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What factors affect sustained adoption of safe water, hygiene and sanitation technologies?

August 2015

Systematic
Review
Summary 2

Water and sanitation

3ie International Initiative for Impact Evaluation

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About this summary report

This report, *What factors affect sustained adoption of safe water, hygiene and sanitation technologies? 3ie Systematic Review Summary 2*, is a summary of the full review that is designed to be useful to policymakers and practitioners. The full review and all of its appendixes is available through the EPPI-Centre here. All content is the sole responsibility of the authors and does not represent the opinions of 3ie, its donors or the 3ie Board of Commissioners. Any errors are the sole responsibility of the authors. Questions or comments about this review should be directed to the corresponding author, Kristyna Solawetz at kristynasolawetz@gmail.com

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What factors affect sustained adoption of safe water, hygiene and sanitation technologies?

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3ie Systematic Review Summary 2
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Summary of the full systematic review

Safe water, sanitation and hygiene (WASH) behaviours, such as treating drinking water, washing hands at key times, or using a latrine rather than openly defecating, are cornerstones of building strong, healthy communities and reducing mortality due to diarrhoea and other preventable diseases. Interventions introducing these behaviours typically involve (1) a WASH technology (hardware), such as liquid chlorine, soap and a basin to wash hands, or a latrine, and (2) a behaviour change component (software), for example being taught how to use chlorine drops to treat water, or the key times at which to wash hands.

Many studies have shown health benefits of and researched factors that affect initial adoption of short-term WASH use. However, few have assessed what factors affect long-term, sustained WASH practice. Here, we investigate the enablers of and barriers to sustained WASH use. Sustained use for our purposes is defined as the continued practice of a WASH behaviour and/or continued use of a WASH technology at least six months after the end of the project period.

We searched a large body of published peer reviewed and grey literature sources to locate over 75,000 articles that discussed the use of a WASH technology. We then limited the results based on where or when the study was conducted, who participated and whether the study presented primary data (see Appendix A for full inclusion criteria). Findings from these remaining 148 articles are presented in the mapping stage of our technical report. We then narrowed this pool of articles to 44 studies that had an explicit focus on examination of sustained or continued WASH adoption and reviewed these to determine behavioural factors contributing to WASH practice. We also looked at a subset of 21 articles on sustained WASH technology use, defined as assessments of WASH behaviours conducted at least six months after the project period ended. These findings are presented in Section 5.

The mapping stage provides an expansive overview of the current literature on WASH behaviours and WASH technologies. Promotion of handwashing, treatment of water, and latrine use and construction are the most common types of WASH interventions. Behaviour change is promoted through multiple channels of communication. WASH technologies include soap, handwashing stations, water treatment with filters, solar disinfection or chlorination, and various latrine styles. Our in-depth synthesis revealed that factors within an individual's environment, characteristics of the technology itself and psychological motivators are influential in whether there is sustained adoption of a WASH behaviour. Currently, there is emphasis on factors affecting initial uptake of WASH technologies, but little discussion about what is needed to maintain that behaviour.

This work has implications for researchers, implementers, donors and policymakers. Scientific researchers and implementers can set clearer standards for what comprises sustained WASH practice. Donors and policymakers can specify standards for monitoring and evaluation in the programmes they support, develop indicators that better capture sustained practice, and direct funds to evidence-based programmes and intervention designs that effect long-term WASH use. Future research should examine the crucial period in which an initial behaviour becomes a long-term habit, to truly make a WASH behaviour sustainable.

Executive summary

Background: the review question

Among the exciting advances in water, sanitation and hygiene (WASH) programmes and policies, sustainability counts as a renewed and crucial area of focus for implementers, scientists, policymakers and donors alike. To further our understanding of the barriers to and facilitators of sustained adoption and use of water and sanitation technologies, we conducted a systematic review of studies concerning both initial and sustained adoption of WASH interventions at the individual, household and community levels in low- and middle-income countries. We built on previous reviews of handwashing and point-of-use water treatment, with a comprehensive review that is dramatically larger and broader in scope than previous studies. It is the only review we know of that examines a range of WASH interventions and factors associated with adoption. The review questions are:

1. What are the factors that influence the sustained adoption of clean water and sanitation technologies?

2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies, and how successful are these interventions at fostering both adoption and sustained adoption?

In answering these questions, we examined the extent to which existing interventions addressed known barriers to and/or leverage known facilitators of the sustained adoption of water and sanitation technologies.

Important terminology

Sustained use is defined as the continued practice of a WASH behaviour and/or continued use of a WASH technology at least six months after the end of the project period. By project period, we refer to any one of the following periods:

1. In a mass media behaviour change communication intervention, it is the period during which project-related material was being broadcast or disseminated through radio, television, newspapers or other mass channels of communication, or through mobile phone applications.
2. In a community-based intervention, it is the period during which there was external support to community groups, leaders and volunteers in the form of training, supervision and feedback, distribution of technology, or provision of communication materials.
3. In a research project, it is the period during which the research team or the team's local partners were implementing the behaviour change intervention and/or WASH intervention being evaluated as part of the study.

This differs from maintenance, which refers to the continued practice of a WASH behaviour or use of a technology during the project period. While many behavioural models specify factors that motivate initial adoption of a WASH technology during a project, these may not be the same factors that motivate the sustained practices of WASH behaviours into the extended future after the project ends.

Key interventions

WASH interventions typically promote both a technology (hardware) and regular use of the technology in the correct way (key behaviours). In this review, our focus is on the behaviours and the effectiveness of their promotion rather than on the effectiveness of technologies alone.

- Specific examples include (WHO/UNICEF 2014): *household water treatment and storage* (Centers for Disease Control 2014) including: filter technologies, point-of-use water treatment with chemical additives (for example sodium hypochlorite-based water treatment systems), ultra-violet filtration devices, solar disinfection, boiling, and modified or improved water storage containers;

- *sanitation*, including: improved latrine or toilet designs, ecological sanitation technologies, child potties, sani-pads (for infant faeces disposal);

- *handwashing hardware*, including: handwashing stations with soap and water, hand sanitisers and soapy water; and

- *water supply*, including: specific handpump technologies, small-scale treatment and distribution systems, rainwater harvesting interventions, protected and/or improved wells, and other technologies specifically designed to improve water availability or distribution at the community or household levels.

Promotion strategies employed involved a combination of household and community level outreach. Communication strategies occurred at the interpersonal (one-on-one), group or mass media distribution level. Interpersonal communication was associated with longer-term behaviour change and was widely represented across studies.

Other factors influencing sustained adoption, such as the design, durability and continued functioning of various WASH technologies, are mentioned in this review in the context of how they influence behaviour.

Outcomes of interest

The principal WASH-related behaviours that we examine in this review are:

- *water*: filtering, boiling and chlorinating drinking water, solar disinfection of drinking water;
- *sanitation*: building, using and maintaining latrines and toilets; and
- *hygiene*: handwashing with soap at key times – before eating, before food preparation and after visiting the toilet.

These behaviours can be promoted across a wide range of settings. We do not examine adoption of WASH behaviours in schools, hospitals, restaurants and other institutional settings. Rather, we focus on the promotion of these behaviours primarily at the household and community levels.

Methods of the review

We searched commercial databases, hand-screened journals and web resources, and conducted a search to access databases of peer reviewed and grey literature to identify articles documenting: (1) water, sanitation or hygiene interventions; (2) incorporating behaviour change, uptake or sustainability; (3) in low- and middle-income countries. Citations were screened by title and abstract. We identified 225 studies for full text review and 148 articles and reports were included in the mapping and keywording (identifying key words and/or themes of each included article) stage of our review. From these 148 articles, we extracted descriptive data that provided general information about the available literature documenting sustained adoption of water, sanitation and/or hygiene interventions. We identified 44 articles specifically reporting on long-term use or sustained adoption for in-depth review and further synthesis.

Implementation evidence

The evidence for WASH intervention implementation is the focus of this study; details are presented in the results section. Briefly, WASH interventions were typically undertaken by either academic research teams or non-governmental organisations. Distribution and promotion of technologies occurred at the community, household or individual levels, through health promoters, volunteers or community mobilisation efforts. Seventy-five per cent of studies occurred in Sub-Saharan Africa or South Asia.

