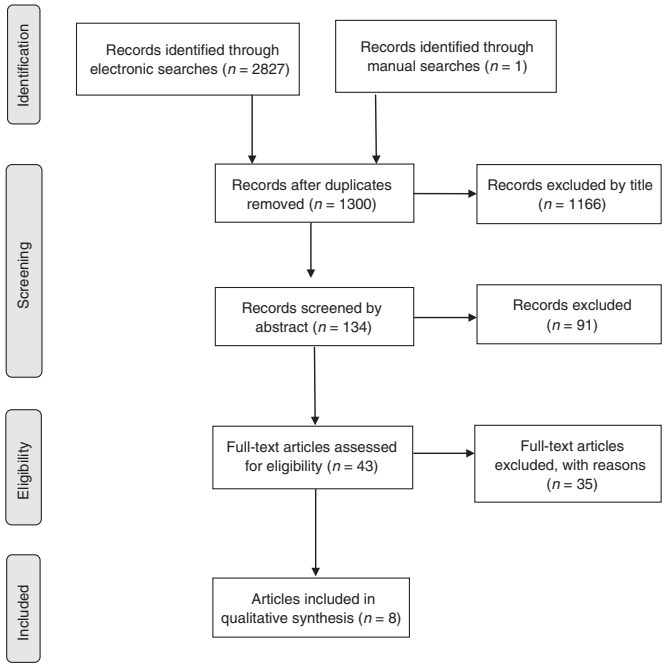

Figure 1 PRISMA flow diagram.

transmission and prevention, including handwashing [24, 25, 28]. One study (Pickering, 2013) [30], a three-arm cluster RCT, compared two independent interventions of combined soap provision and handwashing promotion versus a waterless hand sanitiser and hand cleaning promotion. For this study, we considered the results of both the soap and hand sanitiser interventions. The interventions in five of the studies included soap or hand sanitiser provision [24, 26, 29–31], whereas soap was not provided as part of the intervention in the other three studies [25, 27, 28]. Table 2 outlines the intervention activities, intervention intensity, and soap provision in each of the studies. More detailed characteristics of included studies can be found in Appendix S4.

Outcomes

Table 3 shows a summary of the outcomes measured in each study and if a positive effect was observed. To facilitate comparison, the studies were categorised according to their outcomes. Studies were marked as having a 'positive effect' if there was an increase in handwashing behaviour, a reduction in diarrhoea, a reduction in STH infection, and/or an increase in knowledge related to handwashing, in the intervention group compared to control group, and the effect was statistically significant at $P < 0.05$. Due to heterogeneity of the studies in terms of interventions and outcome measures, a meta-analysis was not considered appropriate and a narrative summary of the results is presented below. The magnitude of the positive effect is also presented in the narrative summary.

Handwashing behaviour change

Six studies measured the effect of handwashing promotion on handwashing behaviour change [24, 25, 27–30]. Across the studies, three methods were used to measure handwashing behaviour change. Al-delaimy (2014) [24] and Gyorkos (2013) [28] used self-reported measures. Bieri (2013) [25], Graves (2011) [27] and Pickering (2013) [30] used structured observations and Nicholson (2014) [29] indirectly assessed handwashing behaviour using soap consumption as a proxy measure (soap wrapper collection).

Al-delaimy (2014) [24] measured the handwashing behaviour of the parents of target children, at 12-week follow-up, and reported that the proportion of the parents

Table 2 Intervention activities

Study	Intervention activities	Intervention intensity	Soap provision
Al-delaimy (2014) [24]	Fun activities (comics books, drawing, puppet shows, nursery song videos, mascot)	High – activities repeated regularly throughout length of intervention (up to twice a week]	Soap provided
Bieri (2013) [25]	'Magic Glasses' cartoon, group discussions, drawing and essay competitions	High – activities throughout length of intervention	No soap provided
Bowen (2007) [26]	Standard intervention: 40-minute classroom session (animated videotape, hygiene competition, posters)	Standard: Low – 1 session only	Standard: one soap bar (hygiene pack)
	Expanded intervention: standard intervention plus peer handwashing monitors	Expanded: High – 1 session plus regular input from peer monitors	Expanded: continuous supply
Graves (2011) [27]	Poster design competition	Low – 1 session only	No soap provided
Gyorkos (2013) [28]	60-minute class on STH transmission and prevention and poster display	High – initial 1-hour session followed by 30 minute refresher activities every 2 weeks throughout length of intervention	No soap provided
Nicholson (2014) [29]	Fun activities (songs, poems and stories), environmental cues (wall hanger, etc.), HWWS rewards (stickers, toys, animals etc.), children encouraged to advocate HWWS at home), HWWS pledges for children and mothers, 'Best Mums' club.	High – activities throughout length of intervention	Soap provided
Pickering (2013) [30]	Distribution of hygiene promotion kits for teacher use (posters, stickers, classroom activities, DVD, promotional songs)	Unclear	Soap schools: liquid soap provided Sanitiser schools: liquid hand sanitiser provided
Talaat (2011) [31]	Fun activities (e.g. games), poster displayed near sinks, songs. Supervised HWWS twice daily.	High – activities repeated throughout length of intervention (at least one activity per week)	Soap provided

practising handwashing in the intervention group was three-and-a-half times higher than the proportion of parents practising handwashing in the control group, both before eating (odds ratio [OR] 3.5, 95% confidence interval [CI]: 1.9–6.4), and after using the toilet (OR 3.5, 95% CI: 1.7–7.1). Soap was supplied in this intervention and the odds of HWWS was six-and-a-half times higher in the parents in the intervention group, compared to parents in the control group (95% CI: 3.2–13.1). Gyorkos (2013) [28] found no statistically significant difference (at the 5% significance level) between proportions of children washing their hands before eating or after visiting the toilet at the 16-week follow-up, and no difference in children using soap to wash their hands. Bieri (2013) [25] found a statistically significant increase in the number of children who washed their hands after toilet use in the intervention group *vs.* the control group (44.6% increase, 95% CI: 10.1%–79.1%, $P = 0.005$) at 36-week follow-up. Graves (2011) [27] reported no significant difference in the proportion of children practising handwashing after toilet use, at 16-week follow-up; the mean difference in the proportion of students washing their hands was 0.07 (95% CI: −0.13, 0.27). Pickering (2013) [30] reported no significant differences in handwashing at intervention schools compared to control schools after toilet use (prevalence ratio = 1.0, 95% CI: 0.3–3.8) and before eating (prevalence ratio = 1.2, 95% CI: 0.7–2.0). Nicholson (2014) [29] reported a median soap consumption of 45 g per household in the control group, compared to 235 g per household in the intervention group.

Soil-transmitted helminth infection

Three studies reported the effect of hygiene promotion interventions, which included messages around handwashing, on STH infections [24, 25, 28].

Although Al-delaimy (2014) [24] showed a significant decrease in hookworm infection rates in the intervention

Table 3 Study outcomes and effects

Outcome	Study	Outcome measurement	Outcomes measured	Positive effect
Behaviour	Al-delaimy (2014) [24]	KAP survey	Washing hands before eating	✓
			Washing hands after defecation	✓
			Washing hand with soap	✓
	Bieri (2013) [25]	Observations	Washing hands after toilet	✓
	Graves (2011) [27]	Observations	Handwashing	✗
	Gyorkos (2013) [28]	KAP survey	Washing hands after toilet	✗
			Using soap when washing hands after toilet	✗
			Washing hands before eating	✗
			Using soap when washing hands before eating	✗
	Nicholson (2014) [29]	Soap wrapper collection	Soap consumption	✓
	Pickering (2013) [30]	Observations	Soap Intervention	
			Hand cleaning after toilet use	✗
			Hand cleaning before eating	✗
			Hand Sanitiser Intervention	
			Hand cleaning after toilet use	✓
			Before eating	✗
Diarrhoea	Bowen (2007) [26]	Teacher records	Standard Intervention	
			Diarrhoea Incidence	✗
			Expanded Intervention	
			Diarrhoea Incidence	✗
	Nicholson (2014) [29]	Caregiver interviews	Predictive relative risk reduction (Intention-to-treat analysis)	
			Target children	✗
			Children aged ≤ 5 (non-target)	✓
			Children 6-15 (non-target)	✓
			Whole families	✓
	Pickering (2013) [30]	Student interviews	Soap Intervention	
			Diarrhoea prevalence	✗
			Sanitiser Intervention	
			Diarrhoea prevalence	✗
	Talaat (2011) [31]	Teacher records	School absence due to diarrhoea	✓
STH	Al-delaimy (2014)[24]	Laboratory analysis	*A. lumbricoides* re-infection	✗
			A. lumbricoides infection intensity	✓
	Bieri (2013)[25]	Laboratory analysis	STH Incidence	✓
			STH infection intensity	✗
	Gyorkos (2013)[28]	Laboratory analysis	*A. lumbricoides prevalence*	✗
			A. lumbricoides infection intensity	✓
Knowledge	Al-delaimy (2014)[24]	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓
	Bieri (2013)[25]	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓
	Gyorkos (2013)[28]	KAP survey	Knowledge of handwashing as a STH infection preventative measure	✓

group compared to the control group 24 weeks after deworming (75.5% *vs.* 39.6%, $P < 0.05$), the reduction in *A. lumbricoides* infection rates in the intervention group was not significant (82.3% *vs.* 63.3% $P > 0.05$). This study did, however, show a significant decrease in the intensity of *A. lumbricoides* at the 24-week follow-up, assessed as the mean *A. lumbricoides* egg count per gram of faeces. Bieri (2013) [25] reported significant reductions in incidence of STH infections, 36 weeks after deworming, between the intervention group and control group (OR 0.50, $P < 0.001$), but not in the intensity of infections (OR 1.12, $P = 0.12$), assessed as the geometric mean number of eggs per gram of faeces. Although researchers present results as 'all STHs', 100% of the infections detected were *A. lumbricoides* and thus were amenable to the handwashing promotion intervention

[25]. Gyorkos (2013) [28] showed no significant difference in *A. lumbricoides* infection between the intervention group and the control group 16 weeks post-deworming (adjusted OR 0.88, 95% CI: 0.57–1.34); however, the intensity of *A. lumbricoides* infection was significantly lower in the intervention group (adjusted incidence rate ratio 0.42, 95% CI: 0.21–0.85).

Diarrhoea

Four studies measured the effect of handwashing on diarrhoea [26, 29–31]. Talaat (2011) [31] measured the incidence of school absence due to diarrhoea among children (in the first three grades of primary school) and reported incidence was 33% lower in the intervention school compared to the control school ($P < 0.0001$, no 95% CI given). This intervention included a 'Hand Hygiene Team' comprising three teachers who supervised children to ensure handwashing was being practised, a method that may account for the pronounced effect of the intervention. Bowen (2007) [26] also measured diarrhoea incidence using teacher records of school absence due to diarrhoea, as well as diarrhoea reported during school time; however, the incidence of diarrhoea was reported to be zero in control, standard intervention and expanded intervention groups, and thus, no significant difference was reported. Pickering (2013) [30] measured prevalence of diarrhoea, as reported in interviews with children, and found no significant effect in either the soap intervention group (risk ratio 0.84, 95% CI: 0.58–1.22, $P = 0.36$) or the waterless hand sanitiser group (risk ratio 0.89, 95% CI 0.61–1.30, $P = 0.56$) at 8-week follow-up, although the authors highlight that the study was not designed to have adequate power to detect effects on health outcomes. Nicholson (2014) [29] reported the effect of the intervention on diarrhoea incidence in the target children (age 5), and in household members stratified by different age groups (under-5s, ages 6–15 and adults), measured by interviews with caregivers. In the per-protocol analysis, the target children in the intervention group were reported to have a predictive relative risk reduction (PRRR) of 21.3% (95% CI: 36.6%–2.3%); however, in the intention-to-treat (ITT) analysis the PRRR was no longer significant. The PRRRs for the under-5s, 6- to 15-year-olds and whole families were similar to that of the target children; however, all remained significant in the ITT analysis.

Knowledge

The three studies that focused on education around STH also measured changes in knowledge as a secondary outcome, along with STH infection and handwashing behaviour, and all reported statistically significant increases in knowledge [24, 25, 28]. Bieri (2013) [25] reported a 32.8 percentage point increase (95% CI: 28.9%–36.8%, $P < 0.001$) in the KAP scores (measuring knowledge of STH transmission, symptoms, prevention and treatment) of the intervention group compared to the control group; however, these results may be biased as KAP scores were also higher in the intervention group at baseline. Gyorkos (2013) [28] reported significantly higher KAP scores in the target children in the intervention group compared to the control group (OR 18.4, 95% CI: 12.7–26.6) and Al-delaimy (2014) [24] measured knowledge of handwashing as a STH infection preventative measure in parents of the target children, using KAP surveys, and recorded significantly higher scores from parents in the intervention group compared to parents in the control group (OR 2.5, 95% CI: 1.5–4.1).

Quality assessment

Judgements about the risk of bias are summarised in Figure 2 and Figure 3. The full-quality assessment is presented in Appendix S5.

The random sequence was judged to be adequately generated in five of the seven cluster-RCTs and these studies were classed as having a 'low risk' of bias [25, 26, 28, 29, 31]. In the other two cluster-RCTs the sequence generation was unclear [27, 30]. The method of allocation concealment was classed as 'low risk' in Gyorkos (2013) [28], whilst the risk was 'unclear' in all other cluster-RCTs. Five of the studies were at 'low risk' of confounding bias [24, 28–31] and the other three studies were classed as 'high risk' because of differences in soap availability (Graves [2011]) [27], KAP scores (Bieri [2013]) [25], household water and sanitation and student age (Bowen [2007]) [26], at baseline. Data were collected contemporaneously and classed as 'low risk', in all studies except for Bowen (2007) [26], which was classed as 'high risk' due to the replacement of some schools in the study during the second week of data collection. Seven studies were judged to have a 'high risk' of performance bias as neither of the participants nor the personnel were blinded [24–30], whilst the blinding status of participants or personnel could not be determined in Talaat (2011) [31]. Seven of the studies had a 'high risk' or 'unclear risk' of detection bias as the outcome assessors were not blinded to intervention status or blinding was unclear [24–27, 29–31], whilst Gyorkos (2013) [28] was judged to have a 'low risk' of detection bias as the laboratory technologists testing STH in stool samples were blinded to the intervention. In four of the studies, over 80% of

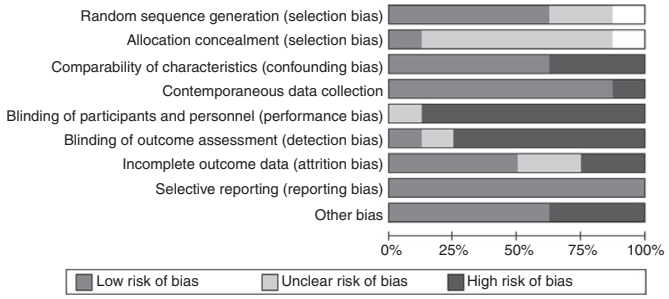

Figure 2 Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

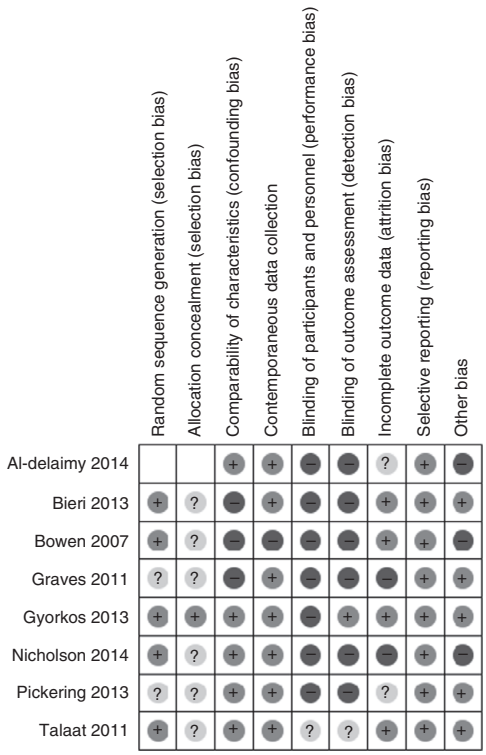

Figure 3 Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

those allocated to the study were included in the analysis and these studies were classed as 'low risk' of attrition bias [25, 26, 28, 31]. Al-delaimy (2014) [24] and Pickering (2013) [30] did not report loss to follow-up, and hence, the risk of attrition bias was unclear. Graves (2011) [27] and Nicholson (2014) [29] were classed as 'high risk' of attrition bias, with less than 80% of participants allocated to the study, included in the analysis. Other sources of bias identified in the studies were lack of adjustment for clustering in the analysis (Nicholson [2014] [29] and Al-delaimy [2014] [24]) and misrepresentation of the source population (Bowen [2007] [26] and Al-delaimy [2014] [24]).

Discussion

The main finding from the review is that the evidence base for child-focussed handwashing promotion in LMICs is extremely scarce; only eight relevant studies were found [24–31] and meta-analysis was not deemed possible due to heterogeneity in the interventions and measurement of outcomes across the studies. This was also evident in a recent review of the effect of handwashing promotion on diarrhoea, in which only three trials were identified that were conducted in schools or day-care centres in LMICs [1]. Studies also suffered from a number of design limitations which compromised the validity of their findings. The heterogeneity of the results, however, reflects the 'real-world' circumstance of handwashing promotion and hence a qualitative approach to synthesising the evidence is necessary.

Our review showed mixed evidence on the effectiveness of handwashing promotion, targeted at children, on infection with the STH, *A.lumbricoides*. Only one of the three studies identified showed a statistically significant reduction in *A.lumbricoides* infection in children [25], whilst two of the studies showed a significant reduction in *A.lumbricoides* intensity [24, 28]. These studies, however, may have been affected by bias due to a lack of blinding of the assessors. In one study that did blind the laboratory technologists assessing STH infection, and

therefore was at a low risk of detection bias, no significant effect on *A.lumbricoides* infection was recorded [28].

Handwashing promotion targeted at children was only reported to have a significant effect on diarrhoea in the intervention target children in one study, in which handwashing was obligatory and teacher-supervised, potentially masking the true effects of the other hygiene promotion activities in this study [31]. No other significant effects on diarrhoea incidence were reported in the other studies; however, incidence of diarrhoea was measured by self-report or through caregiver reports across all studies. As the responders were not blinded to the intervention, these reports are at high risk of response bias, influenced by perceived social desirability, and thus, diarrhoea is likely to be under-reported and may not accurately represent the effectiveness of the interventions [32]. A meta-analysis in Ejemot's (2015) review did show handwashing promotion to have a positive effect on the diarrhoea incidence of children within child day-care centres or schools in LMICs (rate ratio 0.66, 95% CI: 0.43-0.99); however, this meta-analysis only included two trials which were both graded as low quality [1].

All three of the studies in this review which used hygiene-related knowledge as a secondary outcome measure of intervention effect recorded a significant increase in knowledge post-intervention [24, 25, 28]. However, although knowledge is quick and easy to measure, it is not a good proxy indicator of behaviour change as it does not necessarily translate into behaviour change [33], as evident in Gyorkos' (2013) [28] study where children in receipt of the intervention scored significantly higher on a STH-related knowledge survey, but no significant change in handwashing behaviour was recorded. This intervention also had no significant effect on *A. lumbricoides* infection. By contrast, Bieri (2013) [25] and Al-delaimy (2014) [24] did both show a significantly higher increase in knowledge as well as change in behaviour in the intervention group compared to the control group. However, all studies measured behaviour outcomes in different ways – observations of target children's handwashing in Bieri (2013) [25], self-report of target children's handwashing in Gyorkos (2013) [28] and self-report of parent's handwashing in Al-delaimy (2014) [24] – and hence, comparisons should be made with caution. Although knowledge is necessary for behaviour change, it is not always sufficient and thus studies assessing the effect of handwashing promotion interventions should also include direct measures of behaviour change wherever possible.

Only three of the eight studies in our review used direct observations to measure handwashing behaviour change [25, 27, 30], whilst the remaining studies measuring handwashing behaviour used self-report, via KAP surveys [24, 28], or soap consumption as a proxy measure [29]. Whilst using self-reported behaviour and soap consumption to measure handwashing may be easier and less expensive than direct observations as less enumerator time and training is required, the validity of these measures is questionable. Participant awareness of the social desirability of handwashing, coupled with possible courtesy bias, is likely to lead to an overestimation of self-reported handwashing behaviour [32] and proxy measures such as soap consumption do not necessarily correlate with actual practice or prevalence of handwashing [34]. Direct observation of behaviours is considered the current 'gold standard' for measuring handwashing [34], although it is still at risk of bias; the presence of an observer has been shown to introduce reactivity and observed individuals may over-perform, leading to overestimates of actual behaviour [35, 36]. However, only one of the studies with observed handwashing behaviour [25] saw an overall statistically significant increase in the handwashing practices of children post-intervention compared to pre-intervention, which may suggest the effect of reactivity bias in schools was minimal. Although Nicholson (2014) [29] did record an increase in hand cleaning after using the toilet in the hand sanitiser intervention, no such effect was recorded in the soap intervention group.

The range of methods used to assess changes in behaviours across the studies made direct comparisons of findings difficult. Meta-analysis would be facilitated if future studies used more consistent measures of behaviour change to enable comparison. Direct observation should be the outcome measure selected where possible to improve the validity of results. Furthermore, a standard unit of measurement, such as the proportion of participants HWWS at a specified moment, for example after defecation, would better enable comparative analysis. The use of covert video cameras in both schools and homes has become increasingly common; however, video surveillance has also been shown to introduce reactivity [37] and remains logistically difficult and expensive.

All of the handwashing promotion interventions identified in this review were targeted at children attending primary school, between the ages of five and twelve. There is a clear lack of handwashing promotion interventions targeting teenagers, who may represent a potentially very important group in the disruption of the pathogen transmission considering the high adolescent fertility rate in low-income settings, which may indicate a large number of teenagers in caregiving roles [38]. Another overlooked target group, identified by this review, is children who do not attend school, the numbers of whom are substantially

higher in LMICs than in high income countries [38]. The findings of Ejemot's (2015) review also highlights this, with no trials included which were focussed on teenagers or out-of-school children [1].

A lack of good-quality evidence exists to prioritise specific handwashing promotion interventions targeted at children in LMICs. A variety of intervention methods are being employed to promote handwashing among children and not one accepted method of implementation or outcome measure has yet come to the forefront as the most effective. Due to the limited number of studies and heterogeneity of interventions, we were not able to assess the relationship between intervention effectiveness and the duration or intensity of the intervention. However, a recent systematic review of school-based interventions to modify dietary behaviour found no relationship between intervention intensity and effectiveness [39].

There has been some recent innovation in the science of changing handwashing behaviour. The Behaviour Centred Design (BCD) framework offers a new generalised approach to behaviour change which incorporates both a theory of change for behaviour and a practical process for designing and evaluating interventions [40]. BCD aims to change behaviour through surprise, revaluation and disruption of performance rather than traditional 'messaging' and has been used successfully in the design and evaluation of handwashing interventions, for example the SuperAmma programme in rural India [41]. Central to the BCD framework is changing both the environment and the brain (cognitive processes related to a specific behaviour). Pilot research in Bangladesh found large, sustained changes in handwashing behaviour associated with nudges – environmental changes in schools that included brick paths and painted symbols that prompted handwashing behaviours [42]. Larger trials examining the effect of environmental modification on handwashing outcomes in schools are underway [43]. Whilst more evidence is needed, environmental modification may present a viable approach to changing handwashing behaviours in schools.