Results

Of the 148 articles and reports identified in our mapping and keywording phase, the literature was well distributed between interventions or programmes that addressed handwashing (n = 55 studies), safe water (n = 62) and sanitation (n = 59). Forty-six per cent of studies explicitly mentioned sustained adoption. After conducting an in-depth synthesis of the 44 studies explicitly reporting on sustained adoption, we found the following trends in that subset of articles, presented here in relation to our research questions.

- **Research question 1 (in part): measuring sustained adoption**

    o Twenty-one (21/44) studies assessed WASH practices at least six months or more after the end of a study's project period. Due to the heterogeneity of outcome definitions, measurement methodologies and comparisons made, WASH use trends over time appear variable.

    o Post-intervention sustainability is often measured by a combination of survey, interview and observation. There is no clear definition for sustained adoption employed in WASH literature, and sustained adoption is measured through self-report, observed practice, functionality and recalled knowledge.

- **Research question 1 (in part): behavioural factors that influence sustained adoption**

    o Psychosocial factors: perceived susceptibility and severity of disease and perceived benefits and barriers are common psychosocial factors identified as influences on sustained adoption. However, some other factors, such as

injunctive and descriptive norms and nurturing, may be more predictive as motivators of continued use over time.

- o Contextual factors: these factors are often included in the study design. Age and gender are important factors that influence both who is able to practice the behaviour at the household level, and to determine roles in providing water, soap and childcare.

- o Technology factors: cost is an important factor regardless of the technology. Factors like durability, rate of water flow and maintenance are key in ensuring that technologies withstand frequent use over a long period of time.

- **Research question 2: programme characteristics influencing sustained adoption**

  - o Fourteen (14/44) articles assessing sustained adoption explicitly described programme or intervention tools and strategies utilised to promote WASH behaviour change.

  - o Of the 14 articles reviewed, communication strategies were the most commonly described.

  - o Evidence from this analysis suggests that the most influential programme factors associated with sustained adoption include frequent, personal contact with a health promoter over a period of time. Personal follow-up in conjunction with on-going communication and support through mass media advertisements or group meetings may further contribute to sustained adoption.

Conclusion

The success of water, sanitation and hygiene schemes worldwide depend on daily practices and long-term commitment, in conjunction with appropriately usable and durable technologies. This review begins the conversation on factors that motivate sustained adoption of WASH technologies, and provides a platform from which to guide further research in behaviour change and post-intervention sustainability.

We found that studies often inconsistently defined sustained behaviour change. This inconsistency makes it difficult to compare results across studies or to draw general conclusions about the factors that affect sustained WASH adoption.

Individual psychosocial factors, such as perceived benefit, self-efficacy and other factors derived from individual-level behavioural models, strongly dominate the WASH literature. Interpersonal factors such as social norms are also reported to strongly affect an individual's continued practice of WASH behaviours. The greater context around an individual was found to be highly influential. Particularly in latrine use and handwashing practice, age and gender were strong determinants of an individual's continued WASH practice. Finally, cost and durability were the two most important factors related to a technology, indicating areas where more research could be done on balancing cost-effectiveness of materials and supply-chain systems that support long-lasting hardware and long-term behaviour practice.

Evidence from this review suggests that the most influential programme factors associated with sustainability include frequent, personal contact with a health promoter and accountability over a period of time. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

Implications

The findings of this review are limited by the scope of our search, and capture only the literature reporting on WASH interventions and measures of adoption in low- and middle-income countries. Many definitions of sustained adoption exist and measurement methodologies are diverse and poorly detailed, leading to difficulties in evaluating and replicating long-term WASH use. We propose that the scope of WASH programme planning be widened to put in place conditions during the project period that favour sustained use of WASH technologies and sustained adoption of WASH practices after a project ends. We also propose that more resources be devoted to the evaluation of sustained use and the development of new methods for such evaluation.

Our findings imply a need for direction and leadership in guiding the research agenda on sustained adoption of WASH technologies. We discuss the steps necessary in supporting and evaluating sustained adoption from the research to policy levels.

Contents

List of figures and tables

Abbreviations and acronyms

CLTS   community-led total sanitation
IBM-WASH   integrated behavioural model for water, sanitation and hygiene technologies
L&MICs   low- and middle-income countries
WASH   water, sanitation and hygiene

1. Background

1.1 Why water, sanitation and hygiene?

Water, sanitation and hygiene (WASH) remain central in the post-2015 development agenda. According to recent estimates from the WHO/UNICEF (2014) Joint Monitoring Programme for Drinking Water and Sanitation, only 56 per cent of the population in low- and middle-income countries (L&MICs) has access to improved sanitation and 86 per cent lack access to an improved water supply. Global diarrhoea related mortality in children under 5 years of age remains a major justification for investment in WASH interventions, despite recent declines to an estimated 700,000 deaths in 2011 (Walker *et al.* 2013). Improvements in water quality, sanitation and handwashing are associated with 15–40 per cent reductions in the risk of diarrhoea among children under the age of 5 (Freeman *et al.* 2014; Wolf *et al.* 2014). Environmental enteropathy (Korpe and Petri Jr 2012; Lin *et al.* 2013; Ngure *et al.* 2014) and the recognition of clean water, sanitation and hygiene as human rights (Gleick 1998; Hunt 2006) are also important motivators to investigate sustained WASH adoption.

The majority of systematic reviews and meta-analyses related to water and sanitation technologies have focused on impact and health gains related to water, sanitation or hygiene improvements (Esrey 1991; Fewtrell *et al.* 2005; Arnold and Colford 2007; Clasen *et al.* 2007; Waddington 2009; Cairncross *et al.* 2010; Engell and Lim 2013; Wolf *et al.* 2014) and typically support the conclusion that these improvements are effective at reducing the risk of diarrhoea in children under 5 years of age.

Recent analyses by Enger *et al.* (2012, 2013) and Brown and Clasen (2012) demonstrated that compliance is a key factor in achieving the health benefits from WASH interventions: Sanitation programmes require more up-front investment for materials and construction. Twenty studies involved training personnel in proper latrine construction, while 10 studies provided materials free of charge, and in 17 studies they were sold to the community through local distribution points or at subsidized prices. Only five studies discussed community latrines or sanitary scoops for removal of faeces.

Decreases in compliance of 5–10 per cent drastically reduced the reduction in diarrhoea observed with perfect compliance. These findings highlight the fact that the impact of water and sanitation interventions on diarrhoea is likely tied to behaviour change and adoption among intended beneficiaries. Arnold and Colford (2007) and Waddington *et al.* (2009) also note an inverse relationship between study duration and impact on diarrhoea, suggesting either an attenuation of health benefits or lack of sustained adoption and use of household technologies over time.

1.2 Theoretical grounding

This systematic review employs the Integrated Behavioural Model for Water, Sanitation and Hygiene (IBM-WASH) to provide theoretical grounding to our research questions as well as to guide our analysis and characterisation of factors that may influence adoption and sustained adoption of water and sanitation technologies (Dreibelbis *et al.* 2013).

The framework has three large, overlapping dimensions that mutually influence one another (see Table A4 in Appendix A):

- *Contextual factors:* factors related to the individual, setting and/or environment that can influence behaviour change and adoption of new technologies;

- *Psychosocial factors:* behavioural, social or psychological determinants that influence behavioural outcomes and technology adoption; and

- *Technological factors:* specific attributes of a technology, product or enabling device that influence its adoption and sustained use.

The three interacting dimensions not only encompass our understanding of WASH-related practices, but also are consistent with the idea of reciprocal determinism in social cognitive theory which describes mutual interactions between the individual, the behaviour and the environment in which the behaviour is practised (Bandura 1989).

1.3 Motivation for this review

The meaning of sustainability in WASH behaviour change interventions is very diverse. The Millennium Development Goal for drinking water calls for halving the proportion of people without sustainable access to safe water from 1990 to 2015. The Millennium Task Force on WASH stated that sustainability must encompass 'social, economic, and environmental perspectives' (Lenton *et al.* 2005). WASH behaviours must be performed regularly and repeatedly over a long period of time.