This review has some limitations. Firstly, because the studies were judged too heterogeneous to conduct a meaningful meta-analysis, no quantitative conclusions could be drawn. Due to the heterogeneity of the studies, it was also not feasible to assess publication bias; however, many of the studies did report negative findings indicating that publication bias was not an important bias in this review. One potential method of reducing publication bias would be to include unpublished studies, although unpublished studies may be of lower quality and do not always reduce the publication bias but often alter the effect size [44]. Whilst this review only included concurrently controlled trials, there may also be some useful information to gain from those uncontrolled studies excluded from this review, especially as in low-income settings, RCTs and non-randomised controlled trials are often considered ethically or financially challenging. Inclusion of these lower quality studies, however, may have resulted in inclusion of evidence with an unacceptably high risk of bias. Additionally, the exclusion of non-English language studies from this review may limit the generalisability of the findings as we may have excluded valid international work. A final limitation of this review is the exclusion of studies where the effect of the handwashing promotion intervention could not be distinguished from the effect of other WASH improvements. Whilst this was necessary to assess the effectiveness of handwashing promotion interventions, it does not reflect the best approaches to improving health through hygiene where access to water, improved water quality and sanitation also play an important role. Organisational support is a key factor in the sustainability of health service interventions [45]. In the school-based handwashing promotion interventions identified in our review, soap supply, WASH infrastructure and maintenance, along with other organisational aspects of handwashing, over which children have very little agency, will impact the sustainability of these interventions and are important considerations.

Whilst regular handwashing with soap is regarded as an effective and cost-effective public health measure, no previous reviews have assessed whether interventions targeting children are effective in changing handwashing behaviours nor health outcomes. Our review found just eight studies that evaluated such interventions and those identified were heterogeneous in nature and had various methodological limitations. As much of the hygiene attributable disease burden is concentrated among children, it is plausible that interventions which succeed in changing children's handwashing practices will lead to significant health impacts. The current paucity of evidence in this area, however, does not permit any recommendations to be made as to the most effective route to increasing handwashing with soap practice among children in LMIC.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:
Appendix S1. Detailed Search Strategy and Hits – Medline.
Appendix S2. PRISMA Checklist.
Appendix S3. Characteristics of Excluded Studies.
Appendix S4. Characteristics of Included Studies.
Appendix S5. Risk of Bias.

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Appendix B: Supplementary Materials for Research Paper 1

A. Prisma Statement

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1-2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	29
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix S2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-11
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	8-10
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10-11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10-11
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11-12
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1, page 14-15
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	15-16 & Appendix S7
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Table 2, page 18-18
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Table 2, page 18-19
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Figure 2, page 16
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 19-20 & Figure 3 & 4
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21-26

Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	26-29
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	29-30
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	No funding

B. Medline Database Search Strategy

HAND HYGIENE TERMS	
1	("handwash*" or "hand-wash*").tw.
2	exp Hand Hygiene/
3	(hand adj1 (hygien* or clean* or disinfect* or decontaminat* or wash* or sterili* or sanit*)).tw.
4	1 or 2 or 3
PROMOTION TERMS	
5	(promotion* or education* or intervention* or program* or lesson or campaign*).tw
CHILDREN TERMS	
6	(child* or youth or minor or schoolchild* or pupil or "young person*" or "young people" or kid or junior).tw.
TERMS COMBINED	
7	4 and 5 and 6

C. Risk of Bias Tool

#	RISK OF BIAS ITEMS
1	Were the research questions or objectives in this paper clearly stated and appropriate?
2	Was the study population clearly specified and defined?
3	Was a sample size justification, power description or variance and effect estimates provided?
4	Were the intervention/s clearly described and delivered consistently against the study population?
5	Were the outcome measures pre-specified, clearly defined, valid, reliable, and assessed consistently across all study participants?
6	Was the outcome observed rather than self-reported? (only 0 or 1 possible)
7	Were the measures of outcome assessors blinded to the exposures/interventions of participants?
8	Was loss-to-follow up after baseline 20% or less?
9	Were those lost to follow-up accounted for in the analysis?
10	Were key confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?
11	Does the study have a control group? (only 0 or 1 possible)
12	Was the study randomised? (score 0 if there is no control group)
13	Were the groups similar at baseline on important characteristics that could affect outcomes? (score 0 if 'no' or if there is no control group)
14	Was the allocation sequence concealed? (score 0 if there is no control group)

D. Behaviour Change Taxonomy (BCTv1)

BCT Taxonomy (v1): 93 hierarchically-clustered techniques

Page	Grouping and BCTs
1	**1. Goals and planning**
	1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behavior goal(s) 1.6. Discrepancy between current behavior and goal 1.7. Review outcome goal(s) 1.8. Behavioral contract 1.9. Commitment
3	**2. Feedback and monitoring**
	2.1. Monitoring of behavior by others without feedback 2.2. Feedback on behaviour 2.3. Self-monitoring of behaviour 2.4. Self-monitoring of outcome(s) of behaviour 2.5. Monitoring of outcome(s) of behavior without feedback 2.6. Biofeedback 2.7. Feedback on outcome(s) of behavior
5	**3. Social support**
	3.1. Social support (unspecified) 3.2. Social support (practical) 3.3. Social support (emotional)
6	**4. Shaping knowledge**
	4.1. Instruction on how to perform the behavior 4.2. Information about Antecedents 4.3. Re-attribution 4.4. Behavioral experiments
7	**5. Natural consequences**
	5.1. Information about health consequences 5.2. Salience of consequences 5.3. Information about social and environmental consequences 5.4. Monitoring of emotional consequences 5.5. Anticipated regret 5.6. Information about emotional consequences
8	**6. Comparison of behaviour**
	6.1. Demonstration of the behavior 6.2. Social comparison 6.3. Information about others' approval
9	**7. Associations**
	7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues 7.4. Remove access to the reward 7.5. Remove aversive stimulus 7.6. Satiation 7.7. Exposure 7.8. Associative learning
10	**8. Repetition and substitution**
	8.1. Behavioral practice/rehearsal 8.2. Behavior substitution 8.3. Habit formation 8.4. Habit reversal 8.5. Overcorrection 8.6. Generalisation of target behavior 8.7. Graded tasks
11	**9. Comparison of outcomes**
	9.1. Credible source 9.2. Pros and cons 9.3. Comparative imagining of future outcomes
12	**10. Reward and threat**
	10.1. Material incentive (behavior) 10.2. Material reward (behavior) 10.3. Non-specific reward 10.4. Social reward 10.5. Social incentive 10.6. Non-specific incentive 10.7. Self-incentive 10.8. Incentive (outcome) 10.9. Self-reward 10.10. Reward (outcome) 10.11. Future punishment
15	**11. Regulation**
	11.1. Pharmacological support 11.2. Reduce negative emotions 11.3. Conserving mental resources 11.4. Paradoxical instructions
16	**12. Antecedents**
	12.1. Restructuring the physical environment 12.2. Restructuring the social environment 12.3. Avoidance/reducing exposure to cues for the behavior 12.4. Distraction 12.5. Adding objects to the environment 12.6. Body changes
17	**13. Identity**
	13.1. Identification of self as role model 13.2. Framing/reframing 13.3. Incompatible beliefs 13.4. Valued self-identify 13.5. Identity associated with changed behavior
18	**14. Scheduled consequences**
	14.1. Behavior cost 14.2. Punishment 14.3. Remove reward 14.4. Reward approximation 14.5. Rewarding completion 14.6. Situation-specific reward 14.7. Reward incompatible behavior 14.8. Reward alternative behavior 14.9. Reduce reward frequency 14.10. Remove punishment
19	**15. Self-belief**
	15.1. Verbal persuasion about capability 15.2. Mental rehearsal of successful performance 15.3. Focus on past success 15.4. Self-talk
19	**16. Covert learning**
	16.1. Imaginary punishment 16.2. Imaginary reward 16.3. Vicarious consequences

E. Excluded studies with reasons

Study	Year	Title	Reason for Exclusion
Akos et al	2018	Direct effect of contemporary health education programmes on the knowledge about hand hygiene and technique of hand washing in primary school age children	Not available in English
Amin et al	2015	Effects of complex handwashing instructions on adherence among school children in a low income urban community of Dhaka, Bangladesh	Conference abstract only
Annesi et al	2010	An evidence based multi-activity handwashing education program in children	Not published in peer-reviewed journal
Appaiah-Brempong et al	2020	Effect of a theory-based hand hygiene educational intervention for enhancing behavioural outcomes in Ghanaian schools: a cluster-randomised controlled trial	Children outside 5-12 age group
Biran et al	2009	The effect of a soap promotion and hygiene education campaign on handwashing behaviour in rural India: a cluster randomised trial	No eligible outcomes measured
Biran et al	2014	Effect of a behaviour-change intervention on handwashing with soap in India (SuperAmma): A cluster-randomised trial	No eligible outcomes measured
Blanton et al	2010	Evaluation of the role of school children in the promotion of point-of-use water treatment and handwashing in schools and households: Nyanza Province, Western Kenya, 2007	Intervention not targeting hand hygiene
Bonnesen et al	2015	Process evaluation of a multi-component intervention to reduce infectious diseases and improve hygiene and well-being among school children: the Hi Five study	Children outside 5-12 age group
Boubacar et al	2014	Assessing the health impact of the following measures in schools in Maradi (Niger): Construction of latrines, clean water supply, establishment of hand washing stations, and health education	No eligible outcomes measured
Bowen et al	2007	A cluster-randomized controlled trial evaluating the effect of a handwashing-promotion program in Chinese primary schools	No eligible outcomes measured
Bowen et al	2013	Sustained improvements in handwashing indicators more than 5 years after a cluster-randomised, community-based trial of handwashing promotion in Karachi, Pakistan	No eligible outcomes measured
Briceno et al	2015	Promoting handwashing and sanitation: evidence from a large-scale randomized trial in rural Tanzania	Intervention not targeted at children & not published in peer-reviewed journal
Brorzekowski et al	2015	Sesame street in the tea estates: A multi-media intervention to improve sanitation and hygiene among Bangladesh's most vulnerable youth	Conference abstract only
Buck et al	2018	Educators Teach Effective Hand Washing with a Simplified Method	Non-eligible study design (behaviour outcome not reported at baseline)
Burns et al	2018	Washing with hope: evidence of improved handwashing among children in South Africa from a pilot study of a novel soap technology	Children outside 5-12 age group
Caruso et al	2014	Assessing the impact of a school-based latrine cleaning and handwashing program on pupil absence in Nyanza Province, Kenya: a cluster-randomized trial	Children outside 5-12 age group

Celik et al	2012	Healthy school environment: effectiveness of hand washing instruction in an elementary school setting	No eligible outcomes measured
Chittleborough et al	2010	A cluster-randomised controlled trial to test the effectiveness of a hand washing intervention in reducing infection-related absence in primary schools: insights from an embedded process evaluation	Conference abstract only
Christensen et al	2015	Pilot cluster randomized controlled trials to evaluate adoption of water, sanitation, and hygiene interventions and their combination in rural western Kenya	Intervention not targeted at children
Contzen et al	2015	Changing handwashing behaviour in southern Ethiopia: a longitudinal study on infrastructural and commitment interventions	Intervention not targeted at children
Cumberland et al	2008	The impact of community level treatment and preventative interventions on trachoma prevalence in rural Ethiopia	Intervention not targeted at children
Curtis et al	2001	Evidence of behaviour change following a hygiene promotion programme in Burkina Faso	No eligible outcomes measured (reported for children)
Day et al	1993	Effectiveness of a handwashing program	Non-eligible setting and population
Denbak et al	2018	Effect Evaluation of a Randomized Trial to Reduce Infectious Illness and Illness-related Absenteeism among Schoolchildren: The Hi Five Study	No eligible outcomes measured
Dreibelbis et al	2012	Reductions in diarrhea and clinic visits for diarrhea among children under the age of five associated with a school-based water supply, sanitation and hygiene intervention in western Kenya: A cluster-randomized trial	Conference abstract only
Dreibelbis et al	2014	The impact of school water, sanitation, and hygiene interventions on the health of younger siblings of pupils: a cluster-randomized trial in Kenya	No eligible outcomes measured
Freeeman et al	2013	The impact of a school-based water supply and treatment, hygiene, and sanitation programme on pupil diarrhoea: A cluster-randomized trial	No eligible outcomes measured
Freeman et al	2012	The impact of improved school water, sanitation and hygiene access on pupil diarrhea: A clusterrandomized trial	Conference abstract only
Freeman et al	2012	The impact of a school-based hygiene, water quality and sanitation intervention on soiltransmitted helminth reinfection: A clusterrandomized trial	No eligible outcomes measured
Freeman et al	2016	School-based health education programmes, health-learning capacity and child oral health-related quality of life	No eligible outcomes measured
Freeman et al	2012	Assessing the impact of a school-based water treatment, hygiene and sanitation programme on pupil absence in Nyanza Province, Kenya: A cluster-randomized trial	Children outside 5-12 age group
Galiani et al	2016	Promoting Handwashing Behavior: The Effects of Large-scale Community and School-level Interventions	No eligible outcomes measured
Galiani et al	2012	Promoting handwashing behavior in Peru: the effect of large-scale mass-media and community level interventions	No eligible outcomes measureds & not published in a peer-reviewed journal
Garg et al	2013	Effect of a school-based hand washing promotion program on knowledge and hand washing behavior of girl students in a middle school of Delhi	Children outside 5-12 age group

Geethatani et al	2016	Effect of behaviour change-intervention on hand washing practices and knowledge about hand washing among school students, Perambalur district, Tamil Nadu, India, 2014-2015	Conference abstract only
Greene et al	2012	Impact of a school-based hygiene promotion and sanitation intervention on pupil hand contamination in Western Kenya: a cluster randomized trial	Children outside 5-12 age group
Guinan et al	2002	The effect of a comprehensive handwashing program on absenteeism in elementary schools	No eligible outcomes measured
Hetherington et al	2017	Participatory science and innovation for improved sanitation and hygiene: process and outcome evaluation of project SHINE, a school-based intervention in Rural Tanzania	Children outside 5-12 age group
Jess et al	2019	Effects of a handwashing intervention package on handwashing in preschool children	Children outside 5-12 age group
Kaewchana et al	2012	Effect of intensive hand washing education on hand washing behaviors in thai households with an influenza-positive child in urban Thailand	Intervention not targeted at children
Kaur el at	2019	A Study to Assess the Effectiveness of Child to Child Approach on Knowledge and Practices Regarding Hand Washing among the Primary School Children of a Selected School Faridkot, Punjab	Full text unavailable
Lang et al	2012	Implementation of an evidence-based hand hygiene program in elementary schools in Ghana, as part of a City-to-City partnership between Ottawa public health and KEEA health directorate	No eligible outcomes measured
Lary et al	2013	Improving children's and their visitors' hand hygiene compliance	Non-eligible setting
Luby et al	2010	A community-randomised controlled trial promoting waterless hand sanitizer and handwashing with soap, Dhaka, Bangladesh	Intervention not targeted at children
Luby et al	2011	The effect of handwashing at recommended times with water alone and with soap on child diarrhea in rural bangladesh: an observational study	Non-eligible study design
Lynch et al	1994	Testing a participatory strategy to change hygiene behaviour: Face washing in central Tanzania	No eligible outcomes measured
Maycock et al	2010	The importance of hand washing using an interactive glitter technique	Conference abstract only
Mbakaya et al	2019	Effect of a school-based hand hygiene program for Malawian children: A cluster randomized controlled trial	No eligible outcomes measured
McDonald et al	2015	Evaluating a handwashing with soap program in Australian remote Aboriginal communities: a pre and post intervention study design	No eligible outcomes measured (reported for children)
Mohamed et al	2018	Effects of "bacterfree hand intervention" on the knowledge, attitude of handwashing and its technique, among pre-schoolers in Wilayah Persekutuan, Malaysia	No eligible outcomes measured
Naluonde et al	2019	A disruptive cue improves handwashing in school children in Zambia	Children outside 5-12 age group
Nicholson et al	2014	An investigation of the effects of a hand washing intervention on health outcomes and school absence using a randomised trial in Indian urban communities	No eligible outcomes measured
Njuguna et al	2009	The sustainability and impact of school sanitation, water and hygiene education in Kenya	Not published in peer-reviewed journal
Nkhata et al	2017	Soap on a rope hall pass: A randomized controlled trial of a disruptive cue to improve handwashing behavior in Namwala District, Zambia	Conference abstract only

Null et al	2018	Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial	No eligible outcomes measured & children not targeted
Nzengya et al	2015	The impact of a school-based hygiene education intervention on student knowledge in Kenya	No eligible outcomes measured
Onyango-Ouma	2005	The potential of schoolchildren as health change agents in rural western Kenya	Children outside 5-12 age group
Ozcan et al	2020	Hand Washing in Primary School Students Using "Demonstration, Puzzle, Dance, Song": A Nursing Project Based on Multifaceted Skills Training	No eligible outcomes measured
Randle et al	2013	Impact of an educational intervention upon the hand hygiene compliance of children	Non-eligible setting
Reinhardt et al	2012	Comparison of three forms of teaching - a prospective randomized pilot trial for the enhancement of adherence	Intervention not targeted at children
Rosen et al	2011	Enabling hygienic behavior among preschoolers: improving environmental conditions through a multifaceted intervention	No eligible outcomes measured
Rosen et al	2006	Can a handwashing intervention make a difference? Results from a randomized controlled trial in Jerusalem preschools	Children outside 5-12 age group
Ruby et al	2017	Impact of school health education program on personal hygiene among school children of Lucknow district	Non-eligible study design (behaviour outcome not reported at baseline)
Sahin et al	2008	An intervention study on hand washing among 6-14 years of age children	Not available in English
Smith et al	2012	Prevention of diarrhea and intestinal parasitosis through community education in belen, Peru	Conference abstract available only
Stanton et al	1987	An educational intervention for altering water-sanitation behaviors to reduce childhood diarrhea in urban Bangladesh. II. A randomized trial to assess the impact of the intervention on hygienic behaviors and rates of diarrhea	Intervention not targeted at children
Talaat et al	2011	Effects of hand hygiene campaigns on incidence of laboratory-confirmed influenza and absenteeism in schoolchildren, Cairo, Egypt	No eligible outcomes measured
Tidwell et al	2020	Impact of a teacher-led school handwashing program on children's handwashing with soap at school and home in Bihar, India	Children outside 5-12 age group
Trinies et al	2014	Impact of a school-based water, sanitation and hygiene program on diarrhea, respiratory infections and absenteeism: A longitudinal evaluation	Conference abstract available only
Trinies et al	2016	The impact of a school-based water, sanitation, and hygiene program on absenteeism, diarrhea, and respiratory infection: A matched-control trial in Mali	No eligible outcomes measured
Vally et al	2019	The Impact of a School-Based Water, Sanitation and Hygiene Intervention on Knowledge, Practices, and Diarrhoea Rates in the Philippines	Non-eligible study design
Wichaidit et al	2016	Effect of a combined hardware and behavior change intervention on handwashing behaviors in primary school children: The povu poa school pilot study	Conference abstract available only
Wichaidit et al	2019	Effectiveness of a large-scale handwashing promotion intervention on handwashing behaviour in Dhaka, Bangladesh	Intervention not targeted at children
Witt et al	2004	Using educational interventions to improve the handwashing habits of preschool children	Children outside 5-12 age group
Zhang et al	2013	Promoting clean hands among children in Uganda: a school-based intervention using 'tippy-taps'	Children outside 5-12 age group

F. Study Characteristics Table

Author	Title	Study Design	Setting/ Country	Urban /Rural	Country classification	Intervention Description	Control Group	Study population & sample size	Intervention intensity	Follow-up	Outcome Measure	Results	Outcome score
Al Delaimy 2014	Developing and evaluating health education learning package (HELP) to control soil-transmitted helminth infections among Orang Asli children in Malaysia	Cluster NRCT	Primary school/ Malaysia	Rural	LMIC	The intervention involved: 1. posters, 2. comic book 3. drawing activities, 4. puppet show, 5. nursery songs videos, 6. mascot, 7. group discussions, and 8. distribution of sanitary bags (slippers, hand soap and nail clippers)	Yes - No intervention	Primary school children Age range: 6-12 years Median age: 9 Sample size: 317 children (172 intervention group, 145 control group)	Ongoing for 6 months with visits every 2 weeks	3 months	Self-Reported (by parents) handwashing	Washing hands before eating rose from 38.2% to 89.9% in the intervention group Washing hands before defecating went from 55.1% to 82% Washing hands with soap went from 18.% to 67.4% Intervention group vs. control analysis: Washing hands before eating OR = 3.5 (1.9, 6.4), p<0.001 Washing hands after defecation OR = 3.5 (1.7, 7.1), p<0.001 Washing hand with soap OR = 6.5 (3.2, 13.1), p<0.001	1
Au 2010	Handwashing programme in kindergarten: a pilot study	RCT (pilot)	Preschool/Hong Kong	Urban	HIC	The programme integrated storytelling, health education, games (including a glo-germ activity), experiments, and hands-on activities. A pocket-sized booklet, which consisted of information regarding the recommended handwashing procedures for	Yes - No intervention	Kindergarten students age 5-6 2 classes (1 intervention, one control). 15 children in each group)	5 x 20-minute teaching sessions - one per week (5 weeks total)	Immediately after the 5-week programme then 1,2,3, and 4 months after the	Observed handwashing technique	Handwashing practice scores rose from 6.3 to 11.20 in the intervention group. At the first follow-up, the intervention group had an average handwashing score that was higher than the control group by 2.2701 (β= 2.2701, p < 0.0001).	1

						children, a handwashing song, and stickers' area for rewards associated with proper handwashing behaviours, was distributed to each student in the experimental class.				programme			
Beiri 2013	Health-education package to prevent worm infections in Chinese schoolchildren	Cluster RCT	Primary school/ China	Rural	LMIC	The intervention involved: 1.'Magic Glasses' cartoon video on the topic of STH transmission and prevention (including handwashing messages). 2. Classroom discussions following cartoon. 3. Pamphlet with STH messages distributed. 4. Drawing and essay-writing competitions on STH. 5. Puppet show 6. Provision of sanitary bag (includes soap)	Yes - Health education poster only (normally displayed in schools)	School children, age 9-10 Sample size: 19 Intervention schools, 19 controls schools; 1718 children (825 intervention, 893 control)	Ongoing for 7 months with activities in months 1 and 7	9 months	Observed handwashing after toilet use	Observed handwashing increased in the intervention group from 46% to 98.9% In the control group handwashing did not increase from, baseline (54%) to endline (54.2%) 44.6% (10.1%-79.1%), P=0.005, more children washed hands after using toilet. *Adjusted for clustering * Not adjusted for age and school grade	1
Chard and Freeman 2018	Design, Intervention Fidelity, and Behavioral Outcomes of a School-Based Water, Sanitation, and Hygiene Cluster-	Cluster RCT	Primary school/ Laos	Rural	LMIC	The intervention included both infrastructure (hardware) and behaviour change (software) components. The hardware consisted of provision of a school water supply, sanitation facilities, and handwashing facilities, consisting of two sinks with taps connected to the water supply. The software component, called	Yes - No intervention	Children in grade 3-5 Sample size: 100 schools (50 intervention, 50 control)≥ 40 children from each school (4000 children)	Hardware delivered first followed by software at a few points over the intervention period	Every 6-8 weeks for 1.25-2 years	Observed handwashing after toilet use	Improvements in HWWS after toilet use were observed among students in intervention schools 1–6 and 13–18 months following software implementation (Group 2), but these improvements were not sustained across the evaluation period	0

	Randomized Trial in Laos					Hygiene Action led by Pupils in Schools (HAPiS), was implemented after the installation of the hardware components and consisted of group handwashing with soap at critical times, in which schools were provided with three group handwashing tables and children were instructed to wash their hands with soap twice per day, guided by teachers in charge of hygiene activities							
Dreibelbis 2016	Behavior change without behavior change communication: Nudging handwashing among primary school students in Bangladesh	BA	Primary school/ Bangladesg	Rural	LMIC	Handwashing infrastructure improvements and nudges were developed to facilitate handwashing with soap after using the latrine. Infrastructure improvements included the construction of a dedicated location for handwashing (raised cement platform) with a 60 L water container. Two nudges were used at both schools: (1) connecting latrines to the handwashing station via paved pathways that were painted bright colors; and (2) painting footprints on footpaths guiding students to the handwashing stations and handprints on stations. Soap was also provided.	No control group	School children Sample size: 2 schools A total of 962 observations of children leaving toilet across all follow-ups (approximately 200 children observed at each follow up)	Infrastructural improvements remained in the school throughout follow period and beyond	2 and 6 weeks after installing full intervention	Observed handwashing after toilet use	Handwashing with soap among school children was low at baseline (4%), increasing to 68% the day after nudges were completed and 74% at both 2 weeks and 6 weeks post intervention.	**1**

Early 1998	Effect of several interventions on the frequency of handwashing among elementary public school children	RCT (multi-arm)	Primary school/ USA	Urban	HIC	In the peer education group, selected fourth graders conducted a class for the first graders, with assistance from their teachers and project staff members. The content of the class for the fourth graders included a video presentation of a clown doing a handwashing demonstration, storyboards, overheads, posters, and training on how to use various teaching techniques for first graders. NB. Data was not extracted for the hand wipes and instructional poster group, or the combination of peer education plus handwipe group because hand wiping is not our behaviour of interest	Yes - No intervention	Primary school children	Single session delivered	2-3 weeks and 4-6 weeks after intervention	Observed handwashing before lunch and after toilet use	After intervention, significant differences in the proportion of handwashing between the peer education and the control group existed. In the control school, handwashing occurred 46% of the time and in the peer education group handwashing occurred 73% of the time ($p < 0.01$).	1
Graves 2011	Enhancing a safe water intervention with student-created visual aids to promote handwashing behavior in Kenyan primary schools	Controlled BA	Primary school/ Kenya	Rural	LMIC	Pupils were engaged in an activity in which they were asked to create posters promoting handwashing behaviour and winning posters were distributed in all classrooms of the intervention schools. This research took place in Kenyan primary schools already engaged in the NICHE program providing infrastructure for	Yes - also received handwashing infrastructure (soap and water containers)	Sample size: 23 schools (11 intervention and 2 control	Activities over 2 weeks	4 months	Observed handwashing after toilet use	No significant between-group differences in handwashing frequency, soap availability, or visibility of handwashing stations was observed. At follow-up, the mean proportion of pupils washing hands differed by 0.07 between intervention and comparison schools	0

						handwashing such as soap and water containers and educational manuals on handwashing and hygiene delivered at the beginning of the NICHE intervention. This study evaluated the additional effect of the poster intervention beyond the effects of other NICHE interventions. All schools had received the SWS products from NICHE one to three months before the intervention.						(p = 0.45). Comparing baseline to follow-up, the proportion of pupils washing hands increased by 2.7% in comparison schools and decreased by 2.8% in intervention schools. This difference represents a non-significant intervention effect over the period of the intervention (0.06, 95% CI: –0.27, 0.38).	
Grover 2018	Comparing the behavioural impact of a nudge-based handwashing intervention to high-intensity hygiene education: a cluster-randomised trial in rural Bangladesh	Cluster RCT reclassified to two BA studies	Primary school/ Bangladesh	Rural	LMIC	20 schools were randomly selected and allocated without blinding: 10 to a high intensity hygiene education (HE) with improved handwashing stations and 10 to nudge intervention with improved handwashing stations. HE consisted of four 30- to 45-min HE sessions, delivered once per week over the course of 4 weeks. Nudges included a paved path connecting latrines to the handwashing facility, a painted handwashing station with handprints and a dedicated location for soap, and painted shoeprints and arrows leading from the latrine to the handwashing station.	No control group as redefined as two BA studies	Primary school children 20 schools (10 with HE and 10 with Nudge). 3722 total children. 4506 toileting events observed	HE intervention: HE sessions delivered once per week over course of 4 weeks Nudge intervention: Nudges present throughout the 4 weeks	Weeks 6-7, 12-13, 18-19, 24-25	Observed (both by video cameras and in-person) handwashing after toilet use	The nudge intervention and the HE intervention were found to be equally effective at sustained impact over 5 months post-intervention (adjusted IRR 0.81, 95% CI 0.61–1.09). HE intervention: handwashing after toileting = 40% at baseline and 59% at combined follow-ups. P<0.001 Nudge intervention: handwashing 24% at baseline and 58% at 24 combined follow ups. P<0.001	HE intervention = 1 Nudge intervention = 1

Lewis 2018	Effect of a school-based hygiene behavior change campaign on handwashing with soap in Bihar, India: Cluster-randomized trial	Cluster RCT	Primary school/ India	Rural	LMIC	Unilever's 'school of 5 program' - campaign focused on avoiding germs by handwashing at five specific occasions. School intervention consisted of: displaying posters around school, including near handpumps, lessons describing handwashing steps and actions, lessons on handwashing, children pledge to wash hands, children undertake a daily diary task, class monitors supervised handwashing with soap during midday meal, soap distribution, stories of superheroes and their handwashing-related adventures, students who can recall steps were rewarded, glitterball demonstration. Mothers invited to meeting - glitterball demonstration and handwashing pledge. Children were also given 10 “enrolment cards” for telling up to 10 relatives or friends what they learned during the sessions and having them pledge to also HWWS at the target occasions.	Yes -No intervention	Primary School-age children (age 6-12) Sample size: 32 villages (1:1 intervention: control) 501 children: 240 intervention/ 261 control	21 days, 4 visits over the 21 days	8-10 weeks post intervention	Observed handwashing (after toilet, during bathing, before main meals)	No significant difference: At follow-up handwashing with soap in control group = 19.5% and in intervention group = 24.2%. Difference = 4.6%, p = 0.223 (-2.8% 12.0%)	0
Pasewaldt 2018	Impact of a Hand Hygiene Curriculum and Group	BA	Primary school/ Uganda	Urban and Rural	LMIC	Intervention the same in both schools. A 6-day handwashing promotion session consisting: - using glow-germ and	No control group	Primary school students (ages not specified)	6-day intervention and hygiene club set up with group handwashing	10 days post intervention	Self-reported handwashing frequency	Prior to intervention implementation, students washed their hands an average of 3.34 times a day, but after implementation,	**1**

	Handwashing Station at Two Primary Schools in East Africa					an F-diagram matching game to teach about transmission - teaching proper handwashing technique and use of soap using glo-germs and demonstration -teaching important times to wash hands - creation of handwashing maps to help students observe and identify places to wash their hands at school and at home - teaching benefits of handwashing - a paper chain-link creation activity linking handwashing to healthy futures - teaching others about handwashing and sustaining healthy behaviours - a handwashing role model pinning ceremony Promotion of handwashing in community - students participated in an advocacy march throughout the school's community to promote handwashing - students taught handwashing songs and made up their own handwashing chants for the march - Students discussed with community members about the purpose of their march, explained the handwashing program		Sample size: 1 primary school Kenya (n=38) and one primary school in Uganda (n=57)	daily			students washed their hands an average of 4.51 times a day (p<.001).	

						their school was participating in, and discussed their new group handwashing station. - After the march, students washed their hands as a group before eating lunch - Handwashing/hygiene promotion club introduced to student - Group handwashing stations installed – Monitored daily group handwashing before eating.							
Patel 2012	Impact of a hygiene curriculum and the installation of simple handwashing and drinking water stations in rural Kenyan primary schools on student health and hygiene practices	Controlled BA	Primary school/ Kenya	Rural	LMIC	Teachers in intervention schools were trained about handwashing and water treatment and provided instructional materials for their students. Water stations were installed near latrines for handwashing and classrooms for drinking and schools were given a 3-month "starter" supply of soap. Schools were expected to provide their own commodities after exhausting free supplies.	Yes - no intervention	Primary school children grade 4-8 Sample size: 783 students from 43 schools	Unclear how many educational sessions	1 year	Self-reported handwashing	The median percentages of students (aggregated by schools) in intervention and comparison schools that reported washing their hands at school was significantly higher in intervention than comparison schools at first follow-up (100% versus 40%, EDM 60%, 90% CI 53–73%),	1
Pickering et 2013	Access to waterless hand sanitizer improves student hand hygiene behavior in primary	Cluster RCT	Primary school/ Kenya	Urban	LMIC	Two intervention groups: 1. Provision of waterless hand sanitizer 2. Provision of soap and water In both intervention groups teacher also delivered handwashing	Yes - No intervention	Primary school children (age 5-13) Sample size: 6 schools (2 hand sanitizer, 2 soap, 2	8 weeks One teacher training session and sanitizer soap delivered throughout	8 weeks	Observed handwashing with product after toilet use and before lunch	The mean proportion of students cleaning hands with product before lunch was 0.61 at sanitizer schools (prevalence ratio = 126.8, 95% CI =31.9–503.8), 0.70 at soap intervention schools	Hand sanitizer group = 1 Soap group = 1

	schools in Nairobi, Kenya					promotion using posters, stickers, classroom activity and a DVD presentation on handwashing along with a promotional song.		control). 1364 children				(prevalence ratio = 143.0, 95% CI = 38.9–525.6), and 0.01 at control schools	
Saboori 2013	Impact of regular soap provision to primary schools on hand washing and E. coli hand contamination among pupils in Nyanza Province, Kenya: a cluster-randomized trial	Cluster -RCT	Primary school/ Kenya	Rural	LMIC	The HW group received one 3.5-kg bag of powdered soap and 10 x 500-mL plastic bottles. The teachers were encouraged to review the hand washing concepts and teach the soapy water preparation method to the school health club members as well as the rest of the pupils in the school. Soap was replenished 2–3 weeks after the start of the third school term. Note: the other group was HW plus latrine cleaning and so data not extracted for this group	Yes - No intervention	Primary school children Sample size: 60 schools (20 soap intervention arm, 20 soap plus latrine cleaning arm, 20 control arm)	Soap supply over the 4 months	Every month for 4 months	Observed handwashing after toilet use	Practicing HWWS after latrine use at baseline was observed to be less than 7% in all study arms at baseline and increased significantly to 32% in the handwashing intervention arm in the aggregated follow-up visits compared with the control (p<0.0001)	1
Snow 2008	Inexpensive and time-efficient hand hygiene interventions increase elementary school children's hand hygiene rates	RCT multi-arm	Primary school/ USA	Urban	HIC	Intervention 1. consisted of the teacher instructing the students to ‘‘Wash your hands then line up for lunch,’’ followed by the teacher walking over to the classroom sink and washing his/her hands. Intervention 2 involved a guest educator teaching a 30-minute grade-appropriate lesson that introduced what germs are, how	Yes - standard school policy - Students instructed by the teacher to ‘‘Wash your hands then line up for lunch."	Primary school children grade 1-6 Sample size: 492 children	Single session	Immediately after and 3 months later	Observed handwashing before lunch	Hand hygiene frequency was significantly higher in both intervention groups compared to control immediately following intervention: Control: 0.38 (321/845) Intervention 1: 0.53 (430/815) (P<0.01) Intervention 2: 0.78 (627/800), (P<0.01)	Intervention 1 = 1 Intervention 2 = 1

						germs can make people ill, when to wash hands, how to wash your hands, and when it is appropriate to use alcohol hand sanitizers. After the guest educator presented the information, students were given an on-hands experience using simulated germ lotion to see the effectiveness of their hand washing using soap and water. The teacher instructed the students every day following the guest presentation to ‘‘Wash your hands and line up for lunch and remember we don’t want germs on our hands.”						This improvement remained at 3-month follow-up	
Solehati 2017	Effect of school community empowerment model towards handwashing implementation among elementary school students in Dayeuhkolot Subdistrict	BA	Primary school/ Indonesia	Rural	LMIC	Handwashing with soap education and demonstration delivered by Little Doctors (24 fellow school students who have been selected and trained) to all students in the fourth to the sixth grade using a question and answer session, videos, and live demonstrations	No control group	377 elementary school students in the 4th – 6th grade	Activities over 3 months	Immediately after the 3 months	Handwashing pattern (likely means frequency)	There was a significant difference of handwashing pattern among students pre and post-test (1, 2, and 3, month) P=0.001	**1**
Taware 2018	Outcome of School-Based	Controlled BA	Primary school/ India	Urban	LMIC	A 45- to 60-minute edutainment session was designed for	Yes - No intervention	Primary school children in	One session	6 months	Self-reported	Practices were significantly different at end-line	1

	Intervention Program in Promoting Personal Hygiene in Primary School Children of Mumbai, India					primary school children with the core message of the importance of handwashing, general hygiene, and oral hygiene. All the sessions were conducted using big size flip charts featuring the message woven around a story with characters the children could relate to. Games like Flashcard and Jigsaw Puzzle and activities such as songs and pledge were also an integral part of the program. A set of eight informative posters were also put up in classrooms for reinforcement of the message. Handwashing demonstration was given. The posters depicted handwashing scenarios, showing a proud mum when a child washed their hands, a little boy getting sick after not washing his hands and also the methods for handwashing.		standard 3 and 4 24 control schools, 119 intervention schools. 516 students in control school, 2283 students in intervention school			handwashing practice	compared to baseline in the intervention group and had better effects as reflected in scores compared with control group.	
Tousman 2007	Evaluation of a hand washing program for 2nd-graders	BA	Primary school/ USA	Urban	HIC	The program consisted of interactive class discussions and activities using GlitterBug training devices and agar plate materials. Hand washing dispensers and sanitizer bags were installed in all intervention classrooms	No control group	406 2nd-grade students/7 schools	4 weeks, visits every week	Immediately following the 4 weeks of intervention	Parent and teacher-report children's handwashing	64% of parents noticed an increase in the frequency of their child's handwashing behaviour. 94% of teachers said that they noticed an increase in student hand washing during the program.	1

						Each week, two to four members of the hand washing coalition staff visited each of the 19 classrooms and implemented the hand washing program for approximately 30 minutes. The general format for each week was: - Open-ended class discussion on germs and handwashing - Learning demonstration and activity - Glitterbug followed with learning about handwashing, touching agar plates before and after handwashing, discussing result of agar plate with teachers, - Distribution of handouts - hand hygiene colouring sheets and stickers to take home and students received a hand washing program completion certificate. - Summary of Key Learning Points/and encouraging self-monitoring							
Watson 2019	Child's play: Harnessing play and curiosity motives to improve child handwashing in a	Controlled BA	Household/ Iraq	Rural	LMIC	Children in intervention households received transparent soaps with embedded toys, delivered within a short, fun, and interactive household session with minimal, non-health-based, messaging. Household	Yes - Household session based on standard health messaging and plain soap.	Children age 5-12 Sample size 80 households/children (40 intervention/ 40 control)	One 10-minute household session	4 weeks	Observed handwashing behaviour after key moments	Children in the intervention group were 4 times more likely to wash their hands with soap after key handwashing occasions than expected in the counterfactual (if there had been no intervention) based	1

	humanitarian setting					sessions involved a glitter game, teaching how to handwash and practicing handwashing with the toy soaps	Included instruction of how to perform handwashing and demonstration of behaviour					on the comparison to children in the control group (adjusted RR=3.94, 95% CI 1.59–9.79).	
Wichaidit 2019	Effect of an equipment-behavior change intervention on handwashing behavior among primary school children in Kenya: the Povu Poa school pilot study	BA	Primary school/ Kenya	Urban	LMIC	The intervention included the “Povu Poa”, a new type of handwashing station that dispensed foaming soap and rinse water, combined with school-wide behaviour change promotion based on disgust and social norms. The promotion activities included a "The Toilet Shake Skit" where the session lead pretends to go the toilet, not wash his/her hands and then try to shake the children's hands, and a handwashing song to remind the children to wash their hands, a handwashing pledge. Group 1 received the intervention 3–5 weeks after the baseline period. Group 2 received the intervention 6–8 weeks after baseline. Group 3 received the intervention 19–24 weeks after baseline.	No control group (intervention delivered later).	Sample size: 30 schools (10 received intervention first, then 10 second, then last 10)	One session of 2 hours, no repetition	5 weeks	Observed handwashing after toilet use	Before intervention, handwashing with water was observed after 11% of 461 toilet use events and there was no handwashing with soap. In post-intervention schools, we observed handwashing (with water or soap and water) after 62% of 383 toilet use events (PR = 5.96, 95% CI = 3.02, 11.76)	1

G. Risk of Bias Assessment

Author	Were the research questions or objectives in this paper clearly stated and appropriate?	Was the study population clearly specified and defined?	Was a sample size justification, power description or variance and effect estimates provided?	Was the intervention clearly described and delivered consistently against the study population?	Was the behavioural outcome measure pre-specified, clearly defined and assessed consistently across all study participants?	Was the outcome observed rather than self-reported (only 1 [yes] or 0 [no] possible	Were the measures of outcome assessors blinded to the exposures /interventions of participants	Was loss-to-follow up after baseline 20% or less?	Were those lost-to-follow up accounted for in the analysis?	Were key confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Does the study have a comparator group? (only 0 or 1 possible)	Does the study report randomisation? (score 0 if 'no' or if there is no control group)	Were the groups similar at baseline on important characteristics that could affect outcomes? (score 0 if 'no' or if there is no control group)	Was the allocation sequence concealed? (score 0 if 'no' or if there is no control group)	Total score
Al-Delaimy 2014	1	1	1	1	1	0	0	0	0	1	1	0	1	0	8
Au 2010	1	1	0	1	1	1	0	0	0	0	1	1	1	0	8
Beiri 2013	1	1	1	0.5	1	1	0	1	0.5	1	1	1	0	0	10
Chard 2018	1	1	1	0.5	0.5	1	0	0	0	0	1	1	1	1	9
Dreibelbis 2016	1	1	0	1	1	1	0	0	0	0	0	0	0	0	5
Early 1998	1	0.5	1	0.5	1	1	0	0	0	0	1	0	0	0	6
Graves 2011	1	1	0	0.5	1	1	0	0	0	0.5	1	0	1	0	7
Grover 2018	1	1	1	1	1	1	0	1	1	1	0	0	0	0	9
Lewis 2018	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Pasewaldt 2018	1	1	0	1	1	0	0	1	1	0	0	0	0	0	6
Patel 2012	1	1	0	0.5	1	0	0	0	0	0	1	0	0	0	4.5
Pickering 2013	1	1	0	1	1	1	0	0	0	1	1	1	0	0	8
Saboori 2013	1	1	1	1	1	1	0	1	0	1	1	1	1	0	11

Snow 2008	1	1	0	1	1	1	0	0	0	1	1	1	0	0	8
Solehati 2017	0.5	0.5	0	0.5	0	1	0	1	1	0	0	0	0	0	4.5
Taware 2018	1	1	0	1	0	0	0	1	0	0	1	0	1	0	6
Tousman 2007	1	1	0	1	1	0	0	0	0	0	0	0	0	0	4
Watson 2019	1	1	1	1	1	1	0	1	0	1	1	0	1	1	11
Wichaidit 2019	1	1	0	1	1	1	0	1	1	1	1	1	0	0	10

H. Behaviour Changes Techniques Coded in Each Intervention

Study	Intervention Description	BCTs Present
Al-Delaimy 2014	The intervention involved: 1. posters, 2. comic book 3. drawing activities, 4. puppet show, 5. nursery songs videos, 6. mascot, 7. group discussions, and 8. distribution of sanitary bags (slippers, hand soap and nail clippers)	**Intervention Group:** 3.1 Social support (unspecified) 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 6.1 Demonstration of the behaviour 7.1 Prompts/cues 8.1 Behavioural practice/rehearsal 12.2 Restructuring the social environment 12.5 Adding objects to the environment **Control Group**: No intervention
Au 2010	The programme integrated storytelling, health education, games (including a glo-germ activity), experiments, and hands-on activities. A pocket-sized booklet, which consisted of information regarding the recommended handwashing procedures for children, a handwashing song, and stickers' area for rewards associated with proper handwashing behaviours, was distributed to each student in the experimental class.	**Intervention Group:** 2.2 Feedback on behaviour 4.1 Instruction on how to perform the behaviour 5.2 Salience of consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 8.1 Behavioural practice/rehearsal 8.3 Habit formation 10.1 Material incentive (behaviour) 10.2 Material reward (behaviour) 11.3 Conserving mental resources **Control Group**: No intervention
Beiri 2013	The intervention involved: 1.'Magic Glasses' cartoon video on the topic of STH transmission and prevention (including handwashing messages). 2. Classroom discussions following cartoon. 3. Pamphlet with STH messages distributed. 4. Drawing and essay-writing competitions on STH. 5. Puppet show 6. Provision of sanitary bag (includes soap) In control school a health education poster only was displayed (normally displayed in schools)	**Intervention Group:** 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.2 Salience of consequences 5.3 Information about social and environmental consequences 5.6 Information about emotional consequences 6.1 Demonstration of the behaviour 9.1 Credible source 12.5 Adding objects to the environment 15.3 Focus on past success **Control group:** 5.1 Information about health consequences
Chard & Freeman 2018	The intervention included both infrastructure (hardware) and behaviour change (software) components. The hardware consisted of provision of a school water supply, sanitation facilities, and handwashing facilities, consisting of two sinks with taps connected to the water supply. The software component, called Hygiene Action led by Pupils in Schools (HAPiS), was implemented after the installation of the hardware components and consisted of group handwashing with soap at critical times, in which schools were provided with three group handwashing tables and children were instructed to wash their hands	**Intervention Group:** 7.1 Prompts/cues 8.1 Behavioural practice/rehearsal 8.3 Habit formation 12.1 Restructuring the physical environment 12.2 Restructuring the social environment

	with soap twice per day, guided by teachers in charge of hygiene activities	12.5 Adding objects to the environment **Control Group**: No intervention
Dreibelbis 2016	Handwashing infrastructure improvements and nudges were developed to facilitate handwashing with soap after using the latrine. Infrastructure improvements included the construction of a dedicated location for handwashing (raised cement platform) with a 60 L water container. Two nudges were used at both schools: (1) connecting latrines to the handwashing station via paved pathways that were painted bright colors; and (2) painting footprints on footpaths guiding students to the handwashing stations and handprints on stations. Soap was also provided.	3.2 Social support (practical) 7.1 Prompts/cues 12.1 Restructuring the physical environment 12.5 Adding objects to the environment
Early 1998	In the peer education group, selected fourth graders conducted a class for the first graders, with assistance from their teachers and project staff members. The content of the class for the fourth graders included a video presentation of a clown doing a handwashing demonstration, storyboards, overheads, posters, and training on how to use various teaching techniques for first graders. NB. Data was not extracted for the hand wipes and instructional poster group, or the combination of peer education plus handwipe group because hand wiping is not our behaviour of interest	**Intervention Group**: 3.2 Social support (practical) 4.1 Instruction on how to perform the behaviour 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 10.2 Material reward (behaviour) 11.3 Conserving mental resources 12.2 Restructuring the social environment **Control Group**: No intervention
Graves 2011	Pupils were engaged in an activity in which they were asked to create posters promoting handwashing behaviour and winning posters were distributed in all classrooms of the intervention schools. This research took place in Kenyan primary schools already engaged in the NICHE program providing infrastructure for handwashing such as soap and water containers and educational manuals on handwashing and hygiene delivered at the beginning of the NICHE intervention. This study evaluated the additional effect of the poster intervention beyond the effects of other NICHE interventions. All schools had received the SWS products from NICHE one to three months before the intervention. Control group also received handwashing infrastructure (soaps and water containers)	**Intervention Group:** 4.1 Instruction on how to perform the behaviour 7.1 Prompts/cues 12.5 Adding objects to the environment **Control Group:** 12.5 Adding objects to the environment
Grover 2018	20 schools were randomly selected and allocated without blinding: 10 to a high intensity hygiene education (HE) with improved handwashing stations and 10 to nudge intervention with improved handwashing stations. HE consisted of four 30- to 45-min HE sessions, delivered once per week over the course of 4 weeks. Nudges included a paved path connecting latrines to the handwashing facility, a painted handwashing station with handprints and a dedicated location for soap, and painted shoeprints and arrows leading from the latrine to the handwashing station.	**High Intensity Education Intervention** 1.1 Goal Setting (behaviour) 1.2 Problem Solving 1.4 Action planning 1.5 Review behaviour goal(s) 1.9 Commitment 3.1 Social support (unspecified) 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 6.1 Demonstration of the behaviour 11.3 Conserving mental resources 12.2 Restructuring the social environment **Nudge Intervention** 7.1 Prompts/cues 12.1 Restructuring the physical environment 12.5 Adding objects to the environment