We note that while summarising the evidence base on sustained adoption of WASH behaviours is the subject of this review, methodologies for measurement of sustained adoption are not well developed. It is our hope that one result of this review will be to stimulate further efforts to develop such methodologies.

1.4 Methodology

We searched commercial databases, hand-screened journals and web resources, and conducted a search to access databases of peer reviewed and grey literature. We identified over 75,000 articles documenting: (1) water, sanitation or hygiene interventions; (2) incorporating behaviour change, uptake or sustainability; (3) in L&MICs. Citations were screened by title and abstract using pre-specified inclusion/exclusion criteria (see Appendix A). We identified 225 studies for full-text review and 148 articles and reports were included in the mapping and keywording (identifying key words and/or themes of each included article) stage of our review. From these 148 articles, we extracted descriptive data that provided general information about the available literature documenting sustained adoption of water, sanitation and/or hygiene interventions. We identified 44 articles specifically reporting on long-term use or sustained adoption for in-depth review and further synthesis.

1.5 Structure of the report

The focus of this review is to examine sustained adoption of WASH technologies and behaviours. We discuss why sustained adoption is important, particularly considering that the practice of WASH behaviours must be repeated multiple times throughout the day over a long period of time by all members of the community in order to provide health and environmental benefits.

Given this context, this review seeks to answer the following questions:

1. What are the factors that influence the sustained adoption of clean water and sanitation technologies?
    1a. What are the contextual factors that result in adoption of water and sanitation technologies (that is, what are the key environmental, political and demographic factors influencing behaviour)?
    1b. What are the psychosocial factors that result in adoption of water and sanitation technologies?
    1c. What are the technological factors that result in adoption of water and sanitation technologies (that is, what aspects of WASH technologies facilitate behaviour change)?

2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies and how is sustained adoption measured?

We also examine how programmes address known barriers to and facilitators of sustained adoption to promote successful interventions. We describe our research questions and sub-questions and briefly outline a format of the review in the last portion of this section. Lastly, we include a section for how readers may be able to use the findings presented in this report.

2. WASH: water, sanitation and hygiene interventions

WASH interventions typically promote both a technology (hardware) and regular use of the technology in the correct way (key behaviours). In this review, our focus is on the behaviours and the effectiveness of their promotion, rather than on the effectiveness of technologies alone.

WASH technologies refer to the specific technologies, hardware, tools or devices that support consumption of safe drinking water, effective containment and/or deactivation of human faeces, or improved handwashing practices. Specific examples include (WHO/UNICEF 2014):

- *household water treatment and storage* (Centers for Disease Control 2014), including filter technologies, point-of-use water treatment with chemical additives (for example, sodium hypochlorite-based water treatment systems), ultraviolet filtration devices, solar disinfection, boiling, and modified or improved water storage containers;
- *sanitation*, including improved latrine or toilet designs, ecological sanitation technologies, child potties, sani-pads (for infant faeces disposal);
- *handwashing hardware,* including handwashing stations that include soap and water, hand sanitisers and soapy water; and
- *water supply*, including specific handpump technologies, small-scale treatment and distribution systems, rainwater harvesting interventions, protected and/or improved wells, and other technologies specifically designed to improve water availability or distribution at the community or household levels.

In addition to the behaviour to be practised, interventions also involve promotion efforts across a wide range of settings including schools, hospitals and restaurants. While handwashing with soap may be promoted before and after patient contact in clinics and hospitals, before food preparation in restaurants, and before eating and after visiting the toilet in schools, we do not examine adoption of WASH behaviours in schools, hospitals, restaurants and other institutional settings. Rather, we focus on the promotion of these behaviours primarily at the household and community levels.

Household level promotion of WASH behaviours commonly takes the form of household visits by paid or voluntary health promoters. The promoter might help to set up the technology, demonstrate how to use and maintain the technology, or demonstrate the target behaviour using various promotional strategies. Examples include stating the benefits of the behaviour such as reduced risk of cholera and dysentery or avoidance of the toxic effects of heavy metals, stating that others in the community are adopting the behaviour (social norms), or leveraging disgust surrounding faeces.

Community level promotion of WASH behaviours may involve convening a community group to assess the situation and make recommendations, sale and distribution of WASH technologies by community groups or individual entrepreneurs, community-wide events such as meetings and festivals where the technologies and behaviours are promoted, and organising a community level system to maintain WASH technologies such as well or latrine maintenance, ordering replacement parts, making repairs and performing routine maintenance. Other factors influencing sustained adoption, such as the design, durability and continued functioning of various WASH technologies, are mentioned in this review in the context of how they influence behaviour.

We differentiate specific technologies from the associated messaging and/or intervention activities pursued to promote their use and adoption. Interventions or behaviour change communication strategies can focus on specific technologies (such as social marketing of point-of-use water treatment methods) or specific behavioural outcomes (that is, community-led total sanitation [CLTS] as a means to increase latrine construction). Interventions may target specific psychosocial factors (such as increasing knowledge regarding disease risk), contextual factors (such as financing or microcredit loans for water supply improvements), or technological factors (increasing local manufacturing capacity for sanitation components).

2.1 Outcomes of interest

This review seeks to assess factors influencing sustained adoption of WASH technologies and practice of WASH behaviours. These behaviours are important because they represent the fundamental actions that must be performed to become long-term habits.

For the purposes of this review, sustained use is defined as the continued practice of a WASH behaviour and/or continued use of a WASH technology at least six months after the end of the project period.

By project period, we refer to any one of the following periods of time:

1. In a mass media behaviour change communication intervention, it is the period during which project-related material was being broadcast or disseminated through radio, television, newspapers or other mass channels of communication, or material was disseminated through mobile phone applications.
2. In a community-based intervention, it is the period during which there was external support to community groups, leaders and volunteers in the form of training, supervision and feedback, distribution of technology, or provision of communication materials.
3. In a research project, it is the period during which the research team or the team's local partners were implementing the behaviour change intervention and/or WASH intervention being evaluated as part of the study.

The principal WASH-related behaviours that we examine in this review are:

- *water*: filtering, boiling and chlorinating drinking water, solar disinfection of drinking water;
- *sanitation*: building, using and maintaining latrines and toilets; and
- *hygiene*: handwashing with soap at key times – before eating, before food preparation and after visiting the toilet.

These behaviours can be promoted across a wide range of settings. As already stated, we focus on the promotion of WASH behaviours primarily at the household and community levels. We do not examine adoption of WASH behaviours in schools, hospitals, restaurants and other institutional settings.

Additionally, this review is interested in identifying factors influencing sustained adoption. For convenience, we have drawn factors from the IBM-WASH framework, and have classified them into three main categories (Dreibelbis *et al.* 2013):

- *Contextual factors*: background characteristics of the individual, setting or location, for example age, gender or household structure, that can influence behavioural outcomes;

- *Psychosocial factors*: psychological, social or cultural factors influencing practice of a behaviour, like perceived self-efficacy or community norms; and
- *Technological factors*: characteristics of a specific technology or device that influence its initial and sustained use over time such as cost, size and ease of use.

3. Effecting sustained adoption of WASH behaviours

Behaviour change does not occur in isolation, but exists within the greater context of an individual's thoughts, external environment, and influences of past actions and governmental policy. We divide the life of a WASH behaviour change project into four time periods:

1. early project period
2. late project period
3. early post-project period, and;
4. late post-project period.

During each of these four periods, there is a different context for practising WASH behaviours. Here we sketch the main features of the four periods. Details on the enabling and constraining factors in each of the four periods are provided in Figure 1.

1. **Early project period** – This is frequently a period of excitement and enthusiasm. New technology is introduced into a community at low cost or no cost, and project personnel and/or community promoters explain the new technology and its advantages. The novelty of the technology, the promotional activities and other special events all encourage people to try the technology or practice the new behaviour. Conversely, failure of the project to adequately adapt the technology and behavioural recommendations to the needs of the population and the specific environmental conditions may slow adoption.