Lewis 2018	Unilever's 'school of 5 program' - campaign focused on avoiding germs by handwashing at five specific occasions. School intervention consisted of: displaying posters around school, including near handpumps, lessons describing handwashing steps and actions, lessons on handwashing, children pledge to wash hands, children undertake a daily diary task, class monitors supervised handwashing with soap during midday meal, soap distribution, stories of superheroes and their handwashing-related adventures, students who can recall steps were rewarded, glitterball demonstration. Mothers invited to meeting - glitterball demonstration and handwashing pledge. Children were also given 10 "enrolment cards" for telling up to 10 relatives or friends what they learned during the sessions and having them pledge to also HWWS at the target occasions.	**Intervention Group:** 1.9 Commitment 2.1 Monitoring of behaviour by others without feedback 2.3 Self-monitoring of behaviour 3.1 Social support (unspecified) 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.2 Salience of consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 7.1 Prompts/cues 8.1 Behavioural practice/rehearsal 8.3 Habit formation 11.3 Conserving mental resources 12.2 Restructuring the social environment 12.5 Adding objects to the environment **Control Group**: No intervention
Pasewaldt 2018	Intervention the same in both schools. A 6-day handwashing promotion session consisting: - using glow-germ and an F-diagram matching game to teach about transmission - teaching proper handwashing technique and use of soap using glo-germs and demonstration -teaching important times to wash hands - creation of handwashing maps to help students observe and identify places to wash their hands at school and at home - teaching benefits of handwashing - a paper chain-link creation activity linking handwashing to healthy futures - teaching others about handwashing and sustaining healthy behaviours - a handwashing role model pinning ceremony Promotion of handwashing in community - students participated in an advocacy march throughout the school's community to promote handwashing - students taught handwashing songs and made up their own handwashing chants for the march - Students discussed with community members about the purpose of their march, explained the handwashing program their school was participating in, and discussed their new group handwashing station. - After the march, students washed their hands as a group before eating lunch - Handwashing/hygiene promotion club introduced to student - Group handwashing stations installed – Monitored daily group handwashing before eating.	1.4 Action planning 2.5 Monitoring of outcome(s) of behaviour without feedback 3.1 Social support (unspecified) 3.2 Social support (practical) 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.2 Salience of consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 8.1 Behavioural practice/rehearsal 8.3 Habit formation 12.1 Restructuring the physical environment 12.2 Restructuring the social environment 12.5 Adding objects to the environment 13.1 Identification of self as a role model 13.2 Framing/reframing
Patel 2012	Teachers in intervention schools were trained about handwashing and water treatment and provided instructional materials for their students. Water stations were installed near latrines for handwashing and classrooms for drinking and schools were given a 3-month "starter" supply of soap. Schools were expected to provide their own commodities after exhausting free supplies.	**Intervention Group:** 4.1 Instruction on how to perform the behaviour 12.5 Adding objects to the environment **Control Group**: No intervention
Pickering 2013	Two intervention groups: 1. Provision of waterless hand sanitizer 2. Provision of soap and water In both intervention groups teacher also delivered handwashing promotion using posters, stickers, classroom activity and a DVD presentation on handwashing along with a promotional song.	**Hand Sanitiser Intervention Group** 4.1 Instruction on how to perform the behaviour 6.1 Demonstration of the behaviour 12.5 Adding objects to the environment 13.2 Framing/reframing

		Soap and Water Intervention Group 4.1 Instruction on how to perform the behaviour 6.1 Demonstration of the behaviour 12.5 Adding objects to the environment 13.2 Framing/reframing **Control Group**: No intervention
Saboori 2013	The HW group received one 3.5-kg bag of powdered soap and 10 x 500-mL plastic bottles. The teachers were encouraged to review the hand washing concepts and teach the soapy water preparation method to the school health club members as well as the rest of the pupils in the school. Soap was replenished 2–3 weeks after the start of the third school term. Note: the other group was HW plus latrine cleaning and so data not extracted for this group	**Intervention Group:** 3.2 Social support (practical) 12.5 Adding objects to the environment **Control Group**: No intervention
Snow 2008	Intervention 1. consisted of the teacher instructing the students to ‘‘Wash your hands then line up for lunch,’’ followed by the teacher walking over to the classroom sink and washing his/her hands. Intervention 2 involved a guest educator teaching a 30-minute grade-appropriate lesson that introduced what germs are, how germs can make people ill, when to wash hands, how to wash your hands, and when it is appropriate to use alcohol hand sanitizers. After the guest educator presented the information, students were given an on-hands experience using simulated germ lotion to see the effectiveness of their hand washing using soap and water. The teacher instructed the students every day following the guest presentation to ‘‘Wash your hands and line up for lunch and remember we don’t want germs on our hands.”	**Intervention Group** 1 6.1 Demonstration of the behaviour 7.1 Prompts/cues **Intervention Group 2** 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.2 Salience of consequences 7.1 Prompts/cues **Control Group**: No intervention
Solehati 2017	Handwashing with soap education and demonstration delivered by Little Doctors (24 fellow school students who have been selected and trained) to all students in the fourth to the sixth grade using a question and answer session, videos, and live demonstrations	4.1 Instruction on how to perform the behaviour 6.1 Demonstration of the behaviour 12.2 Restructuring the social environment
Taware 2018	A 45- to 60-minute edutainment session was designed for primary school children with the core message of the importance of handwashing, general hygiene, and oral hygiene. All the sessions were conducted using big size flip charts featuring the message woven around a story with characters the children could relate to. Games like Flashcard and Jigsaw Puzzle and activities such as songs and pledge were also an integral part of the program. A set of eight informative posters were also put up in classrooms for reinforcement of the message. Handwashing demonstration was given. The posters depicted handwashing scenarios, showing a proud mum when a child washed their hands, a little boy getting sick after not washing his hands and also the methods for handwashing.	**Intervention Group:** 1.9 Commitment 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 6.3 Information about others approval 8.1 Behavioural practice/rehearsal **Control Group**: No intervention
Tousman 2007	The program consisted of interactive class discussions and activities using GlitterBug training devices and agar plate materials. Hand washing dispensers and sanitizer bags were installed in all intervention classrooms Each week, two to four members of the hand washing coalition staff visited each of the 19 classrooms and implemented the hand washing program for approximately 30 minutes. The general format for each week was: - Open-ended class discussion on germs and handwashing - Learning demonstration and activity - Glitterbug followed with learning about handwashing, touching agar plates before and after handwashing, discussing result of agar plate with teachers, - Distribution of handouts - hand hygiene colouring sheets	1.1 Goal Setting (behaviour) 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 2.7 Feedback on outcome(s) of behaviour 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.2 Salience of consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour

	and stickers to take home and students received a hand washing program completion certificate. - Summary of Key Learning Points/and encouraging self-monitoring	8.1 Behavioural practice/rehearsal 12.5 Adding objects to the environment 13.2 Framing/reframing
Watson 2019	Children in intervention households received transparent soaps with embedded toys, delivered within a short, fun, and interactive household session with minimal, non-health-based, messaging. Household sessions involved a glitter game, teaching how to handwash and practicing handwashing with the toy soaps. Children in control group received a household session based on standard health messaging and plain soap. Included instruction of how to perform handwashing and demonstration of behaviour	**Intervention Group** 4.1 Instruction on how to perform the behaviour 5.2 Salience of consequences 5.3 Information about social and environmental consequences 6.1 Demonstration of the behaviour 8.1 Behavioural practice/rehearsal 10.1 Material incentive (behaviour) 10.2 Material reward (behaviour) 12.5 Adding objects to the environment **Control Group** 4.1 Instruction on how to perform the behavior 5.1 Information about health consequences 6.1 Demonstration of the behaviour 12.5 Adding objects to the environment
Wichaidit 2019	The intervention included the “Povu Poa”, a new type of handwashing station that dispensed foaming soap and rinse water, combined with school-wide behaviour change promotion based on disgust and social norms. The promotion activities included a "The Toilet Shake Skit" where the session lead pretends to go the toilet, not wash his/her hands and then try to shake the children's hands, and a handwashing song to remind the children to wash their hands, a handwashing pledge. Group 1 received the intervention 3–5 weeks after the baseline period. Group 2 received the intervention 6–8 weeks after baseline. Group 3 received the intervention 19–24 weeks after baseline.	1.9 Commitment 3.2 Social support (practical) 5.3 Information about social and environmental consequences 6.3 Information about others approval 11.3 Conserving mental resources 12.5 Adding objects to the environment

Appendix C: Supplementary Materials for Research Paper 2

A. Data collection tools: Interview guide for semi-structured interviews with caregivers

Guide for Caregiver Semi-Structured Interviews

After obtaining consent and permission to record the interview, proceed with this introduction and the questions below.

My name is Julie Watson I work with the London School of Hygiene. Thank you for meeting with me today.

[The following questions serve as a guide for discussion but can be flexible so long as the topic of conversation remains on the broader context of child hygiene and handwashing]

Introductory questions

1. Tell me about your who lives in the home?

Handwashing practices in the home

We'd like to know a little more about your hygiene in your community and homes.

2. How would you describe the current handwashing practices in the community?
3. Are child handwashing practices different to those of adults in the community?
4. Where do you tend to wash hands? Is this the same for children?
5. What do you think is the best way to wash your hands?
6. Is it important for children to wash their hands? Why?
7. At what times is it important for children to wash their hands?
8. What do children use to wash their hands?
9. Do they wash their hands on their own or are they helped/supervised?
10. During the typical day does anyone in the household remind children to wash their hands?

Soap

11. Where do you get your soap from?
12. How often do you get soap?
13. What do you use soap for?
14. Why is soap used to wash hands? What will happen if it is not used?
15. Do children in your home use soap for handwashing?

Exposure to hygiene promotion

16. How often do you have contact with hygiene promoters?
17. What information do they share about handwashing? Do they talk about child handwashing?
18. Do they directly talk to the children in your household?
19. What have you learnt about child handwashing from the hygiene promoters?
20. To what extent do the messages they give motivate you and your family to wash their hands?

Barriers to handwashing

21. Are there things that prevent the children in your household from washing their hands when they want to, or when you want them to? (*If yes, for each barrier mentioned, ask the likelihood of this occurring and what could be done to remove barrier).* Probe specifically for convenience of location of handwashing materials (soap, water)

Factors that promote handwashing

22. What do you think would help children to practice handwashing more often?
23. What do you think would encourage children to use soap when they wash their hands?

Roles and Responsibilities

24. What role do you think parents take in their children washing their hands?
25. Who else do you think has a role to play in children washing their hands with soap?

Ending question

26. Are there any last comments or questions before we wrap in the discussion?

B. Data collection tools: Interview guide for semi-structured interviews with hygiene promoters

Guide for Hygiene Promoter Semi-Structured Interviews

After obtaining consent and permission to record the interview, proceed with this introduction and the questions below.

My name is Julie Watson; I work with the London School of Hygiene. Thank you for meeting with me today.

[The following questions serve as a guide for discussion but can be flexible so long as the topic of conversation remains on the broader context of child hygiene and handwashing]

Introductory questions

1. Tell me about your experience as a hygiene promoter in Sharia. How did you become involved?
2. What is the best/worst part of your position as a Community Health Promoter?
3. Tell me about your typical day working as a hygiene promoter?

   Probe for:

   a. What time do you start?
   b. How many houses do you visit?
   c. How long do you spend with each house?
   d. What are the things you typically talk about?
   e. Do you talk to other people during the day?
   f. Who do you report to at the end of the day?

   NOTE: If the HP has trouble discussing a TYPICAL day, this can be rephrased as "yesterday" or a specific day in the past. If the HPs activities change day by day, then ask about multiple days – the goal is to get a sense of the HPs typical activities.

Child Hygiene questions

4. Do you think child handwashing is a problem within the community that you serve?
5. What are the current child handwashing practices in the community?
6. Do you talk about child handwashing during your working day?
7. What do you find the general opinion is to child handwashing in the community?

Changing Behavior

8. What are some ways that you have successfully changed hygiene behaviours of children in your community?
9. What type of information and messages do you provide?
10. What are the things that motivate the children you work with to change their practices?
11. How do you tailor your interactions with families?

Barriers to handwashing

12. What do you think gets in the way of children practicing handwashing?
13. What do you think gets in the way for children using soap when they wash their hands?

Ways to promote child handwashing with soap

14. What do you think would encourage children to wash their hands with soap more often?
15. What would help you to promote children handwashing with soap?

Roles and responsibility

16. What role to you think parents have in the children handwashing?
17. Who else do you think has a role in promoting child handwashing with soap?

Ending question

18. Is there any last comments or questions before end the interview?

C. Data collection tools: Interview guide for paired-interviews with children

Guide for Child Paired-Interviews

After obtaining oral consent and permission to record the interview from primary caregivers, and assent from children, proceed with this introduction and the questions/activities below.

Welcome. My name is Julie Watson; I work with the London School of Hygiene. Thank you for meeting with me today. (The following participatory activities should be used to facilitate a discussion around the broader context of hygiene and handwashing and should be used to elicit information according to the topic guide below)

Topic Guide:

- Current handwashing practices
  - When/where do you wash your hands?
  - What do you use to wash your hands?
- Perception of handwashing/perceived importance of handwashing
  - Why do people wash their hands?
- Do you think it is important?
  - Do you think soap is important?
- Motivations for handwashing
  - How do you feel when you wash your hands?
  - Does anyone help you or tell you to wash your hands?
- Perceived barriers and constraints to practicing handwashing
  - Is there anything stopping you washing your hands when you want to?
- What about soap? Probe for convenience of location of handwashing materials – soap and water
  - What would make handwashing easier?
- Exposure to handwashing promotion
  - Who talks to you about handwashing?
- What do they say?
- Important driving motives for children
- What values and motives drive behavior?

.

Participatory tools to facilitate the conversation:

1. Word associations

This tool is used as an icebreaker, to lead the topic towards hygiene and to understand some of the mental associations children have with handwashing and associated domains.

Methods:

(i) The facilitator will call out the following words and ask the children to say the very first things that comes to mind when they hear it. Words will include:

- Mother
- Father
- Dirt
- Clean
- Hands
- Disgusting
- Water
- Handwashing

- Soap
- Toilet
- Disease
- Poo
- Sink
- Home
- Smelly
- Fimgernails
- Dirty hands
- Clean hans

2. Function of handwashing behaviour

The following method will be used to get an understanding of the function that handwashing with soap serves from the perspective of the child.

Methods:

(i) Children will be asked to shout out all the reasons the can think of why someone would wash their hands. Whilst they are doing this the facilitator will write these down on separate pieces of paper to remind children later of the reasons they have listed. This will continue until the children cannot think of any more reasons.
(ii) The children will then be asked to decide which of these reasons they think are the most important and to explain their choices.

3. Routine scripting

This method will be used to understand the children's daily routine, where handwashing fits in and to identify and barriers to handwashing with soap.

Methods:

(i) The children will be asked to go through everything they typically do in a day from the time they wake up to the time they go to bed.
(ii) The facilitator will arrange images depicting these activities as they speak according to the timeline children give.
(iii) The facilitator will prompt the children to add events they might have missed around using the toilet, bathing, washing their hands, cooking etc.
(iv) The facilitator will ask the children more details about the key moments for handwashing, e.g. why or why did they not hand wash, who was there, where it took place, what was used (e.g. soap, nothing) and why, etc.

4. Pictorial vignettes of critical handwashing junctures

This method aims to elicit social norms around handwashing and perceived barriers to handwashing.

Methods:

(i) Children will be shown various pre-developed pictorial vignettes depicting different handwashing scenarios involving children. The facilitator will explain what is happening

in the vignettes and will ask the children how they think the person in the picture feels when they do these behaviours, how they themselves would feel when they do these behaviours and how others would view them. Examples of vignettes are:

- A child coming out of a toilet and washing their hands
- A child coming out of the toilet and not washing their hands
- A child playing outside who has fallen over and hands dirty hands and does not wash their hands
- A child who is about to eat and has not washed their hands
- A child washing their hands before helping his/her mother do the cooking

(ii) The facilitator will also use these vignettes to probe the child to talk about how and when they would wash the hands in this scenario if they wanted to and the barriers and enablers to do so.

5. Ideal handwashing facility drawing/description

This method is used to elicit perceived barriers to practice handwashing with soap.

Methods:

(i) The group will be asked about their current handwashing facility, what they like what they do not like about it, what's at the handwashing facility etc.

(ii) On a large piece of paper, placed in the middle of the group, the children will then be asked to draw their ideal handwashing facility, describe where it would be, who would use it, what products would be there, etc.

(iii) The facilitator will prompt them to include detail and will follow on by asking them how this is different to their current handwashing facility and how they would feel using this new handwashing facility.

6. Perceived social norms

This method is used to understand the perceived social norms around handwashing.

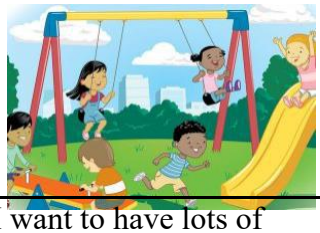
Methods:

(i) 10 counters will be given to each child to depict other children in the camp. Children will be asked: 'if we went around the camp today and asked 10 children the questions below, how many children do you think would':

a. Have soap in their houses right now?
b. Would have a place to wash their hands inside their house?
c. Wash their hands with soap after they go to the toilet to have a wee?
d. Wash their hands with soap after they go to the toilet to poo?
e. Wash their hands with soap before they eat?
f. Wash their hands if they got dirt/mud on them?

- Children will also be asked to give explanations for their estimates

D. Data collection tools: Motive pictures and terms for use in child-paired interviews

STATUS		FEAR	
	I want my neighbours to think I am a very important person		I never want to catch germs or diseases
NURTURE		PLAY	
Term	I want to take good care of my little brother/sister/cousin		I want to have lots of things to play with
AFFILIATION		COMFORT	
	I always want to have lots of friends		I want my house to be very comfortable
ATTRACT		HOARD	
	I always want to look beautiful/handsome		I want to have lots of things in my house
LOVE		JUSTICE	
	I always want to feel loved		I want to make people be fair and honest

HUNGER		CREAT E	
	I always want to have lots of food to eat		I want to be able to make new things
DISGUST		CURIOSITY	
	I never want to be near disgusting, smelly things		I want to learn lots of new things

E. Thematic analysis: Coding structure

Theme	Associated Codes	Example quote
FAMILIAL ROLE *The family's influence and responsibility over children's handwashing behaviour*	Children as role models	*Child: "..little children will learn from us, so if we do not wash our hands they also do not wash their hands too"*
	Children with childcare duties	*Child: "I always care for my little sister and brother and take them outside when I go to play"*
	Parental responsibility	*Child: "everything is available, but it depends on their parents."* *Caregiver: "I think that the parents have a really big role in making the children wash their hands more"* *Hygiene promoter: "I think that the mother has a big role for her children because she spends most of her time with them"*
	Too many children	*Caregiver: "some of my neighbours have many children so it is hard to make them all wash their hands."* *Hygiene Promoter: "I think this carelessness (children not handwashing) comes from the big number of children in one family"*
ENVIRONMENTAL BARRIERS *Physical deterrents to children practising handwashing with soap*	Latrines dirty	*Child: "all the latrines are so dirty so we cannot wash our hands"* *Caregiver: "nobody can wash hands in the latrines because they are very dirty"* *Hygiene Promoter: "the toilets are common in this camp. This increases the germs and therefore makes it harder to clean"*
	Communal water points dirty	*Child: "water points which are near our section are so dirty, people throw food into it"* *Caregiver: "because they are so dirty" (when asked why children don't use the water points for handwashing)*
	Lack of soap at latrines	*Child: "...the soap is not available at the toilet so we must go home to wash them"* *Caregiver: "when they go to the toilets, they use only water because there is no soap there"* *Hygiene promoter: "no, I went there but I could not find it (soap at the latrines)"*
	Communal soap dirty	*Child: "..even if there is soap, I do not think they would use the same soap for everyone because I think it is a dirty thing"*
	Lack of water at latrines	*Child: "yes there is no soap in the latrines even sometimes there is no water"* *Caregiver: "the problem is that all the latrines are dirty and so far from our house, and sometimes the water is not available there so the children can't wash their hands"*
	Cold water	*Child: "we cannot use latrines for washing hands because there is no soap and warm water, just cold water and they are very dirty"*

		*Caregiver: "i*f the latrines were closer for the children and if they had warm water, they would wash their hands more for sure"
	Latrine block distance	*Child: "if they were far from the latrines, they would not wash their hands, if they were near to latrines, they would wash their hands."* *Caregiver: "if the latrines were closer for the children and if they had warm water, they would wash their hands more for sure"*
	Lack of electricity	*Child: "some nights there is no electricity or water at latrines, we are frightened to go to wash our hands, so it is hard for us to wash our hands"* *Caregiver: "the latrines are far away from my children and also the electricity in not always available for us and the water is also not always available."*
	Shared facilities	*Child: "I wish every household had its own toilet to keep our toilet clean and so we could use our own soap after using the toilet …"* *Caregiver: "there wouldn't be a problem if each household had its own bathroom and toilet so the children could wash their hands easily in the sink and with soap"* *Hygiene Promoter: "the toilets are common in this camp. This increases the germs and therefore makes it harder to clean ..."*
HYGIENE PROMOTION EXPOSURE *Perception of hygiene promotion and existing exposure*	Seven steps of handwashing	*Child: "we use soap for handwashing, we wash our hands after using the toilet and before eating according to the seven steps"* *Caregiver: "they (hygiene promoters) tell me that when our children go to the toilets, they should wash their hands with the seven steps"* *Hygiene promoter: "I see that the seven steps of handwashing is a really successful way to show the children how to wash their hands"*
	Give them awareness	*Child: "if we tell them all about handwashing, how handwashing is important and if you wash your hands you will be healthy, they will wash their hands."* *Caregiver: "if the hygiene promoters, CFS and school tell them about handwashing they will wash their hands more because they like it and they will listen to you more than us"* *Hygiene promoter: "the school should increase its education in the field of health awareness and awareness in the home is very low - we should increase this percentage"*
	Past hygiene promotion exposure	*Child: "some NGOs come to our home and give an awareness seminar about handwashing ..."* *Caregiver: "they hear these messages all around the camp, for example at school, CFS and some other places"* *Hygiene promoter: "we go to kindergartens, schools and homes to provide health awareness to them and*

		we focus on the methods of washing hands a lot because it is the basis of human cleanliness"
	Increase in children's handwashing after hygiene promotion	*Hygiene promoter: "The percentage of handwashing in the camp is not 100%, but the percentage has increased after the entry of the organization and we have increased this through the dissemination of awareness.."*
	Out-of-school children practising less handwashing	*Hygiene Promoter: "the reason for the little washing of the hands is that some children do not go to schools and kindergartens"*
	Knowledge of disease transmission	*Child: "we should wash our hands well because dirtiness goes under nails, so when we eat food, germs go into our body and we will be sick"*
	Knowledge of specific diseases	*Child: "Handwashing is so important for us to avoid cholera"* *Caregiver: "… in these last few months mumps is so common in the camp, my little girl had mumps"* *Hygiene promoter: "there are not many diseases, but some are widespread, such as cholera, lice, scabies and diarrhoea"*
	Handwashing to avoid diseases	Child: *"handwashing is so important for us to avoid cholera. We should wash our hands using soap. If we do not wash our hands, we will be sick"* *Caregiver: "I always tell my children to wash their hands to avoid diseases and to look clean"* *Hygiene promoter: I tell them not to let their children play near the dirt and explain the diseases that affect humans because of the dirt and that the parents should continue to follow their children's handwashing"*
	Hygiene promotion popular with children	*Caregiver: "they enjoyed hearing messages because the hygiene promoters were showing them some posters"*
	Hygiene promotion decreasing	*Caregiver: "in the beginning when we came to the camp, they (hygiene promoters) were coming a lot, but now they are not coming as often"*
PRESCRIPTIVE SOCIAL NORMS *Rules specifying handwashing behaviour that persons ought to engage in*	Avoiding dirty people	*Child: "If my hands smell good, people will not try to avoid me, and I will have lots of friends"*
	Social stigma	*Child: "we want our hands to be clean and look to nice, so other children do not laugh at us"*
	Cleanliness a reflection of character	*Child: "they say that he is a polite, good boy and is clean (if he washes his hands)"*
	Cleanliness a reflection of the family	*Child: "they will say he is from a clean family and they are good that they wash their hands"*
	Handwashing to look nice for others	*Child: "children wash their hands to look nice. If they go somewhere and their hands are dirty people will blame them"*
	Handwashing to smell nice for others	*Child: "I wash my hands because I want to smell nice before going to the school"*

	Making parents proud	<u>*Child*</u>*: "our parents are proud of us when we wash our hands, they always encourage us to wash our* ha*nds"*

Appendix D: Supplementary Materials for Research Paper 3

A. Data collection tools: Household survey

COVER SHEET

Participant ☐ **Declined** ☐ **Ineligible** ☐

Date | | | | | | | Day Month Year **Household ID** | | | **Field Worker ID** | | |

Camp: Shariya **Section:** _____

Eligibility Check & Consent

1. Does at least one child between the age of 5 and 12 years old live in the household? YES ☐ → CONTINUE
NO ☐ → STOP

2. Have any of the household members previously taken part in any activities in this project?
YES ☐ → STOP
NO ☐→ ELIGIBLE (continue to Q3)

3. Are you a head of the household?
YES ☐ → continue to Q4
NO ☐ → ask to speak to the household head (female HH unless not home, then male HH)

4. If eligible, is the head of household willing to participate?
YES ☐ → sign consent form and then fill in survey
NO ☐ → ask if you can record some anonymous information
YES → STOP and fill out survey
NO → STOP, say thank you and leave

SURVEY

Who is being interviewed?