2. **Late project period** – The initial enthusiasm for the technology or the behavioural recommendations diminishes, and community members have the chance to weigh the advantages and disadvantages of the new against the pre-existing. The continued presence of project staff may ensure that cost and availability do not constitute significant barriers to use. Health promoters help people to solve problems related to new technologies. At the same time, people may realise that the promised benefits have not materialised, and return to previous technologies and behaviours. It is during this period that the studies that we describe as maintenance assess whether behaviour has been sustained. Ideally there is planning in the late project period, so that community members are in a position to maintain the functionality of the technology, restock on essential supplies, and continue to practice the recommended behaviours after the end of external funding and support.

3. **Early post-project period** – While external support ends, the promotional messages and instructions disseminated by the project are still fresh in people's minds. Projects may have left extra supplies. People may be motivated to continue practicing the behavioural recommendations in order to maintain health benefits. At the same time, breakdowns in equipment or stockouts in essential supplies may start to bring down the previous level of adoption. The behavioural cue (reminder) of regular household visits by promoters may be lost. Household members who, from the outset, have been sceptical of the new technology or behavioural recommendation may reassert their position and encourage other household members to revert to previous ways. Studies assessing WASH behaviours in this and the following period were classified as sustained adoption studies in this review.

4. **Late post-project period** – Problems with breakdowns in equipment and stockouts may worsen, further decreasing levels of adoption. However, the desire to maintain the benefits of the technology or behaviour, and new habits and social norms that resulted from the intervention activities during the project period may help sustain previous levels of practice of the WASH behaviours.

Figure 1: Flow diagram of our theory of change
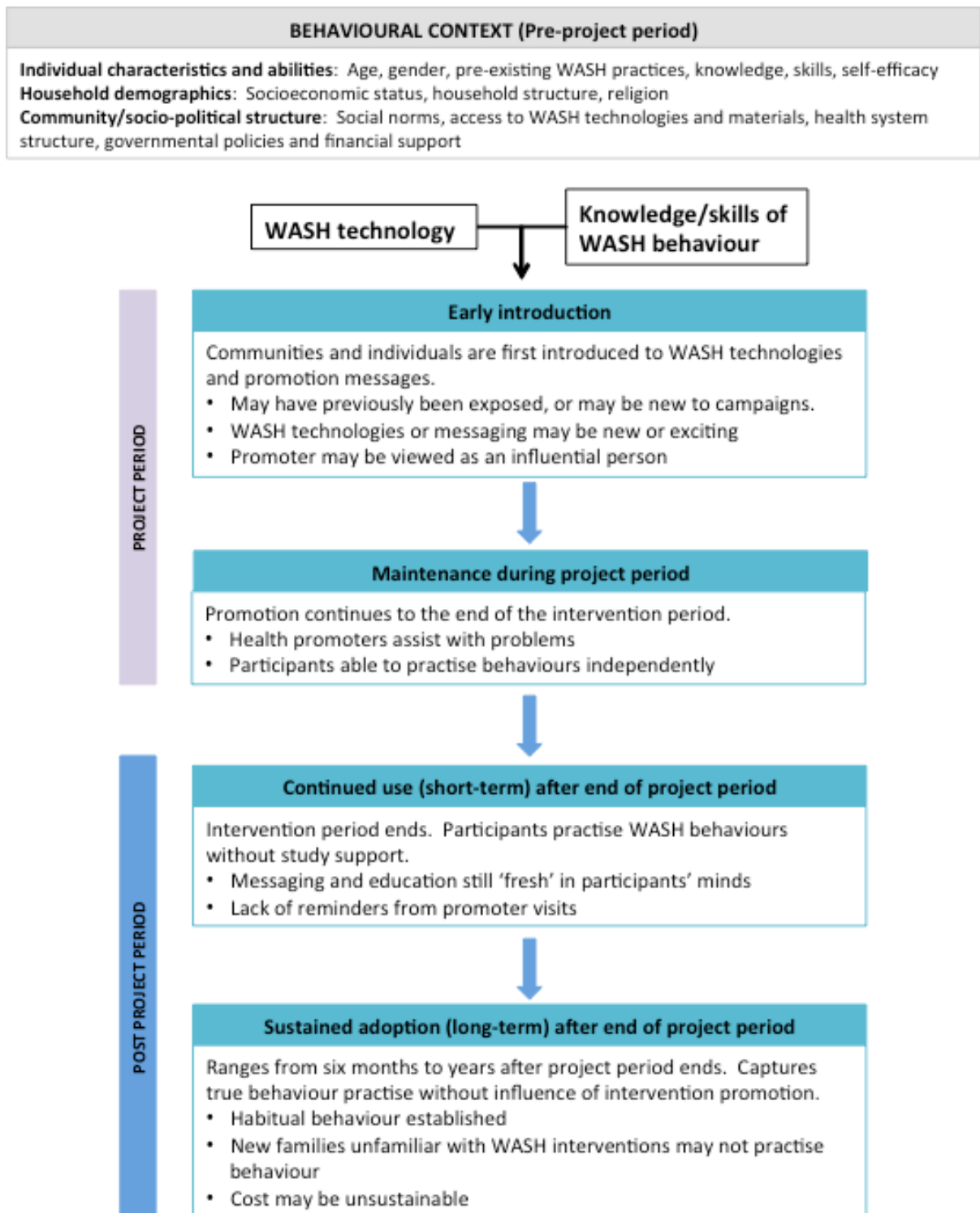
4. Implementing interventions for sustained WASH behaviour practice

The results presented in this section illustrate a systematic map of the 148 articles discussing factors that influence sustained adoption of WASH technologies, providing summary information about the nature and scope of the literature. We highlight the study designs and evaluations used to measure sustainability. Additionally, we identify factors influential in promoting initial and sustained adoption of WASH technologies. Analysis of the trends in the map has helped us to identify gaps in the literature and select studies for in-depth synthesis in the next section.

Articles and reports included in the mapping phase reported on hygiene, water treatment and sanitation interventions with the following frequencies:

Domain	Total
Handwashing	55
Water treatment	62
Sanitation	59

We categorised articles to these domains based on any mention of technology pertaining to that domain. Some articles, for example, Cairncross *et al.* (2005), described multiple WASH domains or combined interventions, such as promotion of handwashing and water treatment during the project period. These articles could be classified under both the handwashing and water treatment domains. Note that several studies assessed more than one type of WASH technology; see Table A2 in the Appendix A.

4.1 Geographical spread of studies

Sub-Saharan Africa and South Asia account for about 75 per cent of the studies identified at this stage of the review. Countries such as Bangladesh, India, Zimbabwe, Ghana and Kenya are well represented in the literature. Under-represented in this pool of literature are the Near East and North Africa as well as any studies conducted in East Asia (Figure 2).

Figure 2: Geographical map of studies (n = 148)

Created using https://developers.google.com/chart/interactive/docs/gallery/geomap
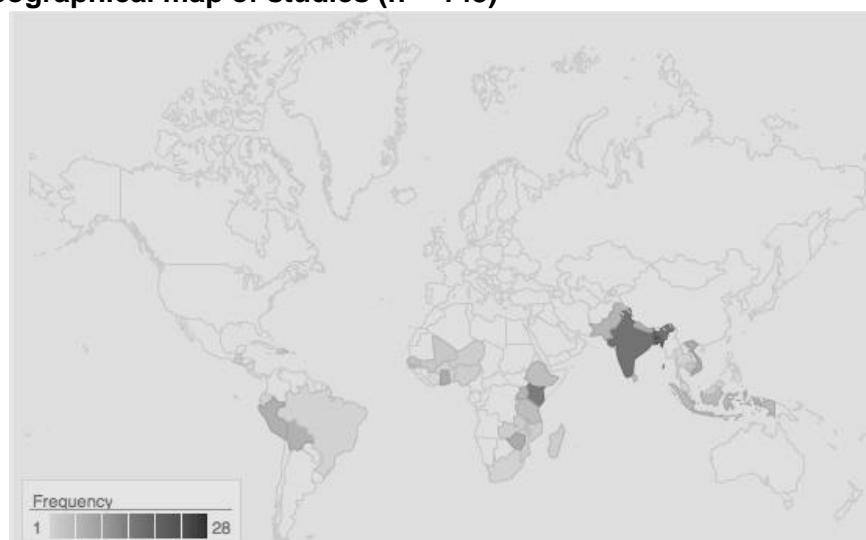
4.2 Study design: level of intervention

We found that most of the studies represented in the literature on adoption and sustained adoption of WASH technologies are implemented on a small scale. Four hundred and fifty-six per cent of studies and reports operated at the level of one village or several villages. Larger studies with a greater target population were generally conducted at the sub-district (10 per cent of studies), district (187 per cent), or provincial or regional (110 per cent) levels. These definitions varied by study and were described by study authors. They typically referred to geographic and/or political divisions established by the government or other census authorities (for example SEUF 2004).

4.3 Study design: overview of behaviour change activities

Of the 148 studies, 103 studies described intervention activities to change WASH behaviour. These include community mobilisation, education through mass media, clubs, groups or health workers. One or more of these activities may be employed as part of an intervention package.

4.4 Study design: WASH technologies represented in the literature

Of the 148 studies identified for mapping, the literature was well distributed between interventions or programmes that addressed hygiene (n = 55 studies), safe water (n = 62) and sanitation (n = 59).

Of the 148 studies, 52 reported on a combined water, sanitation and handwashing intervention. Prior research has not reported any difference in health outcomes when interventions are promoted either separately or concurrently (Fewtrell *et al.* 2005; Arnold and Colford 2007), but combined WASH interventions may have relevance when considering large-scale policy planning or donor investment (Dreibelbis *et al.* 2013).

4.5 Overview of WASH technologies studied: handwashing

A variety of different handwashing enabling technologies are present in the literature; most studies encourage handwashing with soap. However, details on specific handwashing station designs, types of soap and soap presentation mechanisms are lacking. These interventions typically included promotion of handwashing with soap and water, although a few studies focused on other enabling products such as a handwashing station, storage containers for soap to ensure convenient, consistent access, and sanitiser products.

4.6 Overview of WASH technologies studied: water treatment

In contrast to handwashing, water treatment and safe storage enabling technologies tended to be described in detail. The majority of safe water interventions promoted water treatment products for point-of-use. These primarily included filters, solar disinfection, chlorination and flocculent disinfectants. Also included in the safe water group were methods of safe water storage, such as narrow-necked vessels and covered containers to minimise recontamination of water after treatment or collection from a safe source.

Though less common, boiling water is discussed in nine studies. Twenty-seven studies describe a filtration device, 13 presented options for chlorination, and 16 documented solar disinfection techniques.

4.7 Overview of WASH technologies studied: sanitation

Sanitation programmes require more up-front investment for materials and construction. Twenty studies involved training personnel in proper latrine construction, while 10 studies provided materials free of charge, and in 17 studies they were sold to the community through local distribution points or at subsidised prices. Only five studies discussed community latrines or sanitary scoops for removal of faeces.

4.8 Study outcomes: reported focus on sustainability

Though all of the studies in this report assessed factors influencing WASH adoption, only 68 of 148 studies mention sustainability or sustained adoption. Sixty-three of 148 studies specified target behaviours or behavioural objectives; however, the literature identified may under-represent adoption and sustained adoption if behaviour change is not an explicit component of research at the outset of a study. Even though all 148 studies included in this review reported on a WASH behaviour or adoption of WASH practices, only 19 studies provided a full description of the behaviour of interest (that is, 'wash both hands with soap until lather is produced, for 30 seconds or more', or 'treat water by placing bottles in full sun for eight hours before consumption').

4.9 Study outcomes: data collection methods and reporting

Studies typically reported on household surveys, with a smaller number reporting on both surveys and qualitative data, and a small number that were only qualitative. Most articles and reports were incomplete in terms of both the description of the methodology and the reporting of results. Of the data that were available, only a limited subset was presented. The types of data commonly presented were:

- demographic characteristics of respondents;
- description of the study site;
- self-reports of behaviour based on household survey;
- observed behaviour, for example, structured observation of handwashing;
- proxies for behaviour, for example, detection of residual chlorine in drinking water;
- WASH-related knowledge, often measured through a knowledge, attitudes and practices (KAP) survey. However, such surveys rarely formally measure attitudes alone.

Types of data and other aspects of the research that are only rarely analysed include:

- *description of the technology:* where technology is introduced (such as soap dispensers, handwashing stations, water filters, improved latrines), it is not often described in detail.
- *explicit behaviour change model:* Of the 148 studies, 63 set out to change behaviour. Only 32 mentioned or described an explicit behaviour change model. Often there

was an implicit model, which could be discerned through careful reading of the article, and analysis of types of data measured and analysed.

4.10 Study outcomes: comparisons between study groups

Some studies may have included multiple comparisons. We were also interested in identifying the types of comparisons made over time to demonstrate long-term use and/or sustained adoption following a period of implementation.

Of the 148 studies, 66 did not make comparisons of behaviour change over time. These were cross-sectional quantitative evaluations, a single round of qualitative research, or pilot studies. The next most common comparison was between an established baseline and the mid- or end-point of a study or intervention. Thirty-nine reports provided a pre- and post-study comparison, 17 examined before-and-after large scale distribution (for example, distribution of ceramic water filters for household water treatment following a natural disaster), 14 compared results pre- and post-community mobilisation (such as a community-led total sanitation campaign), and 23 compared changes after conclusion of the study. Twenty-five compared changes after a period of intensive implementation. Nineteen studies were designed to assess change over time: seven studies were longitudinal panel designs, and 12 employed continuous monitoring.

4.11 Study outcomes: assessment of study quality

We assessed study rigour by adapting a seven-point scale system adapted from Harden and Thomas (2005) to describe the heterogeneity of the data quality. One study was excluded due to incomplete responses for all the subscores used to calculate the final rigour score; a higher score corresponds to better detail provided on study design and methodology. These scores show that there is a range of quality in the data and thoroughness of reporting.

5. In-depth review: results

From the 148 articles that were mapped, we identified 44 articles whose explicit purpose was to assess sustained use of WASH technologies and behaviour practice. In this section, we discuss outcomes measured and level of adoption achieved by a select number of studies. We present relevant behavioural factors identified from WASH literature, broken down by IBM-WASH concepts. In what follows, we will discuss relevant programme characteristics, including study design and intervention strategies, that support sustained adoption of WASH technologies.

We conducted five discrete syntheses on various subsets of the selected articles:

- Measuring level of adoption
    - o Synthesis 1 – measurement of WASH behaviour practice during post-intervention follow-up

- Research question 1: the syntheses focus on behavioural factors influencing adoption and sustained adoption of WASH technologies and behaviours
    - o Synthesis 2 - psychosocial factors

- Synthesis 3 - contextual factors
- Synthesis 4 - technological factors

- Research question 2: the syntheses address programme characteristics affecting adoption of behaviours and levels of sustained adoption achieved
  - Synthesis 5 - intervention design/intervention components affecting adoption and sustained adoption of behaviours

Some articles are included in several synthesis exercises, others in only one. We present the findings below.

5.1 Research question 1: defining outcomes and measuring the level of sustained WASH adoption

To address research question 1 which is: what are the factors that influence the sustained adoption of clean water and sanitation technologies? it is necessary for a study or programme evaluation to (1) measure sustained adoption of WASH behaviours, (2) measure factors affecting or influencing sustained adoption, and (3) analyse associations between sustained adoption and these factors. In this part of the chapter, we explore how studies measured and reported WASH practices (summarised in Table 1). This information is critical to anyone wishing to implement WASH programmes, or develop indicators to monitor behaviour change and assess the long-term impact of programmes. There was a great diversity in how studies were designed and collected data on both behaviour practice and use of the technology. Measurement methodologies utilised in almost all studies included:

- *self-report*, where a participant is questioned about their WASH practises (usually using a structured or semi-structured survey)
- *spot check*, where the practice of a behaviour or presence of a technology is confirmed visually at the time of the visit
- *demonstration*, where a participant is requested to show how a behaviour is practised to assess level of knowledge and ability to perform the action

5.1.1 Selection of studies for analysis of outcome measures

Twenty-one studies in our in-depth review reported WASH practice at least six months after the end of the project period. This time period was chosen by our team as a reflection of the minimum length of time that evaluation studies waited to assess sustainability of behaviour change resulting from a project or study; actual time to follow-up ranged from six months to over nine years.