☐ Female Head of HOUSEHOLD

☐ Male Head of HOUSEHOLD
(only if female head of household not available)

Field worker to ask respondent:

How many individuals live in your house? ☐☐

How many of these individuals are between the age of 5 and 12? ☐☐

How many of these individuals are under the age of 5? ☐☐

How long have you personally resided in this camp? ☐☐ Years ☐☐ Months

Where did you live before you came to this camp? _____

Are you or any other household members currently earning any income? YES ☐ NO ☐

If YES, how many household members are currently earning an income? ☐ People

What is you highest level of formal education?

	✓
Never attended school	
Attended primary school	
Attended secondary school	
Attended college/vocational training	
Attended university	
Other	

B. Data collection tools: Structured observation form

Household Observations – Pre-intervention Phase Two

Observer ID: _____

Household ID:_____

Date: _____

Observation start time: _____ Observation end time: _____

Directions:

1) *Ensure that the head of household has read/been read the Participant Information Sheet and that consent has been recorded*
2) *Identify one child between the age of 5-12 which you will observe*
3) *Position yourself in an unobtrusive location where you have a clear view of the handwashing station and the index child.*
4) *Record the handwashing events of this child*
5) *Record if there are handwashing supplies available and their location*

	Observer ID:	Household ID:	Date
	TIME	**EVENT TYPE** 1= After using toilet 2= Before eating 3= Before preparing food 4= Before serving food or drink to another person 5= After a handling another person's faeces 6= Hand wash at other time	**ACTION TAKEN** 1 = Washed hands with water only 2 = Washed hands with soap and water 3 = No action taken 4 = Did not see	**DESCRIPTION OF EVENT** *If hands washed, include location, objects used and any other relevant observations*
1		1 2 3 4 5 6	1 2 3 4	
2		1 2 3 4 5 6	1 2 3 4	
3		1 2 3 4 5 6	1 2 3 4	
4		1 2 3 4 5 6	1 2 3 4	
5		1 2 3 4 5 6	1 2 3 4	
6		1 2 3 4 5 6	1 2 3 4	
7		1 2 3 4 5 6	1 2 3 4	
8		1 2 3 4 5 6	1 2 3 4	

Appendix E: Surprise Soap Further Piloting Protocol

Surprise Soap: Further Piloting
A protocol for a multi-site trial of a novel handwashing intervention for children in humanitarian emergency settings

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Acronym Table

Acronym	Definition
AAH	Action Against Hunger
CARE	Cooperative for Assistance and Relief Everywhere
CF	Consent form
FGD	Focus group discussion
HIF	Humanitarian Fund
HWWS	Handwashing with soap
IDP	Internally displaced person
LSHTM	London School of Hygiene and Tropical Medicine
NGO	Non-governmental organisation
PIS	Participant Information sheet
PPE	Personal protective equipment
SSIs	Semi-structured interviews

STH	Soil-transmitted helminths
WASH	Water, sanitation, and hygiene

Introduction

In emergencies, public health infrastructure is often compromised and access to key services, such as water and sanitation can be limited, and consequently the environment can be highly contaminated. These conditions, along with overcrowding and inadequate shelter, increase the risk of disease transmission and thereby threaten the health of already vulnerable populations. Faecal-oral diseases, such as diarrhoea, can account for up to 40% of all deaths in an acute emergency (1).

In these high-risk environments, handwashing with soap (HWWS) can be an effective means of preventing infectious disease transmission. Systematic reviews have consistently shown that HWWS is effective in reducing diarrhoeal disease by up to 48% (2-5), with the current best estimate believed to be around a 23% risk reduction (6), and HWWS is argued to be the single most cost effective of all public health interventions (7). HWWS is also estimated to reduce the risk of respiratory infections by up to 21% (8) and the risk of infection with certain soil-transmitted helminths (STH), including *Ascaris lumbricoides*, by up to 62% (9).

Although it has been demonstrated to be effective in some settings, interventions promoting HWWS have had mixed success among populations in emergency contexts, particularly at key handwashing junctures (10). Lack of soap availability is a key determinant, but studies have documented that, even when soap is available at the household level, soap use is often limited, particularly among children in whom the burden of WASH-related disease is concentrated. One recent study in refugee camps in South Sudan reported that, whilst most households had access to adequate soap and water, and HWWS was promoted, fewer than half actually washed their hands with soap (11).

Children can account for more than 50% of a crisis-affected population and acute diarrhoeal disease and pneumonia account for the majority of deaths in this group. Increasing handwashing practices among children in these settings therefore has the potential to substantially improve health outcomes for populations at risk. The evidence around what works in handwashing promotion for children, however, is limited. Few rigorous studies of handwashing promotion interventions targeting children have been published and the effects of these have been mixed (12).

In 2018, with funding from the Humanitarian Innovation Fund (HIF), the London School of Hygiene and Tropical Medicine (LSHTM), in partnership with Save the Children and Field Ready, pilot-tested a novel soap product - "Surprise Soap" - designed to incentivise child HWWS in high-risk humanitarian settings - in a small proof-of-concept trial in an internally displaced persons (IDP) camp in the Dohuk Governorate of the Kurdistan region of Iraq.

Surprise Soaps are transparent soaps that contain an incentive – a small toy - embedded inside of them and are designed to motivate children to wash their hands with soap through play and curiosity. The soaps are delivered in short, fun household sessions which, unlike traditional interventions, do not rely on health messaging, which research has shown to be a poor motivator of behaviour change, particularly among children (13). The theorised mechanism of change is simple - children are more motivated to wash their hands with soap if there is a toy inside – and it appeals to the behavioural motives of play and curiosity.

The initial pilot of the Surprise Soap intervention took place in 2018 in a Yezidi IDP camp in northern Iraq and used a controlled before-and-after (CBA) study design to evaluate the effect on child handwashing (14). Children in 40 intervention households received the Surprise Soap intervention (5 x Surprise Soaps + fun-based household delivery) and children in the 40 control households received plain soap (x 5) in a standard, health-based, household session of similar length. At the 4-week follow-up, children in the intervention group were observed to wash their hands with soap almost four times more often compared to the counterfactual (adjusted RR = 3.94, 95% CI 1.59-9.79). Furthermore, 97% of intervention households had finished at least one bar of Surprise Soap, indicating that nearly every household had engaged with the soap. 85% of those households which had soap remaining had a bar that was wet on inspection suggesting sustained handwashing practice four-weeks after delivery of the intervention.

These findings are promising and indicate that this rapidly deployable intervention might be an effective means to increase child handwashing behaviour in humanitarian emergency settings and thereby reduce infectious disease risks. However, this study was conducted in an easily accessible camp with a stable and homogeneous population (100% Yezidi), in which children already had a high exposure to hygiene promotion. The study follow-up was also limited to only 4 weeks whereas the acute phase of emergencies may last significantly longer, and the organisation responsible for intervention delivery (Save the Children) were also involved in the design and development of the intervention. In the Iraq study extensive formative work was also undertaken with children from the camp in order to allow them to co-design all aspects of the Surprise Soap bar (colour, size, shape, smell, and toys inside).

Before this intervention can be recommended for deployment at scale, additional questions need answering:

1. Can this intervention be effective in more challenging settings?

2. Can changes in handwashing behaviour be sustained beyond 4 weeks?

3. Can this intervention be successfully implemented by humanitarian partners not involved in the design and development of the intervention?

4. Can this intervention be effective independent of extensive formative work to co-design the Surprise Soap with children from the target setting?

To answer these questions, we will undertake a multi-site evaluation of the Surprise Soap Intervention as deployed by two new agencies in two challenging humanitarian settings and with an increased follow-up of 16 weeks.

The aim of this study is to generate evidence for the effectiveness of this intervention in complex humanitarian emergencies and support possible adoption by humanitarian agencies in these settings.

Research procedures are presented below.

1. Study Procedures

1.1 Research Aims and Objectives

This study will evaluate the impact of the Surprise Soap intervention package (Surprise Soap + short, fun-based household session) on frequency of children's HWWS in two different humanitarian settings. It will evaluate if children's interest in Surprise Soap, and therefore increases in handwashing frequency, can be sustained over periods of longer than 4 weeks, and how feasible and acceptable this intervention is among the participant population and the intervention implementers. This study will also allow researchers to identify potential modifications that may make the intervention more acceptable and/or feasible and unanticipated issues that make it difficult for behaviour change to occur in the event of a future large-scale implementation.

The study has two main objectives:

2. Assess the impact of the Surprise Soap intervention on handwashing behaviour over 16 weeks

2. Assess the feasibility and acceptability of the Surprise Soap Intervention

1.2 Methodology

1.2.1. Study Location

This study will take place in two humanitarian sites in Somalia and Sudan. The same protocol – as described here - will be implemented concurrently in both countries.

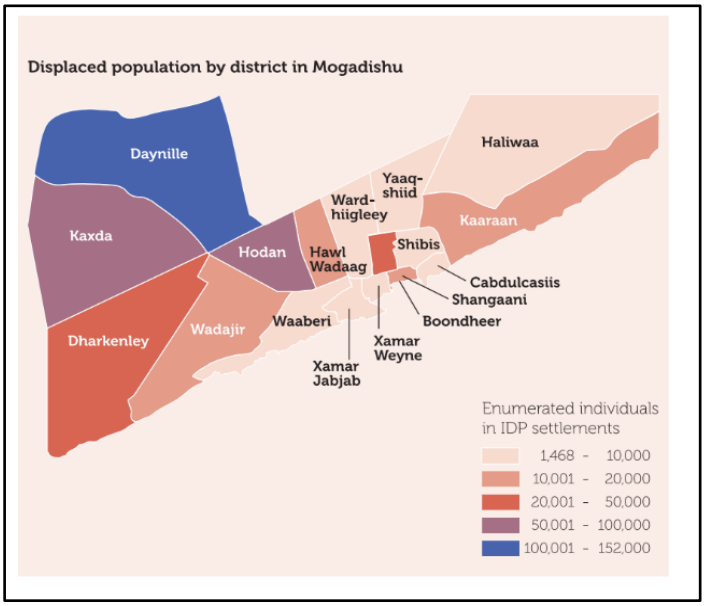
Kahda District, Somalia

In Somalia, the study will be conducted in the Kahda (also known as Kaxda) district of the Banadir region and here, Action Against Hunger (AAH) will be the implementing partner. Kahda is one of 17 districts in Banadir region hosting an estimated population of 60,000 households made up of both host (29,000 households) and IDP communities (31,000 households).

Displacement in Somalia is a recurrent crisis with Mogadishu city being one of the preferred locations for displaced persons. The influx of IDPs dates back to 2005, when the Transitional Federal Government allied with Ethiopians started an offensive war with insurgents to liberate Mogadishu and other major towns in Somalia. Since then, the IDP population has progressively increased, with the latest influx occurring in July and August 2020, when the Shabelle river broke its bank due to unusual flooding in Hagaa (dry) season and displaced many riverine communities. Overall, the ongoing-armed conflict and insecurity, as well as cyclical climatic shocks, compounded by political and socioeconomic factors, continue to drive the humanitarian crisis in Somalia including the protracted population displacements.

The Kahda district is a high-risk area with access challenges (access to the site by external actors). It is located at Afgoye corridor IDP entrance to Mogadishu and has a long open border to the Lower Shabelle region, through which militant groups access the district. It is one of the districts with the largest IDP populations in Mogadishu and experiences significant changes in population, with numbers growing regularly due to disasters outside Mogadishu.

Figure 1: Map of Displaced Population in Mogadishu District including Kahda



According to the district head of humanitarian affairs, the Kahda district has 90 IDPs centres with 200 IDP settlements. Currently AAH is supporting 8 centres and 78 IDP settlements in Kahda with a population of around 7,000 households (approximately 42,000 individuals). We will be working in one AAH-supported IDP centre - the Samadeq IDP centre. This centre has been selected as AAH staff are able to access it and it has a large enough population to allow us to sample from one centre - the estimated population in this centre is 1027 households.

The IDPs in the Samadeq IDP centre, as is the case with almost all IDP settlements in the Kahda district, reside on privately owned land, with the majority having been evicted from government land and property. Through gatekeepers IDPs gain access to small plots of land on which to build their shelters, which are mainly tarpaulin, though some have iron sheet roofing. The gatekeepers organise to rent land from private owners and negotiate the means of payment that apply to all who choose to reside on the property.

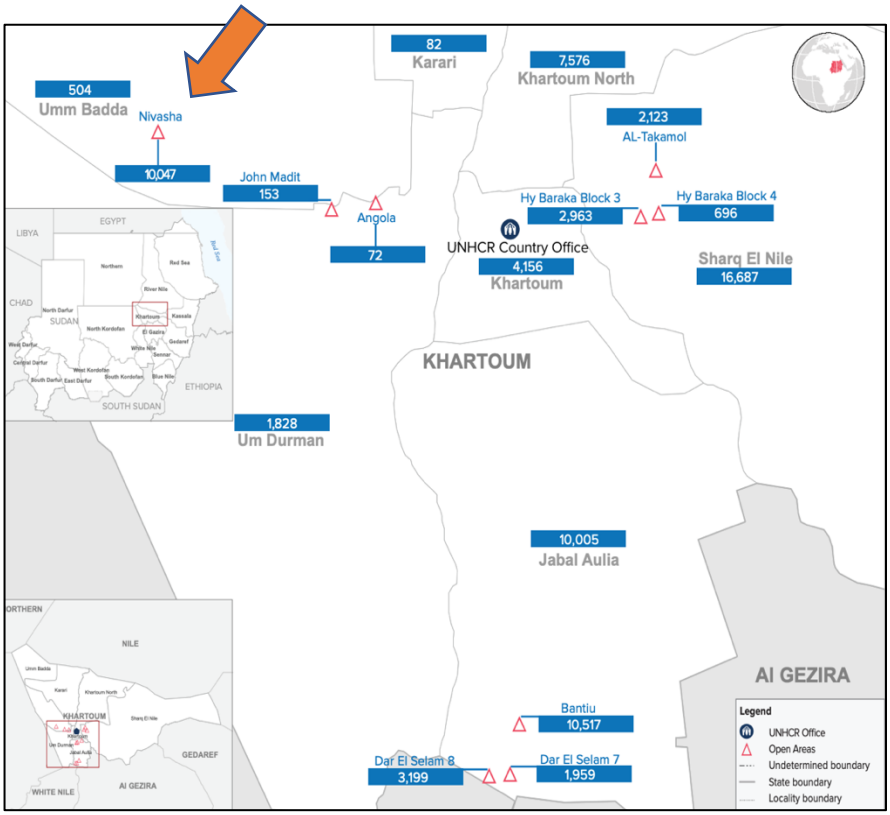
The IDPs access water through a communal tap stand installed by private actors/local vendors and pay for the water (approximately 1500 Somalia shillings for a 20-litre jerrycan). During the last KAP in the Kahda district, 75% of people reported having access to a latrine (43% constructed by landowners) and 65% reported washing their hands with soap and water.

Aerial photo of a Kahda IDP settlement

Naivasha Settlement, Sudan

In Sudan, the study will take place in the Naivasha (also known as Nivasha) refugee settlement and here CARE International will be the implementing partner. Naivasha is one of the nine "open area" refugee settlements within the Khartoum state. "Open areas", as they are so called, are informal refugee settlements that have evolved from departure points for the South Sudanese who were supposed to return to their country of origin but, due to the worsening security situation in their home country, stayed in Sudan. The Naivasha settlement houses more than 12,190 South Sudanese refugees (more than 2,000 households) from the Dinka ethnic group who have been settled there by the government since 2017 to ensure they reside outside the city. The settlement is classed as unstable as refugees are stilling arriving here. Refugees live in semi-permanent structures and for the last two years, CARE has provided WASH services to the area. There is a water yard for water supply services and there are 45 hygiene promoters who conduct outreach activities however there is little existing handwashing promotion targeting children. CARE has also constructed shared household latrines in the area.

Figure 2: Open areas refugee settlements within Khartoum State



Sources: UNHCR, COOR, IPP. Sudan: Khartoum Population Dashboard. Available from: https://reliefweb.int/report/sudan/sudan-khartoum-population-dashboard-refugees-south-sudan-30-september-2020

Table 1: Overview of study sites

	Samdeq IDP centre, Somalia	**Naivasha Settlement, Sudan**
Year established	2018	2017
Total population	6,162	12,190
Population composition (ethnicity)	Mixed	Homogenous (ethnic Dinka) but there is conflict between the different Dinka groups within the population
Stable population	No	No
Conflict affected area (high risk, access limited)	Yes	No
Type of dwelling	Tents, iron sheet roofing	Semi-permanent structures
WASH Indicators -	- Communal water points - Communal latrines - Soap not affordable to most - 5 communal handwashing stations, individual households use jug/bowl	– Communal water points – Shared household latrines – Soap is distributed by UNHCR (through CARE) irregularly and soap not affordable to buy their own in between. Handwashing practice is therefore poor and mostly only performed with water. – No separate handwashing facilities. Households use Ibrik (a small container) that has multiple uses. Overall sanitation and hygiene awareness in the camp is very poor in spite of regular awareness raising campaigns.
Children's existing exposure to hygiene promotion	Low	Low
Food scarce	Yes.	Yes

1.2.2. Study Design

We will conduct randomised controlled trials in the two sites concurrently. Eligible households with children will be randomly assigned to the Surprise Soap intervention or the control arm. Households that are randomly assigned to the intervention arm of the study will receive the Surprise Soap

intervention and children in households randomly assigned to the control arm will receive plain soap in a 'standard' hygiene promotion household session (of matching length), incorporating some materials and messages standardly used by CARE/AAH to promote handwashing to children (likely health and diseased-based messages), in order to control for the effects of both soap delivery and sessions being delivered at the household level.

In each arm, baseline data will be collected prior to soaps being delivered to the children in the household session. Follow-up data will then be collected and at 4-weeks, 10-weeks and 16-weeks. After data collection at each follow-up, soaps will be distributed again but no further household sessions will be given. Study household will receive a total of 22 soaps over the study period. An overview of the study design is presented in Figure 3.

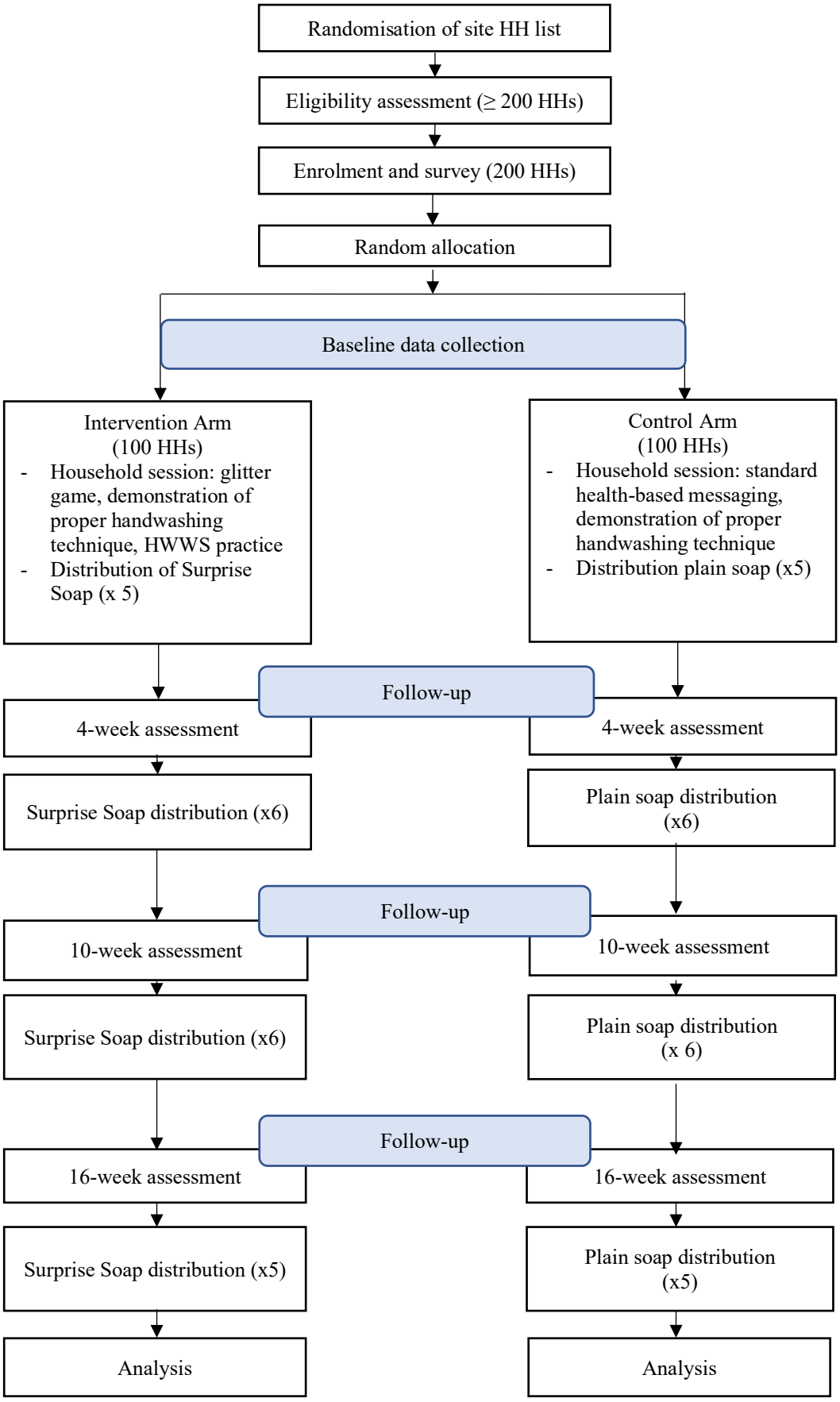
1.2.3 Study Outcomes

Our primary outcome measure is the proportion of key handwashing opportunities (after defecation, before eating, before food preparation, before serving food to another person, and after cleaning another child's faeces) on which children were observed to practice HWWS at all follow-up visits.