5.1.2 Measuring sustained adoption: study design

Across all WASH topics, two study designs are frequently employed: cross-sectional surveys, which provide an at-a-glance measurement of behaviour practice, and longitudinal surveys, which follow a population over time and allow for the assessment of trends in practice over time. Outcomes measured differ by topic, but are almost exclusively ascertained by participant self-report, demonstration (most frequently used to assess handwashing practice), or spot check (favoured as a measure to verify latrine presence or water treatment use).

Only three studies conducted measurements at multiple time points after the end of the project period (SEUF 2004; Parker *et al.*, 2006; Bowen *et al.*, 2013). Additionally, only five out of 21 studies attempting to assess long-term WASH use also included estimates of the level of use or adoption from the end of the project period. Comparison of measurements at multiple time points is fundamental to assessing sustained adoption. In practice, the comparison can be either: (1) between two or more time points after the end of the project period; or (2) between one time point after the end of the project period, with data collected at the end of the project period serving as the point of reference. Making these two types of comparison is essential to building the evidence base for the long-term sustainability of WASH behaviours after the end of the project period.

Table 1: Key findings of outcome measurements in WASH literature

Determinant category	Why this is important	Key findings	How this can be used
Measuring outcomes	• Well-defined indicators and measurements are essential to developing solid evaluations methodology • It helps understand the abilities and limitations of current measurement metrics	• Sustained adoption is interpreted in many ways by studies • Studies employ a variety of measures, and rely heavily on verbal forms of participant report • Observations of practice were not performed, beyond spot checks	• To establish metrics that capture WASH practice, particularly over longer periods or automatic behaviours • To provide an evidence base for selecting and evaluating WASH programming

5.2 Research question 1: behavioural factors influencing sustained adoption (n = 44)

To address research question 1 which is – what are the factors that influence the sustained adoption of clean water and sanitation technologies? –is it is necessary for a study or programme evaluation to: (1) measure sustained adoption of WASH behaviours (see previous sections); (2) measure factors affecting or influencing sustained adoption; and (3) analyse associations between sustained adoption and these factors. In this subsection, we describe factors influencing sustained adoption and their associations with WASH behaviours. All 44 articles reviewed for in-depth synthesis were included in this analysis; these include: (1) sustained adoption articles assessing WASH practice over a period of six months or more after the project period ended (n = 21); and (2) maintenance articles reporting on WASH practice during the project period (n = 23). Behavioural factors (or determinants) encapsulate the physical, social, psychological, environmental or technological factors that shape individual level behaviours. For the purposes of this review, these factors have been classified into three main categories established in the IBM-WASH framework (Dreibelbis *et al.* 2013): contextual, psychosocial and technological factors.

Table 2 summarises the key behavioural factors identified in our review. We found that individual psychosocial factors such as perceived benefit, self-efficacy and other factors

derived from individual level behavioural models strongly dominate the WASH literature. Interpersonal factors such as social norms are also reported to strongly affect an individual's continued practice of WASH behaviours. Understanding these factors can better inform target groups and intervention content to achieve lasting WASH behaviour change.

Cost and durability were the two most important factors related to a technology, indicating areas where more research could be done on balancing cost-effectiveness of materials and supply chain systems that support long-lasting hardware and long-term behaviour practice.

Finally, the greater context around an individual was found to be highly influential. Particularly in latrine use and handwashing practice, age and gender were strong determinants of an individual's continued WASH practice: individuals may be barred from using latrines or unable to practise handwashing or water treatment if they are too young, or otherwise restricted culturally or physically from accessing enabling technologies.

Surprisingly, although referenced in behavioural models, for example, FOAM (the World Bank) or RANAS (Mosler 2012), the concept of the enabling environment was not discussed in any studies in this review. As we will discuss later, an environment that is conducive not only to the uptake but to the continued maintenance of WASH behaviours is crucial to establishing sustained WASH practice.

Table 2: Levels of behavioural factors and key findings

Determinant category	Why this is important	Key findings	How this can be used
Behavioural factors			
Psychosocial	• Psychosocial factors are the core of various behaviour change theories • They provide the basis of intervention design and rationale	• Knowledge of the practice, self-efficacy, perceived benefits and social norms all affect behaviour • Pre-existing habits and perceived susceptibility or severity also contribute to sustained practice	• Designing intervention content • Developing effective communication strategies
Technological	• Enabling technologies • Direct interface between user and behaviour practice • Positive or negative aspects can alter behaviour adoption	• Cost and durability are the most important factors across all three sectors	• Designing intervention content • Selecting an appropriate technology • Implementation logistics

Determinant category	Why this is important	Key findings	How this can be used
Contextual	• Factors external to user or technology influence sustained adoption • Form the environment in which behaviour change occurs	• Socio-economic status, level of education, age and gender are all strongly tied to adoption • Existing infrastructure and prior exposure to interventions are also relevant • Habit-forming environments are not emphasised	• Programme planning and implementation • Communicating results across different groups and settings

5.3 Research question 2: programme characteristics favouring adoption and sustained adoption

To answer research question 2, we identified 14 studies that describe programme characteristics influential in sustained WASH use. These characteristics included various communication strategies, length of follow-up, and time since follow-up; they are summarised in Table 3 and discussed below.

5.3.1 Communication: one-on-one interactions (n = 14)

The most personal and personnel-intensive channel of communication is a one-on-one discussion in a participant's household. In this method, education or communication is delivered through a community health worker, health promoter or volunteer. In all 14 studies in this synthesis, one-on-one interactions are associated with positive changes in behaviour.

5.3.2 Communication: group meetings and group involvement (n = 3)

Group meetings are another popular strategy for communicating about intervention behaviours.

One programme reporting on sustaining hygiene changes in Kerala, India, utilised hygiene classes as a communication strategy. At the end of the study, participating in hygiene classes and receiving training on hygiene and sanitation were linked to better practices (SEUF 2004). Another sanitation study, comparing CLTS with community health clubs, found that though both approaches encouraged construction of latrines, community health clubs were effective at sustaining change due to the use of face-to-face interactions and positive messaging (Whaley and Webster 2011), as opposed to disgust- and shame-driven triggers of CLTS.

Though group involvement is often promoted as a positive way to foster community responsibility, advisory committees were not always successful in sustaining change in the long term. In a follow-up study in Mali one year after a rural water supply project, researchers found that village water committees were ineffective (Parker 1997). Though committees were formed, they fell apart or ceased to function without follow-up. In the only

one of 15 original committees still functioning, the group met to raise funds for maintenance and repair of the water source.

5.3.3 Communication: mass media and public events (n = 5)

Face-to-face communication is reportedly effective in promoting sustained practice, yet it is labour intensive and reaches a limited audience. An alternative to face-to-face communication is providing information through mass media strategies, such as television or radio or during public events like health fairs. Five studies in this review used a combination of interpersonal communication and mass media, while one study (Kullmann and Ahmed 2011) exclusively reported on the influence of mass media.

Mass media was a key component in the Global Scaling Up Handwashing campaign promoted by the Water and Sanitation Programme of the World Bank. In each of the four countries, Peru, Senegal, Tanzania and Vietnam, it was important for each country to develop a shared vision and implementation strategy (O'Brien and Favin 2012). In Senegal, the communications plan had the goal of fortifying intentions to practise handwashing with soap and to use a handwashing station. Using mass media and direct consumer contact, the programme could reach thousands at a time to engage the target audience and refresh their knowledge while interpersonal communication helped to build self-confidence in practising the behaviour (Devine and Koita 2010).