Secondary outcome measures include:

- The proportion of all observed children's handwashes that used soap
- The total number of children's handwashes with soap observed at all follow-up visits
- The proportion of intervention households which have finished at least one bar of Surprise Soaps at follow up visits
- The proportion of intervention households with some Surprise Soap remaining at follow up visits
- The proportion of households with some Surprise Soap remaining that are wet on inspection
- The average number of Surprise Soaps remaining at follow-up visits per intervention household
- The proportion of intervention households reporting that ≥1 Surprise Soap bar was purposefully broken (i.e., 'toy cheats')
- The average reported time to reach the toy inside the Surprise Soap through handwashing

Figure 3: CONSORT flow diagram



1.2.4 Intervention

The Surprise Soap product is a round transparent glycerine soap (140g) with a culturally appropriate and safe toy animal inside.

The Surprise Soap will first be delivered to the children in household by hygiene promoters in a short session lasting approximately 10 minutes. In this session hygiene promoters will carry out the following activities:

- A glitter game – Vaseline and glitter will be applied to one child's hands and they will then be asked to high five or shake hands with the other children in the household to see how the glitter, aka dirt and germs, spread between them. If there is only one child in the household then the hygiene promoter will play the game with the child.
- The hygiene promoter will then present the novel Surprise Soaps to the children and will explain that to reach the toy inside children must wash their hands often and will point out the key times for handwashing (after going to the toilet, before eating, before helping to prepare or serve food, and after changing a younger child's diaper or helping them with the toilet, etc). They will also tell the children that they must not break the soap to reach the toy inside but must reach it through washing hands.
- Hygiene promoters will then have the children wash the glitter off of their hands with the Surprise Soap and will demonstrate the correct handwashing technique.
- Hygiene promoters will then leave behind a pre-defined number of soaps for the children and will leave the house.

Soaps will be replenished (with no further household session) at approximately weeks 4, 10, and 16, as outlined above.

In the control group, children will receive plain soaps identical to the Surprise Soap in shape, volume, colour, and smell but minus the toy inside. After baseline, these plain soaps will also first be delivered to the children in household by hygiene promoters in a short session lasting approximately 10 minutes. In this session hygiene promoters will carry out the following activities:

- Messaging about health-related reasons to wash hands (exact messages will be based on AAH/CARE's current hygiene promotion material but may include explained hands need to be washed to avoid diseases that cause diarrhoea and vomiting).

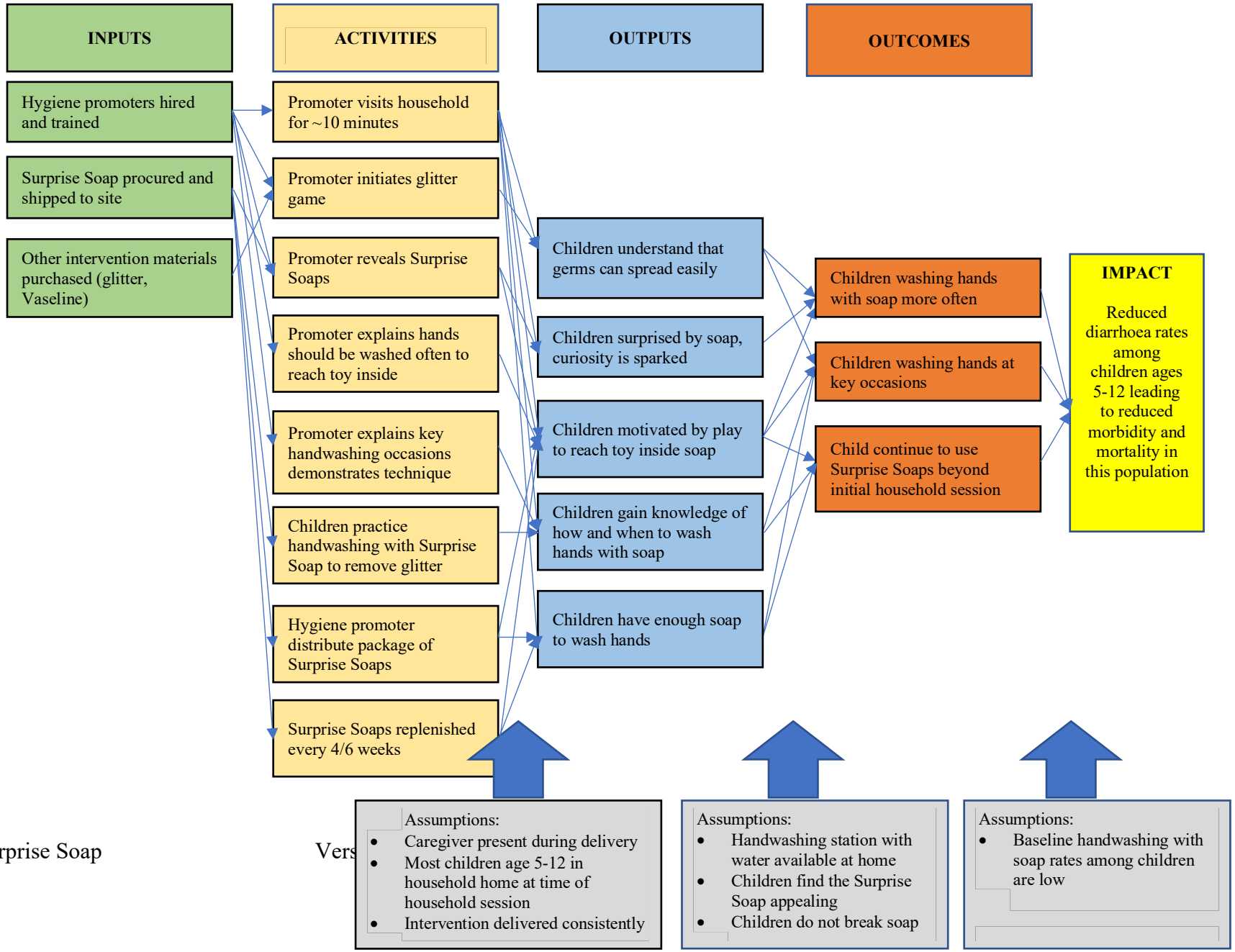
- Hygiene promoters will present the plain soaps and tell children they should wash their hands often and will point out the key times for handwashing.
- Hygiene promoters will demonstrate the correct technique for washing hands and will leave behind a pre-defined number of soaps for the children. They will leave the household.

Soaps will be replenished (with no further household session) at approximately weeks 4, 10, and 16, as outlined above. An overview of activities in the intervention and control arm are outlined in Table 2 and our theory change is illustrated in Figure 4.

Table 2: Overview of study activities

Intervention Arm	**Control Arm**
10-minute household visit from hygiene promoter: • Glitter game • Hygiene promoter reveals Surprise Soap and explain that hands should be washed often to reach the toy inside (key times to wash hands listed) • Demonstration of proper handwashing technique by promoter • Children practice washing hands with the Surprise Soap to remove the glitter • Surprise Soaps distributed Surprise Soap replenished at week 4, week 10 and week 16	10-minute household visit from hygiene promoters: • Messaging about the spread of germs and related diseases linked with lack of handwashing • Key times to wash hands listed • Demonstration of proper handwashing technique by promoter • Plain soaps distributed Plain soap replenished at week 4, week 10 and week 16

Figure 4: Theory of Change



1.3 Study Procedures

1.3.1 Recruitment

To recruit households, in both study sites, the sampling frame will be a complete list of households (i.e., household numbers) in the site from which we will use simple random sampling to select households for participation. In the Sudan site, this household list will be provided by CARE and has been generated by UNHCR who keeps a record of the refugees residing in the Naivasha settlement. In Somalia, this household list will be provided by AAH and has been generated by the 'Gatekeepers' and community leaders in the Samadeq IDP centre, who keep records of the IDP households here since they are all located on rented space.

In each site, the household list will be randomly assigned in equal number to the intervention or control using a random number table and working down the randomised household list. In total, 200 households will be recruited for participation in each site. To be eligible for participation, households must meet the following eligibility criteria:

1) Contain at least one child between 5 and 12 years of age currently living in the household
2) Head of household or primary caregiver (if over 18) consents to participate in the study

Households with plans to move away or travel away from their home for longer than a week over the duration of the study period will be excluded from participation.

If a household on the list is non-eligible the next household on the list should be approached, and so on until 200 households have been enrolled. Once 200 households are enrolled, households will be subsequently randomised to either intervention or control group using a random number generator.

1.3.2 Sample Size

We calculate that a sample of 200 households will allow us to detect a difference in HWWS after key occasions of 10% between control and intervention group (15% HWWS after key occasions in control group, 25% in intervention group), with 80% power (α=0·05), assuming an average of 7 observed handwashing occasions (i.e., when hands could have been washed or not) per household per 3 h observation period, a within-household intra-cluster correlation coefficient (ICC) of 0.21 (1), and a dropout rate of 20%.

Field workers will visit the participant household up to a week before the baseline household structured observation and will introduce the selected households to the study teams and explain the

general purpose of the research to the female head of household. If the female head of household is not home, the male head of household will be the primary addressee. If the head of household is interested, a study team member will present the PIS, obtain and record consent and enrol the household in the study. Following the consent process a socio-demographic survey will be competed with the head of household. If a household declines to participate, the socio-demographic survey will still be completed (excluding the questions related to disabilities), if the head of household agrees, to allow comparison of participants and non-participants and the next household on the randomised list households will be approached and so on until there are 200 households enrolled in the study. If neither the female nor male head of household is home, field workers will try to revisit the household later that day to minimise selection bias. If still no one is available to give consent, or if the head of house refuses to participate, we will attempt to recruit the next household on the random number list, and so on.

As well as structured observations of handwashing, at baseline, and at the 4-week, 10-week and 16-week follow up, we will also conduct the following activities with participants in the **intervention arm only** after the final follow up observation at 16-weeks in order to understand how the intervention was perceived/accepted and how it was used:

- Survey assessing soap use and acceptability
- SSIs with anticipated 6 x primary caregivers, or until saturation is reached
- 1 x FGD with primary caregivers (5-10 participants)
- 2 x FGDs (1 male only, 1 female only) with children age 7-12 (5-10 participants in each)

We will also undertake:

- 2 x FGDs with all implementers (hygiene promoters) of the Surprise Soap intervention. One will be following the household session and first distribution of soap (after baseline) and one will be following the final 16-week follow-up.

Table 3: Overall Participants Engaged

Participants	Focus Group Discussions	Semi-structured Interviews	Structured Observations	Surveys
Children	10-20			
Household head	5-10	6		200
Implementers	~10-20			

Households			200	

1.3.3 Consent Process and Participant Safety

Following recruitment, trained field workers will review the participant information sheet (PIS) with the female head of household (or male head of household, as above) and record informed consent prior to baseline data collection. The PIS will explain the goal of the research, the estimated duration of the study, the duration of each data collection round, general study procedures and will make clear that participation is voluntary, and participants can withdraw at any time. For illiterate participants, the PIS will be presented orally and the participant will be given the option of giving their signature or thumbprint if they consent. For illiterate adult participants, an impartial witness will also be present and will also sign the consent form. Before conducting focus group discussions (FGDs) with children, consent will be sought from their primary caregivers and assent will be sought from the children.

The following PISs are attached:

- PIS 1 - For all study households
- PIS 2 - For the FGDs with intervention implementers

The following consent forms (CFs) are attached:

- CF1 - for adult participants in the household that will take part in the trial
- CF2 – for hygiene promoter to take part in the FGD
- CF3 – information for child taking part in the FGD and record of assent

To ensure participant safety, all soap products used in this study will be manufactured from materials that have been certified as safe and will be manufactured by an approved supplier (GMP certified). Toys inside will all meet international standards (ISO/TR 8124-8:2016), in terms of size, which ensure they will not pose a choking hazard to children of any age (at least 1.25 inches in diameter and 2.25 inches in length), since. Although target at children above five, there may be younger children in the household.

1.3.4 Data Collection

Data collection will be completed through surveys, structured observations of handwashing, semi-structured interviews (SSIs), and FGDs with study participants. It will also involve FGDs with intervention implementers (i.e. hygiene promoters).

Field workers, after receiving comprehensive training from a LSHTM researcher, will undertake each data collection activity. They will also use data collection tools and interview guides developed by LSHTM researchers. These field workers will report to a field supervisor, who will oversee the execution of all the data activities. Since the head of the household at home with the children in the daytime will most likely be female, we will recruit female-only field workers as they will be more readily accepted into the household to conduct the 3-hour structured observations. Each data collection activity is described in further detail below.

1.3.4.1 Data collection from Participants

All of the households in each study arm (intervention group and control group) will be visited at enrolment, baseline, and at the 4-week, 10-week and 16-week follow-up (see Figure 3 above). The following specific data collection activities will occur throughout the project:

Data Collection at Enrolment

- Socio-demographic survey: after a household is enrolled in the study, field workers will verbally administer the survey to the female head of household (or male, as above). Data collected on the number of household members, age of household members, length of stay in the settlement, previous home, income, and education level of head of household and disabilities among children in the household (using short-set Washington Group questions) (Annex 1).

Baseline Data Collection

Baseline data will be collected in the two-weeks prior to intervention delivery. The following data collection activities will be carried out for **all** households:

- Structured observations of child handwashing will be conducted in all households to quantify the proportion of HWWS occurring at key handwashing opportunities (after using the toilet, before eating, before preparing food, before serving food to another person, and after cleaning another child's faeces). In each household all children age 5-12 (who are present during the observation period) will be observed by the field worker. As well as observations of the children's handwashing events, the presence of handwashing materials (water, soap, and a handwashing station – fixed, e.g., sink or mobile e.g., bucket) in the household will also be recorded (Annex 2)

Structured observations will be carried out over a 3-hour period in the morning time when the most observations of children between 5-
12 years handwashing can be made. The exact time will be determined during scoping visits but is likely to fall before school (between 6am-9am) and, once a 3-hour period is decided, this will be the same for all households. For each household, one field worker will position themselves in an unobtrusive position, inside or outside of the house where they are able to see the handwashing place/station as well as the children. To minimise reactivity, field workers will explain to the head of household present that they are interested in observing all household routines but will avoid telling the caregiver that they are observing handwashing practices specifically.

Midline data collection (at the 4-week and 10-week follow-ups)

The following data collection activities will be carried out for **all** households:

- Structured observations of children's handwashing (as described above) will be conducted in all households to quantify the proportion of HWWS occurring at key handwashing opportunities for all children age 5-12 present in the household at the time of observation. As well as observations of children's handwashing events, the presence of handwashing materials (water, soap, and a handwashing station) will be recorded (Annex 2).

Endline data collection (at 16-week follow-up)

The following data collection activities will be carried out for **all** households:

- Structured observations of children's handwashing (as described above) will be conducted in all households to quantify the proportion of HWWS occurring at key handwashing opportunities for all children age 5-12 present in the household at the time of observation. As well as observations of children's handwashing events, the presence of handwashing materials (water, soap, and a handwashing station) will be recorded (Annex 2).

In addition to this, **for the households in the intervention arm only,** the following data collection activities will be carried out:

- ***In the intervention arm only,*** after observation, the female head of household will be asked how many Surprise Soaps there are remaining in the household. If any are remaining, they will be asked to present the Surprise Soap most recently used, and the field worker will record if it appears wet (i.e. indicating if it has been recently used). They fieldworker will then also ask the caregiver approximately how long it typically takes for children to reach the toy inside and if any of the Surprise Soaps they have received over the past 16 weeks were purposely broken by the children to reach the toy inside (instead of by washing). If yes, then the number the number of Surprise Soaps broken will be recorded also, if known) (Annex 3).

- ***In the intervention arm only,*** following on from the presentation of the soap, as described in the point above, the head of head of household will be asked a further number of short survey questions to understand how they and the children in the household used and viewed the Surprise Soaps. These survey questions will capture if adults or children outside of our target age group (5-12) also used the soaps, if they felt the soaps were useful to increase HWWS, and if they felt the children were still excited by the soaps at 16 weeks, etc. (Annex 3).

The data collection forms for the surveys and structured observations described above will be built using LSHTM's Open Data Kit (ODK) to ensure data accuracy, completeness and safety. Field workers will be equipped with tablets loaded with the ODK Collect software and the data collection forms uploaded onto the device and they will enter responses and observations into these data collection forms. The ODK software prompts the field worker at every stage on what to do next. Tablets will be connected to the 3G network and survey answers sent directly to the LSHTM secure server. The LSHTM study coordinator will check data quality daily.

After the above data collection activities have been completed, the following data collection activities will be carried out with **selected households in the Intervention arm only:**

- SSIs will be conducted with 6 randomly selected primary caregivers from intervention households only to, in more detail, assess the acceptability and feasibility of the intervention activities and identify any challenges experienced at the household level. After the structured observation has taken place, caregivers will be asked to attend this interview. Interviews will last approximately 30 minutes (Annex 4).

- FGDs with primary caregivers and children as follows:

- 1 x FGD will be conducted with a total of 5-10 female household heads from intervention households (note that women who took part in the SSIs will be not be asked to join this FGD). The FGD will be completed in accordance with a discussion guide that can be found in Annex 5. FGDs will last approximately 30-45 minutes. The FGDs will be held in existing community gathering areas, for example nutrition clinics or community centres.

- 2 x FGDs will be conducted with children between the ages of 7-12 from intervention households. There will be a total of 5-10 participants in each FGD. One of these FGDs will be female-only children and the other will be male-only children. The FGDs with children will be completed in accordance with an FGD guide that can be found in Annex 6. FGDs will last approximately 30-45 minutes and will be conducted in a safe space near the children's home, for example a space within a school or local nutrition clinic.

1.3.4.2 Data collection from intervention implementers (hygiene promoters)

- An FGD will be completed with hygiene promoters at two time points: [1] after delivery of the household session/first soap distribution (week 0); and [2] after the last distribution of soap (week 16). The FGD will last approximately 45 minutes and will assess the feasibility of the intervention delivery, gain insight into the acceptability of the intervention and how it may be improved in the future (Annex 7).

All FGDs and SSIs will be conducted by a field staff member experienced in qualitative interview techniques, using guides developed by LSHTM to steer the conversations. A second field staff member will also be present to take detailed hand-written notes and, after interviews and FGDs, a researcher from LSHTM will remotely join a debriefing session with the field staff. The notes will be transcribed and translated to English and will be used to document views and recommendations.

Note that for monitoring purposes and a part of their role, intervention implementers will also be asked to record how long they spent delivering the hygiene promotion session to each household, if all planned activities were completed, how many children were present during the household session and their ages, if a caregiver was present during the household session, and how many soaps were delivered to each household at baseline and after each follow up.

COVID-19 RELATED AMENDMENTS TO DATA COLLECTION ACTIVITIES, IF REQUIRED:

At the time of writing this protocol all data collection methods described above are possible in both Sudan and Somalia, whilst taking precautions to prevent transmission of Covid-19, including maintaining 1 metre physical distancing, wearing of face masks and practicing good hand hygiene. However, in the event that the Covid-19 situation escalates and national or local restrictions mean that these methods are no longer safe or permissible, the following alternatives will be implemented:

3. ***Alternatives to structured observations inside the households (including handwashing events and spot observations of the presence of soap and water at the handwashing facility):***

    a. Where site visits are still possible, but field workers are restricted from entering households, and only if household handwashing place/stations are visible from outside the household and children spend much of their time outside the household but still within vision, structured observations of handwashing events and subsequent HWWS will still be undertaken, as described above, but field workers will be positioned outside the house and will not enter inside at any point.

    b. If children do not spend much of their time outside and it is therefore not possible to observe most of the index child's activities, but it is possible to observe the handwashing place/station from outside the household, field workers will still observe the handwashing station but during their observation they will only record the total number of times all children in the household wash their hands with soap, unaided, at the station, rather than after specific events such as eating. After the observation, they will ask caregivers the age of each child they have observed. Field workers will also record if there is soap and water available at the handwashing station. In addition, field workers will, in-person but standing outside of the house, administer a survey to female household heads or caregivers asking them how many times a day on average one of their children between the ages of 5-12 washes their hands with soap. Other non-handwashing related questions will also be asked to minimise the bias related to the caregiver's awareness that we are specifically measuring children's handwashing. At endline, in addition to this, **for the households in the intervention arm only,** questions will also be administered on the use of Surprise Soaps (Annex 8).

    c. If the handwashing place/station is also not visible from outside the household, field workers will instead administer a survey to female household heads/caregivers which asks if a handwashing station is available and if there is currently soap and water at the station and how many times children wash their hands with soap in a day. For the follow-

up data collection rounds (i.e., post baseline) only, field workers will also ask household heads/caregivers how many of the distributed soaps are remaining, how long on average on bar of soap lasted, and will ask the caregivers to present the soap currently in use so that they can record how much of that soap has been used and if it is wet. At endline, in addition to this, **for the households in the intervention arm only,** questions will also be administered on the use of Surprise Soaps (Annex 9).

d. If field workers are restricted from visiting the site, then household heads/caregivers will be contacted via telephone phone and administered a survey covering all of the same questions as above (Annex 10). If a smart phone is owned by the household, they will also be asked to send a picture of the soap currently in use and we will estimate the volume/percentage of the soap used.

3. Alternatives to face-to-face SSIs with caregivers

- In the event that field workers are restricted from field visits and therefore unable to conduct face-to-face SSIs with caregivers they will conduct these interviews remotely over the phone using the same guide as in Annex 4. Interviews will be conducted on speaker phone to allow another field worker to listen and take notes.

3. Alternatives to FGDs (with caregivers, children, and hygiene promoters)

- In the event that field workers are restricted from field visits and therefore unable to conduct face-to-face FGDs promoters (inside or outside) then they will instead increase the number of remote telephone-based SSIs with caregivers (from 5 to 20) and will also conduct telephone-based SSIs with hygiene promoters instead of the FGDs (all hygiene promoters will be asked to take part on SSIs in this case) and telephone-based SSI with children (with 20 children - 10 female and 10 male). For the SSIs with children, the caregivers will be telephoned first and their consent for their child to speak sought. Once the child is on the telephone their assent with be sought. Telephone-based SSIs with children will be kept to a maximum of 10 minutes. All telephone-based interviews will be conducted on speaker phone to allow another field worker to listen and take notes. The FGD guides in Annex 6 and 7, respectively, will be adapted for a SSI format.

The possibility of needing to use these alternative methods are stated in PIS 1 and PIS 2.

1.3.5. Data Analysis

Data will be analysed using quantitative and qualitative techniques.

Quantitative data collected from the structured observations will be analysed with Stata, using descriptive and analytical statistics. The primary analysis will be assessing the difference between children's HWWS in the intervention arm and control arm. The unit of analysis will be the proportion of observed key occasions on which hands should have been washed (e.g. after using the toilet (if toilets visible from the home), before eating, before preparing food, before serving food or drink to another person, and after cleaning another child's faeces) that were subsequently accompanied by HWWS for children age 5-12, and statistical analysis will be used to assess differences in the handwashing behaviour between the intervention and control arm, accounting for clustering of observations at the household level.

Secondary analyses will explore the number of 'toy cheats' (children who broke the soap to reach the toy inside), the number of households still using the soap (i.e. soap wet on inspection), and the time taken to reach the toy inside. This data will be reported using descriptive statistics.

The CONSORT Statement for randomised controlled trials will guide the analysis and presentation of results (2).

The qualitative data that is collected from SSIs and FGDs, in the form of field worker hand-written notes, will be translated to English and shared with the LSHTM researcher. The LSHTM researcher will also join debriefing sessions (online or over the phone) after interviews have taken place and will make notes of any key points or themes that have arisen. The LSHTM researcher will then produce a short report that synthesises these findings.