Table 3: Key programme characteristics influencing WASH adoption

Programme characteristics			
Determinant category	**Why this is important**	**Key findings**	**How this can be used**
Communication strategies	• Communication and education provide participants with ways to learn about and troubleshoot WASH technologies • Can incorporate key behavioural factors (above under research question 1)	• Interpersonal communication was strongly linked to better recall and continued WASH practices • Mass media events and group communication are also represented in the literature	• To inform programme planning and intervention design • To identify key communication channels to effect sustained behaviour change

5.4   Summary of results of synthesis

- **Research Question 1: measuring sustained WASH adoption outcomes**

  o Twenty-one of the 44 studies were sustained adoption studies that assessed WASH practices at least six months or more after the end of a study's project period. Due to the heterogeneity of the outcome definitions, measurement methodologies and comparisons made, WASH use trends over time appear variable.

  o Post-intervention sustainability is often measured by a combination of survey, interview and observation. There is no clear definition for sustained adoption

employed in WASH literature, and sustained adoption is measured through self-report, observed practice, functionality and recalled knowledge.

- **Research Question 1: behavioural factors that influence sustained adoption:**

    o Psychosocial factors (n=36): perceived susceptibility and severity of disease and perceived benefits and barriers are common psychosocial factors reported to affect sustained adoption. However, some other psychosocial factors, such as injunctive and descriptive norms and nurture, may be more predictive as motivators to continue behaviours over time.
    o Contextual factors (n=29): these factors are often included in the study design. Age and gender are important factors influencing both who is able to practice the behaviour at the household level, as well as indicating roles in providing water, soap and childcare.
    o Technology factors (n=33): cost is an important factor, no matter what type of technology is in question. However, some factors, like durability, rate of water flow and maintenance are key factors in ensuring that technologies withstand frequent use over a long period.

- **Research Question 2: programmes that assess sustainability:**

Fourteen studies evaluated characteristics important to sustained adoption. Evidence from this review suggests that the most influential programme factors associated with sustainability include frequent, personal contact with a health promoter and accountability over a period of time. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

6. Implications

In this section, we discuss the main findings of our review as well as the strengths and limitations of our methodology. We then discuss the larger implications for policies and programmes to promote WASH technologies and behaviours. The findings of this review imply a need for direction and leadership in guiding the research agenda on sustained adoption of WASH technologies. We discuss the steps necessary in examining sustained adoption, including establishing intentions, planning and funding assessments of long-term behaviour change; executing robust interventions that clearly define intervention activities and metrics for assessment; and interpreting and disseminating these findings.

6.1 Key findings of our review

Our review aimed to answer two research questions:

1. What are the factors that influence the sustained adoption of clean water and sanitation technologies, including definitions of sustained adoption and behavioural factors?

2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies, and how successful are these interventions at fostering adoption and sustained adoption?

We describe the findings of these questions in more detail in this section.

6.1.1 Measuring sustained adoption

In our analysis of outcome measurement methodologies in a subset of articles assessing WASH practices after a project period has ended, we found that there is an extremely diverse array of operational definitions of sustained adoption. This poses difficulties in making overarching conclusions about WASH use as there are currently no standard measurement methodologies or definitions of WASH practice. Also, only five of 21 studies of sustained use (according to our definition[1]) provided reference data from the end-point of the project period, limiting our ability to determine what overall trends in adoption were from the end of the project period to the time of the study's assessment.

Most behaviour change models only describe or examine initial adoption. They do not make allowances for, or provide a framework for sustained adoption. We identified two articles that provide a framework for examining sustained adoption: Mosler (2012) and Wood *et al.* (2012). The Mosler article presents a framework for effecting behaviour change, and also provides an 'eight step protocol' for changing behaviour (pp. 443–45), where they briefly discuss the timing of evaluations and definitions to assess sustained adoption. Ideally, measurements should be made '6–12 months after the last intervention to assess sustainable change' (p. 445). The Wood article presents a behaviour change framework adapted from PATH, and describes three broad stages: awareness, action and maintenance. This framework is one of the few frameworks to our knowledge that makes distinctions between initial and sustained adoption, and the factors or other considerations that are influential at these stages. This shift is central to the idea of sustained behaviour change and should be a focus moving forward.

6.1.2 Behavioural factors influencing sustained adoption: psychosocial, contextual and technology

Using the IBM-WASH model as a framework, we found that individual psychosocial factors such as knowledge of a practice or ability to perform the behaviour, perceived health benefits, or perceived severity of a WASH-preventable disease, were predominant in the literature. Social norms were also commonly reported to influence an individual's practice of a WASH behaviour, particularly with latrine use. Psychosocial factors are often both core targets of a programme's behaviour change component, as well as key indicators used in assessing project effectiveness. A better understanding of these factors can contribute to improved implementation and monitoring of WASH behaviour change.

Individuals, however, do not perform WASH practices in a vacuum: many studies assessed found the greater context around an individual to be highly influential to their practice. Higher household level of education and income were frequently positively associated with WASH behaviour practice. Age and gender were also important factors: women are frequently targets of campaigns (O'Brien and Favin 2012), and age may determine the ability to physically use certain WASH technologies.

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[1] The continued practice of a WASH behaviour and/or continued use of a WASH technology at least six months after the end of the project period.

Cost was cited by 27 of 33 studies assessed as a critical influence of WASH behaviour practice. This includes both the initial cost of the technology, as well as the cost to maintain the technology over time and repeated use. If technologies are too expensive, no level of psychosocial motivation will be enough for adoption and sustained use. Maintenance and durability were also important technological factors, indicating areas where new, user-friendly designs and materials could improve sustained WASH use.

6.1.3 Programme and intervention characteristics influencing sustained adoption

Interpersonal communication was utilised in all 14 studies assessed for programme or intervention characteristics influencing sustained adoption. One-on-one interactions, typically between a health worker or volunteer and the participant, were favoured by all studies. Communication strategies reaching a wider audience, such as group meetings or mass media, were employed by a smaller number of studies and were better suited to provide information or refresh knowledge. These findings suggest interventions to promote sustained adoption would benefit by including both forms of communication.

6.2 Setting an agenda for policy, programming and research

Commitment to sustained adoption at the donor and institutional levels is essential to building the evidence base for the benefits of sustained adoption. This review is intended to help inform policy in the following ways:

- **Focus on the long term:** the success of WASH programmes resides in the formation of habits, which may require additional time or resource commitments beyond the current short-term funding and programming cycles.
- **Set an intention to support WASH programming:** in order to promote and study sustained adoption of WASH practices, it is essential to create a supportive environment for examining sustained adoption. The first step is to develop the intention to fund and design programmes that facilitate long-term use and measure sustained adoption among policymakers, donors, programmers and intervention recipients.
- **Fund post-intervention evaluation:** though sustained adoption is the goal of many WASH programmes, follow-up studies or post-implementation evaluations are few and far between. Funders should consider post-intervention follow-up as a key aspect of successful programmes and provide funding mechanisms to ensure long-term follow-up.

6.3 Designing more effective interventions and programmes

A well-planned intervention is crucial to the success of any WASH promotion programme. Using evidence-based technologies and promotion strategies as well as including plans for post-intervention evaluations with relevant metrics will strengthen the rigour and consistency of WASH promotion studies. Groups undertaking sustained adoption should note the following key points:

- **Set definitions and indicators for sustained adoption:** we do not suggest that there should be standard definitions for what sustained adoption of WASH technologies is; each project context is unique and differences in ways various

groups perceive and perform WASH behaviours should be considered in overall intervention design. Rather, more discussion is essential to understanding, measuring and ultimately achieving sustained WASH practices across the world. Using clearly defined indicators is essential to comparing study outcomes across locations and methodologies.

- **Establish common measurement methodologies:** consistent measurements allow for comparisons across multiple study types and groups. Additional details on how interventions were conducted and evaluated can increase transparency and replication of study designs in different locations.
- **Emphasise habit formation from the start:** many studies have elaborated on the factors influencing initial adoption of WASH behaviours, but projects should plan to adapt their strategies as motivations change throughout the course of the project and post-project periods.
- **Consider context:** in addition to basic demographic information, intervention design should incorporate factors of the local environment, roles and responsibilities within households, working patterns, climate and seasonality, and governmental and institutional support.
- **Use technologies that are feasible and acceptable for long-term use:** a user-centred design approach ensures that specific recommendations of the users themselves are incorporated into the design. Pilot testing and qualitative feedback are helpful in identifying factors that facilitate or discourage use of technologies.

6.4 Conclusion

The success of WASH schemes worldwide depends on daily practices and long-term commitment, in conjunction with appropriately usable and durable technologies. This review begins the conversation on factors that motivate sustained adoption of WASH technologies, and provides a platform from which to guide further research in behaviour change and post-intervention sustainability.