Table 4 below gives and overview of the analysis plan for each data collection activity.

Table 4: Analysis Plan

POC Analysis Plan		
Activity	**Tool**	**Analysis Method**
Socio-demographic Survey	Annex 1	Descriptive statistics
Structured Observations	Annex 2	Frequency tables, descriptive and analytical statistics
Endline survey for intervention group only	Annex 3	Frequency tables and descriptive statistics
Semi-Structured Interviews	Annex 4	Descriptive qualitative synthesis of findings
Focus Group Discussions	Annex 5, 6, 7	Descriptive qualitative synthesis of findings

2. Study Management

This study is led by Julie Watson (LSHTM) who is also the Principal Investigator of the study. Oliver Cumming (LSHTM), the study's Co-Investigator, together with Watson, form the Study Management Group (SMG) and are responsible for ensuring all aspects of the protocol are appropriately implemented.

No data will be analysed or published without the approval of the Study Management Group. The specific responsibilities of the SMG are:

Julie Watson (LSHTM) is the Principal Investigator (PI) for the research protocol described here and is responsible for all aspects of study design, development, management, and reporting.

Oliver Cumming (LSHTM) is a co-Principal Investigator (co-PI) for the research protocol described here. He will contribute to study design, development and analysis of the data.

Beyond the Study Management Group, our collaborating partners are represented by Bram Riems (AAH), Ronald Stokes-Walters (AAH), Timothy Nguyai (AAH), Tesfaye Hussein (CARE), and Claudio Deola (Save UK) who will also contribute to study design, development and analysis of the data, as well as implementation of the intervention.

3. Ethics, Confidentiality and Reporting

3.1 Risks of the Study

The study poses minimal risks to participants. This study will involve the exploration of child handwashing practices – a topic that is neither sensitive nor taboo within this population. Personal health and hygiene habits may be discussed during data collection; however, participants will not be questioned directly about protected health information.

Materials used to make the Surprise Soaps will have been certified as safe (material data safety sheets (MSDS) will be provided by the supplier) and the toys inside will be large enough to ensure they do not pose a choking hazard to the children. We will ensure the toys used are also culturally appropriate and acceptable to the population. AAH/CARE will be supplied with photographs of the full range of toys before finalising production and will consult with field staff and community members to ensure all toys are appropriate. If any are deemed inappropriate, they will not be used.

Breach of confidentiality is the greatest risk presented with this study and we have described a number of safeguards below that will be used to protect participant confidentiality during the research process. Complete confidentiality will not be possible to maintain during FGDs due to the presence of other participants. This risk will be mitigated by explaining the confidential nature of the discussion to all participants prior to data collection. However, FGDs will primarily cover child handwashing and soap use - topics that are neither sensitive nor taboo.

If covid-19 transmission is still a risk at the time of data collection, to mitigate the risk of transmission as much as possible, all field workers will be provided with surgical masks, which they will be required to wear at all times whilst collecting data (including during enrolment of households, surveys, 3-hour structured observations, SSI and FGDs). Field workers will also maintain a physical distance of at least 1 metre from participants and other people when collecting data. During structured observations in particular, field workers will explain to participants why they are required to wear the mask and maintain physical distance - to ensure participant safety - and will be expected to move around as needed to maintain this distance. Field workers will also be provided with alcohol-based hand sanitiser and will be required to sanitise their hands before entering and after leaving the household, as well as regularly throughout the day and after sneezing, coughing or touching their face. Field workers will be required to change their masks after completing the 3-hour structured observations in a household and/or after the end of every day. Hygiene promoters delivering the intervention will also be required to wear a mask, practice physical distancing and use hand sanitiser.

Participants taking part in FGDs, including children, will all be asked to wash/sanitise their hands on joining the FGD (handwashing facilities or hand sanitiser to be provided by the field workers). They will be seated at least 1 metre apart and be given a mask that they will be required to wear if national and local policies stipulate masking wearing in gatherings. If mask wearing is not the current policy, participants will still be offered a mask in case they wish to wear one. Note that the above procedures are already reflected in AAH's and CARE's internal guidance on PPE use at the community level (and have been developed in alignment with WHO guidance and relevant national guidelines).

Note that this trial will comply with the principles of Good Clinical Practice.

3.2 Ethical Approval

No participants will be enrolled in the study until ethical approval has been granted by the relevant body in the host country and the lead institution: The National Health Ethics Research Committee in Sudan, the Ethics Review Committee at the Federal Ministry of Health in Somalia, and the Ethics Committee of the London School of Hygiene and Tropical Medicine.

3.3 Recruitment and Consent

Details on recruitment are provided in study procedures above. In brief, households will be randomly selected for participation from a complete list of households in the site. This list will be randomised by LSHTM. The recruitment process will be conducted by trained CARE and AAH field staff. After an eligible household has been identified, the field worker will introduce themselves to the potential participant and provide a brief introduction to the study procedures. If the potential participant is interested in hearing more, the Participant Information Sheet (PIS) will be used to introduce them further to the study, outline its broad objectives, and ask for permission to proceed with recruitment. The PIS will explain, in plain language, the participant's rights (the right to skip or not answer any question, the right to terminate the study at any point free of coercion or denial of any benefits) and how confidentiality will be maintained during data collection, analysis, and reporting. The PIS will explain that there are less than minimal risks associated with the research and that there are no direct benefits or payments associated with participation. Contact information for questions and concerns will be given with contacts both for in-country partners and international partners. A printed copy of the Participant Information Sheet document will be offered to the participant to keep.

Written consent from adults/assent from children will be obtained by the field staff after the PIS has been reviewed and the participant provided an opportunity for any questions. If the participant is

unable to read, the PIS will be read to the participant and their thumbprint, instead of a signature can be given as proof of consent if they so wish.

All PISs and consent forms will be translated into the local language in the study sites.

3.4 Data Security and Confidentiality

Data collected from the households in the form of surveys and structured observations will be completed using ODK software and sent directly to a secure LSHTM encrypted server, to which access will be limited to researchers from LSHTM. For the SSIs and FGDs any identifying information will be redacted from transcripts of notes. All physical forms of data, including these notes as well as consent forms will be kept in a locked file cabinet in a locked office in either LSHTM, CARE, or AAH, to prevent unintended release of information. All electronic data will be encrypted and stored on secured and password protected computers kept in locked offices.

Quantitative data sets will be made publicly available once final results of the study have been reported. Prior to releasing this data to the public, a final edited dataset will be prepared. In this final dataset, any data that could be used to indirectly identify participants will be anonymized – including recoding neighbourhoods / geographic identifiers to alpha numeric codes, removing any records where information that is potentially indirectly identifiable is present, and other key safeguards.

3.5 Use of Study Results

Data from this study will be used in two ways:

1) To share findings in a final report to the funders, with other NGOs (via reports and presentations) and in online publications (in a peer-reviewed journal).

2) To identify any potential modifications to the interventions needed prior to a potential future large-scale trial.

As well as participation in the research, consent forms will also seek permission for study results to be shared as outlined above. All findings shared will be anonymous and cannot be linked back to the participants.

3.6 Direct Personal Benefits and/or Payments

There are no direct personal benefits from participation in this study except from receiving soap as part of the intervention. No payments or any form of remuneration will be provided to study participants.

1. Study Sponsorship

The London School of Hygiene & Tropical Medicine is the sponsor for this research study. They have full responsibility for the project including the collection, storage and analysis of participant data, and will act as the Data Controller for the study. The sponsor can be contacted at the following address:

London Schoool of Hygiene and Tropical Medicine
Keppel St, Bloomsbury
London, WC1E 7HT
United Kingdom
Email: rgio@lshtm.ac.uk

2. Research Timeline

Research Timeline			
	Date: 2020-2022	**Event/Deliverable**	**Description**
Protocol Development	Sep-Jan	Protocol development & ethical review board approval	The protocol will be developed, and ethical approval sought from both the London School of Hygiene and Tropical Medicine Research Ethics Committee, the National Health Ethics Research Committee in Sudan, and the Ethical Review Committee at the Federal Ministry of Health in Somalia.
Recruitment & Training	Jan-Feb	Recruitment and training of field staff and recruitment of households	Field staff - both hygiene promoters and enumerators - will be recruited and trained and field workers will subsequently recruit households for participation.
Implementation & Evaluation	Mar-Sep	Intervention implementation, data collection	The Surprise Soap intervention implemented and evaluated in a randomised controlled trial in both Somalia and Sudan.
	Oct-Jan	Data analysis and reporting	Trial data is analysed, and final report synthesised.
Dissemination	Feb-Apr	Dissemination of findings	Findings disseminated to key stakeholders via reports, publications, presentations, media

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Appendix F: Supplementary Materials for Research Paper 4

A. Data collection tools: Interview guide

Semi-Structured Interview Guide

Introduction

Thank you for agreeing to take part in this interview. My name is Julie Watson and I am a researcher at the London School of Hygiene and Tropical Medicine. I am conducting a piece of research exploring organisational approaches to handwashing promotion in emergency and development responses and trying to understand the factors behind the decision-making process.

Just to clarify so that we are on the same page, since there can be many different interpretations of the term handwashing promotion, here what I mean by handwashing promotion is any activity designed to increase handwashing with soap. So that includes messaging and education as well as infrastructural improvements such as providing soap and handwashing stations.

[The following questions serve as a guide for discussion but can be flexible so long as the topic of conversation remains on the broader context of handwashing promotion for children. Probes are in bullet points]

Background Information

1. Could you briefly describe your current role and how you came to work in the WASH sector and this organisation?

    - Organisation and role
    - Length of time in role
    - Country of work
    - Previous experiences
    - Particular interests

2. In what ways has your organisation been involved with commissioning or implementing handwashing promotion for children?

Understanding of determinants

Firstly, before we delve more specifically into the programmes you have implemented, I'd like to ask you to think about children's handwashing more broadly. I'm going to share my screen with you – this is a broad way we think the determinants of handwashing could be categorised.

3. Looking at these, which do you think are the most important determinants of child handwashing?

- Do you think this is any different in emergency settings/outbreak contexts?

Intervention selection and design

Now, I will move more specifically to your organisation's approaches.

4. Who is involved in the decision-making around which handwashing promotion programmes for children are implemented by your organisation?

    - How much input does the country office have?
    - Who makes the final decision?

5. If presented with a selection of handwashing promotion interventions or programmes your organisation could implement, what factors do you consider when choosing which one to implement?

    - Is a needs assessment done?
    - Is any formative research conducted in order to determine the barriers and enablers to handwashing?
    - Do you consider what motivates children, hardware available, cultural factors?
    - Dependent on funding available?
    - Dictated by what funders wants?
    - Guided by published research?
    - Availability of resources?

Handwashing Promotion Approaches

6. Can you tell me about a few specific child-focused handwashing-promotion interventions your organisation has funded or implemented?

    For each intervention probe on:

    - Where was this? Location and context
    - What age groups were targeted?
    - What did this intervention involve: what hardware, software, specific activities?
    - What were the key messages and what channels were used for message delivery?
    - What was the mechanism of action – how does this intervention lead to a change in behaviour?
    - Who implemented the intervention?
    - What was your organisation's role – implementer/funder?
    - How long was the intervention and how much was it repeated?
    - What was the time scale for delivery?

7. Do you think this/these interventions appropriately address what you feel are the determinants of handwashing behaviour and did they motivate children?

- Why/why not?
- What are the barriers?
- What should have been different?

Effectiveness

8. Can you tell me about the most successful handwashing promotion program that you have worked on for children?
    - Probe on details of the program:
        - Where,
        - Age group
        - Activities

9. What determinants do you think this program focussed on?

10. What do you think led to the success?
    - What components were particularly effective?
    - What makes these components effective (probe further for what determines child handwashing behaviour)?
    - What components were less effective, why?
    - Any other examples (follow the same probes)?

11. How did you know this program was effective?
    - What evaluation was done?

12. Are there any examples of less successful programmes you have worked on?
    - Why did they not work?
    - Probe on approach, funding, delivery

Acceptability and Feasibility

1. What do you think determines the acceptability of behaviour change interventions for children in these settings?
    - Cultural norms, settings, perception, delivery

2. How have the approaches you have talked about been perceived among the community?
    - Which approaches have been the most accepted among the community and why?

3. How have they been perceived among the children?
    - What approaches have been the most popular among children and why?

4. Thinking about the different approaches you have taken, how feasible/practical have these been to implement in the field?
    - Were they well understood by field staff and did they find it easy to implement as directed?

- Were there any time constraints or anything that made it difficult to implement as directed?
- Were they able to reach the right audience?
- Were they easy to repeat?

Challenges

5. What are the challenges facing programs targeted at promoting children's handwashing?
    - How are these challenges different to those facing adult-focused programs?

6. Are there any challenges specific to promoting handwashing to children in emergency settings/responses?

Future Recommendations

7. Given your knowledge and experience, what are your recommendations for future handwashing promotion interventions targeted at children in an emergency setting or during an emergency response such as the COVID-19 response?

Ending question

8. Are there any last comments or questions before we end the interview?

B. Coding Structure

Programme Cycle Stage	Themes	Codes
Funding Acquisition	Lack of prioritisation	Handwashing promotion not prioritised
		Children not prioritised
		Focus on under-fives
		Personal interests dictate programme focus
		Insufficient funding
	Funding inconsistency	Short-term funding
		Changing programme leads
Design	Insufficient formative research	No formative research
		Inadequate formative research
		Consider context
		Consult children
		Tailor intervention
	Demand on resources	Resource-intensive approaches
		Difficulty accessing teaching materials
		Difficulty maintaining facilities
		Limited physical space
		Limited time
		Difficult to integrated into curricula
		Teachers' motivation low
		Sustainability issues
		Low-resource interventions needed
		High intervention frequency needed
		Sustainable interventions needed
	Unengaging intervention content	Children lack motivation to participate
		Reliance on didactic approach
		Health messages unengaging
		Health knowledge important but not sufficient
		Motivational drivers
		Incentives
		Competitions
		Leveraging social norms
		Demonstrations
		Interactive, fun, engaging approaches
	Non-enabling physical environments	Lack of handwashing facilities and materials
		Provide hardware
		Make facilities attractive
		Make facilities child-friendly
		Use environmental cues
Delivery	Availability of skilled implementers	Lack of skilled staff
		Hygiene promoter unwillingness
		Building capacity
		Hire people with right skills
	Reaching out-of-school children	Difficult reaching children outside of schools and CFS
		Delivery mainly in schools and hygiene clubs
		Increase delivery in community
	Community mistrust	Mistrust within community
		Engage community
	Lack of coordination	Lack of standardised tools
		Difficulty standardising tools
		Complicated tools

		Need for coordination
Evaluation	Lack of evaluation rigour	Lack of evaluation
		Anecdotal evidence
		Poor adherence to protocol
		Difficulty measuring handwashing
		Reliance on KAP surveys
		Rigorous evaluations needed
	Failure to assign older children handwashing as a primary outcome in evaluations of hygiene interventions	Handwashing not a major outcome
		Knowledge measured over behaviour

Appendix G: Participant Information Sheets and Informed Consent Forms

A. Participant Information Sheet and Consent forms for Research Paper 2

Information for Caregivers of
Child Participants in paired interviews

Study title: Hidden Incentive Project

Your child is being invited to take part in a research study by the researchers from the London School of Hygiene and Tropical Medicine in England. The study has been approved by the London School of Hygiene and Tropical Medicine Research Ethics Committee and the Hawler Medical University Ethical Review Committee in Erbil. Before you decide if your child can take part, it is important for you to understand why the research is being done and what it will involve for your child. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part. The following is to explain details of the study:

1. What is the purpose of the study?

The purpose of the study is to find out more about household behaviours that can impact your child's health. Certain behaviours can affect the health of our children. For the purpose of this research we are interested speaking with you child together with one of their friends.

2. Why have I been chosen?

Your child is being asked for participation in this study because they are between the age of 5 and 12 years old living in your household. We aim to include a total of 12 children in a paired interviews.

3. Does my child have to take part?

It is up to you to decide if your child may join the study. We will describe the study and go through this information sheet. If you agree to that your child can take part, we will then ask you to sign a consent form. You are free to withdraw your child at any time, without giving a reason. This will not affect any future decisions on public or private initiatives taking place in your neighbourhood.

4. What will happen to my child if they take part?

If you agree to your child's participation in this study, I will ask them to take part in the following activity:

1) A research team member will facilitate a discussion with your child and one of their friends regarding their daily practices and routines. The discussion will last between 45 minutes and 1 hour.

We would like to audio record the group discussion, including your child as he/she talks, to make sure that we remember accurately all the information. The researchers will transcribe these recordings before deleting them, and will keep the transcripts in secure location and these transcripts will only be used by researchers involved in this study. Audio recording is required for participation in this study. If you or your child do not wish to be recorded, it is not possible for your child to be in this study.

5. What are the possible disadvantages and risks of taking part?

There are no direct risks associated with your child being involved in this study.

6. What are the possible benefits of taking part?

If you decide that your child can participate in this study they may not benefit personally but the findings from this study may help us to identify possible ways that we can work with your community to improve the health of your children in the future.

7. Will my child taking part in the study be kept confidential?

Yes. All information collected about your child during the course of the research will be kept strictly confidential. Only people that are involved in this research will have access to your information. All information will be kept in a secure location.

8. What will happen if I don't want my child to carry on with the study?

Participation in this study is voluntary. Your child may withdraw from this study at any time, even after your child has participated in the group discussion - you and your child will not be penalized in any way or lose any sort of benefits for deciding to stop participation. If you and your child decide to withdraw from the study, you can decide whether you want us to destroy the information your child provided us, or whether you allow us to use these data.

9. What if something goes wrong?

If you have a concern about any aspect of this study, you should ask to speak to my supervisor who will try to answer your questions. If you wish to complain formally, or have any concerns about any aspect of the way you or your child has been treated during the course of this study then you should immediately inform the Investigator and Project Director (Oliver Cumming, Department of Disease Control, Faculty of Infectious Tropical Disease, London School of Hygiene and Tropical Medicine, United Kingdom; oliver.cumming@lshtm.ac.uk).

The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If your child experiences harm or injury as a result of taking part in this study, they may be eligible to claim compensation.

10. What will happen to results of the research study?

All the data from the interviews and observations will be analysed by researchers working with the London School of Hygiene and Tropical Medicine. These results will be used to develop an intervention for children around household hygiene that will be evaluated with some children between the ages 5 and 12 years in this camp. The overall results of the research will also be published in a study report and communicated to the Save the Children and other NGOs and may also be published online. All findings that are reported will be anonymised so that they cannot be linked back to you, your child, your household ,or any other individual.

11. Contact Details

Contact for further information on study: Oliver Cumming (Principal Investigator) oliver.cumming@lshtm.ac.uk

Emergency contact number: Solomon Ghebremedhin (Program Manager) Telephone number to be inserted

Email: Solomon.Ghebremedhin@savethechildren.org

You will be given a copy of the information sheet and a signed consent form to keep.
Thank you for considering taking the time to read this sheet.

ID:

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Information for children and assent (FPI)

[READ}

What? We have come to Shariya Camp to try to find out more about children's activities in their houses. We would like to talk to you, together with your friend, about your activities in the house, especially about handwashing.

We will talk to you and your friend in another area in the camp, not inside your house, and It will take about 1 hour. We will ask you to take part in some fun activities whilst we talk with you.

Keeping the information private and safe. We will be recording and writing up everything you and you friend tell us, but we will not write down your names on any reports. It is very important to us to keep children safe.

Why are we doing this? We will use this information to help us to understand children's handwashing in the home and to develop a way to help children wash their hands more.

Harms and Benefit.

We don't think any big problems will happen to you if you take part in this study. You won't get any direct benefits but you can feel good about helping us to learn more about children living here and to try to make washing hands easier for children so they don't get sick as much.

You should know that:

- You do not have to be in this study if you do not want to. You won't get into any trouble if you say no.
- You can stop being in the study at any time. (If there is a question you don't want to answer; just say you don't want to answer, or you don't need to say anything at all.)
- Your parent(s)/caregiver were asked if it is OK for you to be in this study. Even if they say it's OK, it is still your choice whether or not to take part.
- You can ask me any questions you have about the study now.

If you want to be in this research study, please sign your name here on the line below:

_____ _____

Child's Signature or thumbprint Date

_____ _____

Signature of Investigator/Person Obtaining Assent Date

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

INFORMED CONSENT FORM – PRIMARY CAREGIVER
OF CHILD RESEARCH PARTICIPANT (AUDIO RECORDED)

Full Title of Project:

Hidden Incentive Project

Name of Principal Investigator:

Oliver Cumming

	Please initial box
1. I confirm that I have read and understand the participant information sheet dated for the above study. I have had the opportunity to consider the information, ask questions and have had these answered fully.	
2. I understand that my child's participation is voluntary and they are free to withdraw, or I am free to withdraw them at any time, without giving any reason, without my medical care or legal rights being affected.	
3. I understand that the information my child provides as part the study may be reported anonymously to communicate findings of the research.	
4. I give permission to audio-record any conversations involving my child and understand the procedures that will be used to keep this information confidential	
5. I agree for my child to take part in the above study.	

Signing on behalf of:

_____
Name of Participant
(printed)

Name of Witness *(printed)*	Signature/Thumbprint	Date
Name of Person taking consent	Signature	Date

The participant is unable to sign. As a witness, I confirm that all the information about the study was given and the participant consented to taking part.

Name of Impartial Witness *(if required)*	Signature	Date

1 copy for participant; 1 copy for Principal Investigator

Information for Caregivers (SSIs)

Study title: Hidden Incentive Project

You are being invited to take part in a research study by the researchers from the London School of Hygiene and Tropical Medicine in England. The study has been approved by the London School of Hygiene and Tropical Medicine Research Ethics Committee and Hawler Medical University Ethical Review Committee in Erbil. Before you decide if you want to take part, it is important for you to understand why the research is being done and what it will involve for you. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you to take part. The following is to explain details of the study:

1. What is the purpose of the study?

The purpose of the study is to find out more about hygiene behaviours that can impact children's health. Certain behaviours can affect the health of children. For the purposes of this research we are interested in holding in-depth interviews with child caregivers like yourself.

2. Why have I been chosen?

You are being asked for participation in this study because you have a child between the age of 5 and 12 years living in your household in Shariya Camp. We aim to interview about 2-3 caregivers who live in this camp.

3. Do I have to take part?

It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason. This will not affect any future decisions on public or private initiatives taking place in your neighbourhood or the neighbourhood in which you work.

4. What will happen to me if they take part?

If you agree to participate in this study, I will ask you to take part in the following activity:

1) A research team member will talk in-depth with you regarding household activities and routines around hygiene.

We would like to audio record the interview to make sure that we remember accurately all the information. The researchers will transcribe the recording before deleting it, and will keep the transcript in a secure location and the data will only be used by researchers involved in this study. Audio recording is required for participation in this study. If you do not wish to be recorded, it is not possible for you to be in this study.

5. What are the possible disadvantages and risks of taking part?

There are no direct risks associated with being involved in this study.

6. What are the possible benefits of taking part?

If you decide to participate in this study you may not benefit personally but the findings from this study may help us to identify possible ways we can work with your community to improve the health of their children in the future.

7. Will my taking part in the study be kept confidential?

Yes. All information collected during the course of the research will be kept strictly confidential. Only people that are involved in this research will have access to your information. All information will be kept in a secure location.

8. What will happen if I don't want to carry on with the study?

Participation in this study is voluntary. You may withdraw from this study at any time, even after you have been interviewed- you will not be penalized in any way or lose any sort of benefits for deciding to stop participation. If you decide to withdraw from the study, you can decide whether you want us to destroy the information you provided us, or whether you allow us to use this data.

9. What if something goes wrong?

If you have a concern about any aspect of this study, you should ask to speak to my supervisor who will try to answer your questions. If you wish to complain formally, or have any concerns about any aspect of the way you have been treated during the course of this study then you should immediately inform the Investigator and Project Director (Oliver Cumming, Department of Disease Control, Faculty of Infectious Tropical Disease, London School of Hygiene and Tropical Medicine, United Kingdom; oliver.cumming@lshtm.ac.uk).

The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation.

10. What will happen to results of the research study?

All the data from the interview will be analysed by researchers working with the London School of Hygiene and Tropical Medicine. These results will be used to develop an intervention for children around household hygiene that will be evaluated with some children between the ages 5 and 12 years in this camp. The overall results of the research will also be published in a study report and communicated to the Save the Children and other NGOs and may also be published online. All findings that are reported will be anonymised so that they cannot be linked back to you, your household or any other individual.

11. Contact Details

Contact for further information on study: Oliver Cumming (Principal Investigator) oliver.cumming@lshtm.ac.uk

Emergency contact number: Solomon Ghebremedhin (Program Manager) =Telephone number to be inserted

Email: Solomon.Ghebremedhin@savethechildren.org

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for considering taking the time to read this sheet.

Version 1.0;

August 15, 2017

INFORMED CONSENT FORM –ADULT (AUDIO RECORDED)

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Full Title of Project:

Hidden Incentive Project

Name of Principal Investigator:

Oliver Cumming

	Please initial box
1. I confirm that I have read and understand the participant information sheet dated 26.10.2016 (Version .1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered fully.	
2. I understand that my participation is voluntary and I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.	
3. I understand that information I provide as part the study may be reported anonymously to communicate findings of the research.	
4. I give permission to audio-record any conversations and understand the procedures that will be used to keep this information confidential	
5. I agree to take part in the above study.	

Name of Participant *(printed)*	Signature/Thumbprint	Date
Name of Person taking consent	Signature	Date

The participant is unable read or write. As a witness, I confirm that all the information about the study was given and the participant consented to taking part.

Name of Impartial Witness *(if required)*	Signature	Date

1 copy for participant; 1 copy for Principal Investigator

Information for Hygiene Promoters (SSIs)

Study title: Hidden Incentive Project

You are being invited to take part in a research study by the researchers from the London School of Hygiene and Tropical Medicine in England. The study has been approved by the London School of Hygiene and Tropical Medicine Research Ethics Committee and the Hawler Medical University Ethical Review Committee in Erbil. Before you decide if you want to take part, it is important for you to understand why the research is being done and what it will involve for you. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you to take part. The following is to explain details of the study:

1. What is the purpose of the study?

The purpose of the study is to find out more about hygiene behaviours that can impact children's health. Certain behaviours can affect the health of children. For the purposes of this research we are interested in holding interviews with community hygiene promoters like yourself.

2. Why have I been chosen?

You are being asked for participation in this study because you are involved in hygiene promotion in the Shariya camp. We aim to interview about 3 hygiene promoters who work within this camp.

3. Do I have to take part?

It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason. This will not affect any future decisions on public or private initiatives taking place in your neighbourhood or the neighbourhood in which you work.

4. What will happen to me if they take part?

If you agree to participate in this study, I will ask you to take part in the following activity:

1) A research team member will talk in-depth with you regarding your handwashing promotion activities and experiences within the camp.

We would like to audio record the interview to make sure that we remember accurately all the information. The researchers will transcribe the recording before deleting it, and will keep the transcript in a secure location and the data will only be used by researchers involved in this study. Audio recording is required for participation in this study. If you do not wish to be recorded, it is not possible for you to be in this study.

5. What are the possible disadvantages and risks of taking part?

There are no direct risks associated with being involved in this study.

6. What are the possible benefits of taking part?

If you decide to participate in this study you may not benefit personally but the findings from this study may help us to identify possible ways that we can work with your community to improve the health of their children in the future.

7. Will my taking part in the study be kept confidential?

Yes. All information collected during the course of the research will be kept strictly confidential. Only people that are involved in this research will have access to your information. All information will be kept in a secure location.

8. What will happen if I don't want to carry on with the study?

Participation in this study is voluntary. You may withdraw from this study at any time, even after you have been interviewed- you will not be penalized in any way or lose any sort of benefits for deciding to stop participation. If you decide to withdraw from the study, you can decide whether you want us to destroy the information you provided us, or whether you allow us to use this data.

9. What if something goes wrong?

If you have a concern about any aspect of this study, you should ask to speak to my supervisor who will try to answer your questions. If you wish to complain formally, or have any concerns about any aspect of the way you have been treated during the course of this study then you should immediately inform the Investigator and Project Director (Oliver Cumming, Department of Disease Control, Faculty of Infectious Tropical Disease, London School of Hygiene and Tropical Medicine, United Kingdom; oliver.cumming@lshtm.ac.uk).

The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation.

10. What will happen to results of the research study?

All the data from the interviews and observations will be analysed by researchers working with the London School of Hygiene and Tropical Medicine. These results will be used to develop an intervention for children around household hygiene that will be evaluated with some children between the ages 5 and 12 years in this camp. The overall results of the research will also be published in a study report and communicated to the Save the Children and other NGOs and may also be published online. All findings that are reported will be anonymised so that they cannot be linked back to you or any other individual

11. Contact Details

Contact for further information on study: Oliver Cumming (Principal Investigator) oliver.cumming@lshtm.ac.uk
Emergency contact number: Solomon Ghebremedhin (Program Manager) =Telephone number to be inserted
Email: Solomon.Ghebremedhin@savethechildren.org

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for considering taking the time to read this sheet.

INFORMED CONSENT FORM –ADULT (AUDIO RECORDED)

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Full Title of Project:

Hidden Incentive Project

Name of Principal Investigator:

Oliver Cumming

	Please initial box
1. I confirm that I have read and understand the participant information sheet dated 26.10.2016 (Version .1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered fully.	
2. I understand that my participation is voluntary and I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.	
3. I understand that information I provide as part the study may be reported anonymously to communicate findings of the research.	
4. I give permission to audio-record any conversations and understand the procedures that will be used to keep this information confidential	
5. I agree to take part in the above study.	

Name of Participant *(printed)*	Signature/Thumbprint	Date
Name of Person taking consent	Signature	Date

The participant is unable read or write. As a witness, I confirm that all the information about the study was given and the participant consented to taking part.

Name of Impartial Witness *(if required)*	Signature	Date

1 copy for participant; 1 copy for Principal Investigator

B. Participant Information Sheet and Consent forms for Research Paper 3

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Information for Participants

Study title: Hidden Incentives

You are being invited to take part in a research study by researchers from the London School of Hygiene and Tropical Medicine in England. The study has been approved by the London School of Hygiene and Tropical Medicine Research Ethics Committee and the Department of Medical Research (Lower Myanmar) Ethical Review Committee. Before you decide, it is important for you to understand why the research is being done and what it will involve. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. The following is to explain details of the study:

1. What is the purpose of the study?

The purpose of the study is to explore ways to improve children's health and well being. We have been talking to various members of this community about children's health and now would like your help to explore ways to improve it.

2. Why have I been chosen?

Your household is being asked to participate in this study because you have at least one child between the age of 5 and 12 years old living in your household. Your household has been randomly selected from a list of all households with children between the age of 5-12 in this section of the Shariya camp. We aim to include about 80 households in this study.

3. Do I have to take part?

It is up to you to decide if you want to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time during this study, without giving a reason. This will not affect any future decisions on public or private initiatives taking place in your neighbourhood.

4. What will happen to me if I take part?

If you agree to take part in this study we'll be coming to your house to do the following activites:

1. A researcher will complete a very short survey with you about you and your household

    (i) The survey will take approximately 5 minutes.
    (ii) You do not have to answer any of the questions. You may skip any question you choose.

2. A researcher will come to your house to observe your households daily activities at the start of the study and again about 6 weeks later at the end of the study.

    (i) A researcher will arrange a suitable day with you to observe your household routine. This researcher will spend time in your household for 3 hours starting from either early morning or from early afternoon. During this period, you are free to go about your daily activities. We do not require any of your attention. You are even free to leave your home.
    (ii) The researcher will take notes about your household activities and daily routine. They will take notes because they want to learn from you. They will not judge you on how you behave.
    (iii) If at any time during the observations, you would like a moment of privacy, just ask. The researcher will leave and come back at a time that is convenient for you.
    (iv) If you wish to leave your home during the observation period, please let the researcher know if you would like them to remain behind.
    (v) The observations the researcher makes are anonymous and when the results of this study are shared your name and identity will not be mentioned

3. We will distribute soap to your household at the start and at the end of the study.

5. What are the possible disadvantages and risks of taking part?

There are no direct risks associated with being involved in this study.

6. What are the possible benefits of taking part?

If you and your household decide to participate in this study you will play an active role in helping identify possible ways that we can work with your community to improve the health of your children. By participating in this program, you will be helping to improve children's health with no financial cost to you or your family.

7. Will my taking part in the study be kept confidential?

Yes. All information collected about you or your family during the course of the research will be kept strictly confidential. Only people that are involved in this research will have access to your information. All information will be kept in a secure location.

8. What will happen if I don't want to carry on with the study?

You and your family members can decide to stop participating in the study at any time, even after we have been to your house to observe your household acitivities. If you withdraw from the study, you can decide whether you want us to destroy the questionnaire and the information you provided us, or whether you allow us to use these data.

9. What if something goes wrong?

If you have a concern about any aspect of this study, you should ask to speak to my supervisor who will try to answer your questions. If you wish to complain formally, or have any concerns about any aspect of the way you have been treated during the course of this study then you should immediately inform the Investigator and Project Director (Oliver Cumming, Department of Disease Control, Faculty of Infectious Tropical Disease, London School of Hygiene and Tropical Medicine, United Kingdom; oliver.cumming@lshtm.ac.uk).

The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation.

10. What will happen to results of the research study?

All the data from the interviews and observations will be analysed by researchers working with the London School of Hygiene and Tropical Medicine. The overall results of the research will also be published in a study report and communicated to the Save the Children and other NGOs and may also be published online. All findings that are reported will be anonymised so that they cannot be linked back to you, your household or any other individual.

11. Contact Details

Contact for further information on study: Oliver Cumming (Principal Investigator) oliver.cumming@lshtm.ac.uk

Emergency contact number: Solomon Ghebremedhin (Program Manager) =Telephone number to be inserted
Email: Solomon.Ghebremedhin@savethechildren.org

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for considering taking the time to read this sheet.

INFORMED CONSENT FORM –ADULT (Observations)

Full Title of Project:

Hidden Incentive Project

Name of Principal Investigator:

Oliver Cumming

	Please initial box
1. I confirm that I have read and understand the participant information sheet dated for the above study. I have had the opportunity to consider the information, ask questions and have had these answered fully.	
2. I understand that the participation of my household and all household members is voluntary and we are free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.	
3. I understand that observations of activities in my household may be reported anonymously to communicate findings of the research.	
4. I give my consent for all household members below the age of 16 years and for whom I am the parent or guardian to participate in the study and for their actions to be observed and documented.	
5. I agree to take part in the above study.	

_____	_____	_____
Name of Participant *(printed)*	Signature/Thumbprint	Date

Signing on behalf of _____ number of people in the household who are below the age of 16

_____	_____	_____
Name of Person taking consent	Signature	Date

The participant is unable read or write. As a witness, I confirm that all the information about the study was given and the participant consented to taking part.

_____	_____	_____
Name of Impartial Witness *(if required)*	Signature	Date

C. Participant Information Sheet for Research Paper 4

Participant Information Sheet

You are being invited to take part in a research study by researchers working with the London School of Hygiene and Tropical Medicine. (LSHTM). The study has been approved by the LSHTM Ethics Committee. Before you decide if you want to take part, it is important for you to understand why the research is being done and what it will involve for you. The following is to explain details of the study:

1. What is the purpose of the study?

The purpose of the study is to understand how the determinants of child handwashing are perceived among WASH professionals, the approaches to handwashing promotion for children adopted by NGOs, the decision-making process behind this and how these programmes have worked in the past. For the purposes of this research we are interested in holding interviews with WASH professionals like yourself working across a range of different NGOs and countries.

2. Why have I been chosen?

You are being asked to participate in this study because you are a WASH professional involved in some way in the provision of hygiene promotion for children in a development or emergency context. We aim to interview around 18 WASH professionals from a range of NGOs.

3. Do I have to take part?

You do not have to take part in this study if you do not wish to. If you do agree to take part, I will ask you to verbally consent to participation over audio recording. You are free to withdraw at any time, without giving a reason.

4. What does my participation involve?

If you agree to participate in this study, a researcher from LSHTM will interview you about your current role and your experiences and opinions of hygiene promotion approaches for children. To facilitate in-depth analysis, the interview will be audio recorded. The recording will be transcribed and then deleted. Your name will be redacted from the transcript and it will be stored in a secure location. The full transcript will only be used by researchers involved in this study. Audio recording is required for participation in this study.

5. Will my taking part in the study be kept confidential?

You will not be named in any subsequent analysis or reports, however, there is a possibility you or your organisation will be identified due to the topics covered in the interview.

8. What will happen if I don't want to carry on with the study?

Participation in this study is voluntary. You may withdraw from this study at any time, even after you have been interviewed. If you decide to withdraw from the study, you can decide whether you want us to destroy the information you provided us, or whether you allow us to use this data.

9. What if I have concerns about the study?

If you wish to complain formally or have any concerns about any aspect of this study or the way you have been treated during the course of this study then you should immediately inform the Project Director (Oliver Cumming, Department of Disease Control, Faculty of Infectious Tropical Disease, London School of Hygiene and Tropical Medicine, United Kingdom; oliver.cumming@lshtm.ac.uk). The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If you experience harm as result of taking part in this study, you may be eligible to claim compensation.

10. What will happen to the results of the research study?

Information gained from the interview will be analysed by researchers working with the London School of Hygiene and Tropical Medicine. These findings will be used to inform our assessment of approaches to child handwashing behaviour change interventions. The overall results of the research will be published in a scientific journal.

Thank you for considering participating in this study

Appendix H: Ethical Approval Certificates

A. Ethical approval for research paper 2, 3, and 4 from LSHTM

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

Mr Oliver Cumming
Assistant Professor
Department of Disease Control (DCD)
Infectious and Tropical Diseases (ITD)
LSHTM

20 October 2017

Dear Oliver

Study Title: Hidden Incentive Study - Iraq

LSHTM Ethics Ref: 14483

Thank you for responding to the Interventions Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Investigator CV	Oliver Cumming CV	31/08/2017	1
Investigator CV	Robert Dreibelbis CV	31/08/2017	1
Investigator CV	Julie Watson CV	31/08/2017	1
Information Sheet	Consent Forms	31/08/2017	1
Information Sheet	Participant Information Sheets	31/08/2017	1
Covering Letter	RESPONSE LETTER_Cumming (Project 14483)	12/10/2017	1
Protocol / Proposal	PROTOCOL&STUDY DOCS (Project 14483)_v2	12/10/2017	2

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Professor John DH Porter
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

B. Ethical approval for research paper 2, 3, and 4 from Hawler Mecical Unversity Iraq

Meeting Code: 1
Paper Code: 16
Date: 21/11/2017

جامعة هولير الطبية
HAWLER MEDICAL UNIVERSITY

HAWLER MEDICAL UNIVERSITY
COLLEGE OF MEDICINE

RESEARCH ETHICS COMMITTEE APPROVAL SHEET

Title of the project: Hidden Incentive Project

Names of the author and co-authors: Watson J, Dreibelbis R, Deola C, King K, Lamb A, Ghebremedhin S, Cumming O.

Principle investigator: Watson J

Status: Approved

[redacted]

Prof. Dr.
Abbas Al-rabaty
Head of the Ethics Committee

[redacted]

Prof. Dr.
Abed-Alkareem A. Abed-Alkareem
Member

[redacted]

Prof. Dr.
Salah Abubakir Ali
Member

[redacted]

Assistant Prof. Dr.
Diyar HussenTaher
Member

[redacted]

Assistant Prof. Dr.
Muhammed Suheb Subhy
Member

C. Ethical approval for Surprise Soap: Further Piloting from LSHTM

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

Mrs Julie Watson
LSHTM

25 January 2021

Dear Julie

Study Title: Surprise Soaps: Further Piloting

LSHTM Ethics Ref: 22905

Thank you for responding to the Interventions Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Other	J.Watson.Research_Ethics_online_training_certificate		
Protocol / Proposal	Surprise_Soaps_Further_Piloting_PROTOCOL_30.11.20	29/10/2020	1
Protocol / Proposal	ANNEX 1_HH_Survey	29/10/2020	1
Protocol / Proposal	ANNEX 2_HH_Observations	29/10/2020	1
Protocol / Proposal	ANNEX 3_Endline_survey_intervention_HHs_only	29/10/2020	1
Protocol / Proposal	ANNEX 4_Caregiver_SSI_guide	29/10/2020	1
Protocol / Proposal	ANNEX 5_Caregiver_FGD_guide	29/10/2020	1
Protocol / Proposal	ANNEX 6_Children_FGD_guide	29/10/2020	1
Protocol / Proposal	ANNEX 7_Intervention_Implementer_FGD_guide	29/10/2020	1
Protocol / Proposal	ANNEX 8_Covid_alternative_observation_of_HWWS_only_at_outside_facility	29/10/2020	1
Protocol / Proposal	ANNEX 9_Covid_alternative_In-person_survey_as_alternative_to_observations	29/10/2020	1
Protocol / Proposal	ANNEX 10_Covid_alternative_telephone_survey_as_alternative_to_observations	29/10/2020	1
Information Sheet	PIS1_TRIAL.03.11.20	03/11/2020	1
Information Sheet	PIS2_HP_FGD_3.11.20	03/11/2020	1
Information Sheet	CF1_SS_TRIAL_03_11_20	03/11/2020	1

Information Sheet	CF2_SS_IMPLEMENTER_03_11_20	03/11/2020	1
Information Sheet	CF3_SS_Child_Assent_FGD_03.11.20	03/11/2020	1
Other	GCP certifcate_Oliver Cumming	26/11/2020	1
Other	J.Watson_GCP_Certificate_R2_new	27/11/2020	1
Sponsor Letter	2020-KEP-372_sponsorconfirmation_27112020	27/11/2020	1
Investigator CV	Cumming_LSHTM CV_Nov 2020	30/11/2020	1
Investigator CV	Julie_Watson_CV	30/11/2020	1
Information Sheet	PIS1_TRIAL.V2_22.01.21	22/01/2021	2
Covering Letter	Cover_Letter_Surprise_Soap_Further_Piloting	22/01/2021	2

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Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

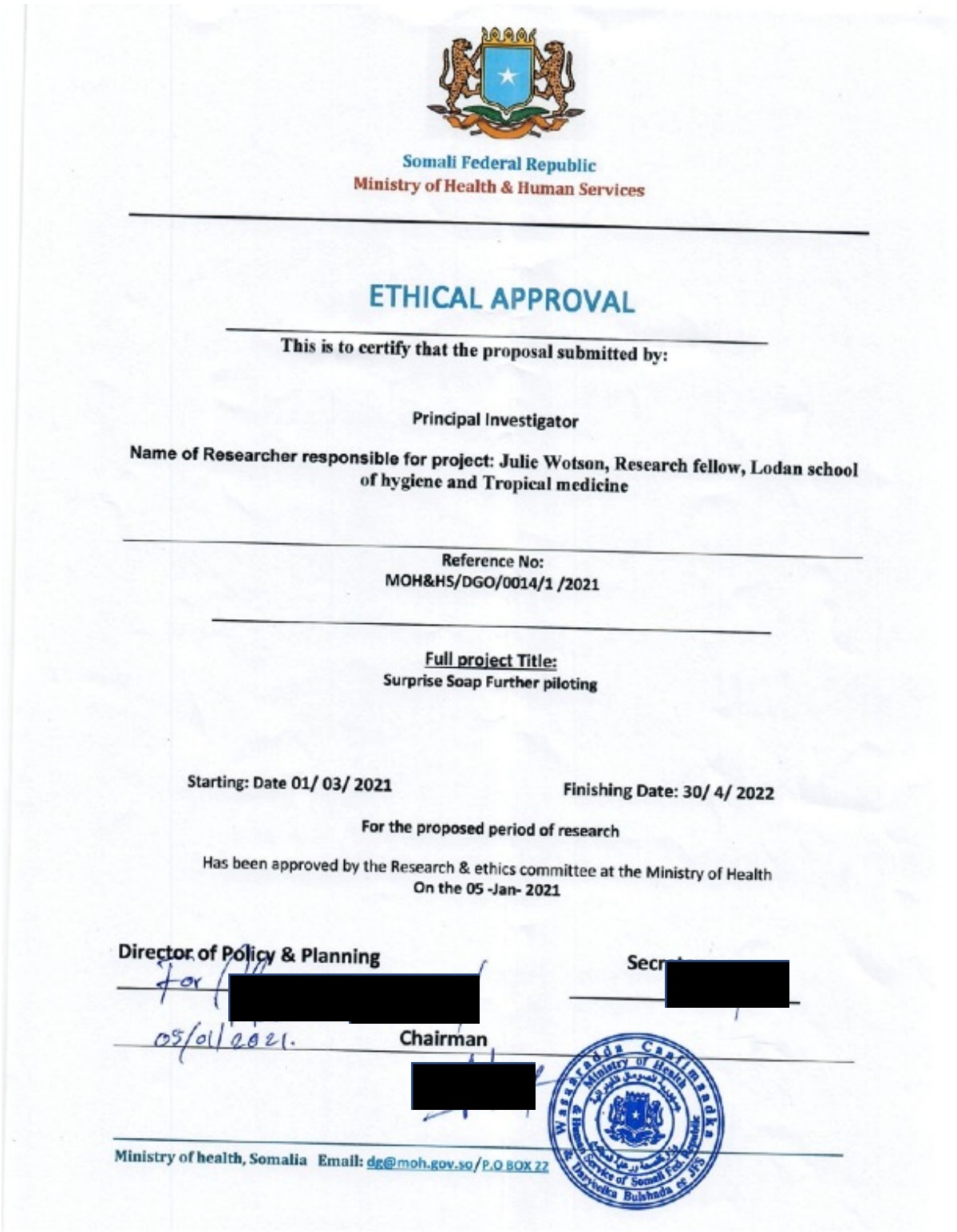
[redacted]

Professor Jimmy Whitworth
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

D. Ethical approval for Surprise Soap: Further Piloting from Somalia



Somali Federal Republic
Ministry of Health & Human Services

ETHICAL APPROVAL

This is to certify that the proposal submitted by:

Principal Investigator

Name of Researcher responsible for project: Julie Wotson, Research fellow, Lodan school of hygiene and Tropical medicine

Reference No:
MOH&HS/DGO/0014/1 /2021

Full project Title:
Surprise Soap Further piloting

Starting: Date 01/ 03/ 2021 Finishing Date: 30/ 4/ 2022

For the proposed period of research

Has been approved by the Research & ethics committee at the Ministry of Health
On the 05 -Jan- 2021

Director of Policy & Planning

for [redacted]

05/01/2021.

Secr[redacted]

Chairman

[redacted]

Ministry of health, Somalia Email: dg@moh.gov.so/P.O BOX 22

E. Ethical approval for Surprise Soap: Further Piloting from Sudan

Republic of Sudan
Federal Ministry of Health

HEALTH RESEARCH COUNCIL

NATIONAL RESEARCH ETHICS REVIEW COMMITTEE

Date: 14/3/2022

Ethical Clearance Certificate

This is to certify that the proposal No.(10-1-21), entitled; (Surprise Soaps: Further Piloting), submitted by; Mrs. Julie Watson, from The London School of Hygiene and Tropical Medicine, has been approved by the National Health Research Ethics Review Committee, Federal Ministry of Health to be conducted in Sudan, time period; March 2022 to March 2024

NB: The principal investigator is requested to submit progress and the final reports to the Research Directorate- Federal Ministry of Health.

[redacted]

Dr. Naiema Abdalla Wagialla
Rapporteur of the
National Research Ethics Review Committee

Federal Ministry Of Health
Directorate OF Research