More emphasis needs to be placed on defining sustainability and translating these definitions into metrics and programme elements that can be used to implement, evaluate and further the discussion on sustained WASH adoption. Programmes and technologies need to be designed to be supportive and flexible to motivators of both initial and long-term WASH practice. Funding mechanisms need to emphasise the importance of routine monitoring and evaluation, and be willing to invest in longer-term behaviour maintenance. Finally, policies and regulations need to be established at the governmental and intergovernmental levels that support the right to safe water, hygiene and improved sanitation for all people globally.

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Subset of studies included in mapping and synthesis*

*This represents only studies cited in the body of this report. A full list of studies included in the mapping and synthesis can be found in Section 6.1 of the full systematic review.

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Appendix A

Authorship of this report

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- We also acknowledge the work of Nina Martin, Andrew Andrada, Meg Glancey, for their participation in data collection and management as well as colleagues at icddr,b for administrative support of our collaboration.

Conflicts of interest

- The authors declare no conflicts of interest.

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Additional details on study methodology
A detailed description of our methodology can be found in Chapter Two of the corresponding technical report. A copy of our detailed protocol can be found at EPPI-Centre, at: http://eppi.ioe.ac.uk/cms/LinkClick.aspx?fileticket=vOKINfcxVWU%3d&tabid=3174. Briefly, we will provide information on sources of articles, a description of the screening process, inclusion criteria and a summary of articles included.

Sources of information searched

We were searching for articles and reports on sustained adoption of WASH technologies in L&MICs. Therefore, we employed a three-part search term using Boolean indicators to find WASH literature from L&MICs that also included a behaviour change component to encompass the three concepts related to our research questions:

- **Concept 1 – WASH technologies:** includes terms for water treatment, sanitation and hygiene. To reduce the number of non-relevant results, concept 1 consists of two parts:
  - Concept 1A refers to stand-alone terms included in our search.
  - Concept 1B consists of terms that are combined with water and hygiene terms using the Boolean indicator 'AND'.
- **Concept 2 – behaviour/sustained adoption**: includes terms reflecting sustained adoption of a behaviour/use of a technology, behaviour change and adherence.
- **Concept 3 –L&MIC:** because we are specifically interested in determining successful interventions in countries with low existing rates of clean water, sanitation and hygiene, the included terms and countries limit our search to L&MIC only.

With guidance from a team of informationists (Davidoff and Florance 2000; Plutchak 2000) from the medical and public health library divisions at Johns Hopkins University and feedback from our review advisory panel, we selected a number of databases to retrieve relevant literature. This method was intended to capture the range of disciplines represented in the field of WASH. Our database search strategy included articles published in the following databases:

Africabib
Anthropology Plus
Bioline
Development in Practice
Embase
Environmental Science and Technology
Global Health – OVID
Global Health – WHO (including LILACS and REPIDISCA)
IBSS
International Journal of Water Governance
JOLIS
Journal of Applied Phytotechnology in Environmental Sanitation
Journal of Applied Sciences in Environmental Sanitation

Journal of Applied Technology in Environmental Sanitation
Journal of Water Reuse and Desalination
JSTOR
PsychInfo
PubMed
Scopus
Sustainable Sanitation Practice
Water Practice & Technology
Water Utility Management International
Waterlines
Web of Science

Table A1 lists the sources for grey literature searched.

Table A1: Grey literature databases

Grey literature source	Website
USAID Development Experience Clearinghouse and programme evaluations	DEC: https://dec.usaid.gov/dec/home/Default.aspx Project evaluation: http://www.usaid.gov/results-and-data/progress-data/evaluations
OECD	http://www.oecd-ilibrary.org/search/advanced;jsessionid=6mrj8k0ic8vbg.x-oecd-live-01
DFID R4D	http://www.dfid.gov.uk/R4D/Search/SearchResearchDatabase.aspx
World Bank/WSP	http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,menuPK:577938~pagePK:64165265~piPK:64165423~theSitePK:469372,00.html
WaterAid	http://www.wateraid.org/international/what_we_do/documents_and_publications/4939.asp
CARE	http://www.care.org/careswork/searchwork.asp
Water.org	http://www.water.org
IRC International Water and Sanitation Centre	http://www.washdoc.info/page/53887
WHO	http://search.who.int/search?ie=utf8&site=default_collection&lr=lang

Grey literature source	Website
CDC	_en&client=_en&proxystylesheet=_en&output=xml_no_dtd&oe=UTF-8&access=p&entqr=3&ud=1&proxycustom=%3CADVANCED/%3E http://www.cdc.gov/Publications/
Health Management Information Consortium database	http://www.ovid.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=13051&catalogId=13151&langId=-1&partNumber=Prod-99
British Library of Development Studies Catalogue	http://bldscat.ids.ac.uk/
Bangladesh Rural Advancement Committee	http://www.bracresearch.org/
UNICEF	http://www.unicef.org/publications/index_pubs_wes.html
Water Engineering and Development Centre	https://wedc-knowledge.lboro.ac.uk/refine-search.html
NGO FORUM FOR PUBLIC HEALTH	http://www.ngof.org/resources00.php
RDRS Bangladesh	http://www.rdrsbangla.net/Page.php?pageId=MzgwNzM=
WSP	http://www.wsp.org/library
ELDIS	http://www.eldis.org/
icddr,b	Personal communication

The searches of databases containing peer reviewed literature were completed by 1 October 2013.

Summary of review stages

The timeline of our review proceeded as follows:

- Stage 1: Identification and screening
  - o Developing the protocol and search strategy
  - o Identifying studies: database searches of published articles
  - o Identifying studies: grey literature searches
  - o Quality control procedures
  - o Defining relevant studies for this review
- Stage 2: Mapping and keywording
  - o Extracting data from studies to describe the landscape of available research on adoption and sustained adoption of WASH
- Stage 3: In-depth review and synthesis
  - o Selection of articles for in-depth synthesis and sub-syntheses
  - o Making comparisons and drawing conclusions on factors that affect sustained adoption of WASH technologies and behaviours based on the available literature
- Stage 4: Implications and reporting
  - o Exploring applications of findings to public health, from scientific knowledge to policy and planning

Inclusion criteria: title and abstract screening

Inclusion criteria (in the order listed below) were applied to the titles and abstracts of the entire pool of articles obtained from our searches of peer-reviewed publications and grey literature, and journal hand searches. This was to exclude any articles obviously not related to our study questions. Criteria were applied sequentially: if an article satisfied the first inclusion criteria (WASH topical focus), then it was evaluated for population and study scope. This process was repeated until the article was either included or failed to meet inclusion criteria. Articles could be marked for failing to meet multiple exclusion criteria (for example, a systematic review of a national WASH programme). We noted these as they were of potential interest for sub-syntheses.

We included studies from the peer-reviewed and grey literature that met the following specifications:

1) **WASH focus**: topical focus is on WASH interventions and associated WASH behaviours. This includes any report, study or document that reviews any combination of WASH technologies (water treatment, harvesting, and hygiene or sanitation technology), implementation and behaviour change methods.
2) **Population and study scope**: target population is users of WASH technologies at the individual, household or community level.
3) **Date**: published since 1990. Given that WASH policies and programming are tied to the Millennium Development Goals, this criterion ensures that research reflects relevant and contemporary WASH strategies.
4) **Geographical location**: studies are conducted in L&MICs. For a complete list, please see part three of our search strategy (Appendix 2.1 in the full systematic review provides the search term for L&MIC countries).
5) **Outcomes**: must report on behavioural outcomes associated with a specific WASH technology, and at least one of the following:
   a. knowledge, attitudes or beliefs (that is, 'views') of primary users of specific WASH technologies;
   b. specific individual/population characteristics (socio-demographic, behavioural or psychological) associated with use or adoption of specific WASH technologies; or
   c. Outcome and/or process evaluations of interventions that include behavioural outcomes of adoption or sustained adoption of WASH technologies either as an end-goal or as part of a larger health or development impact study.
6) **Language**: must be published in English, French, Spanish or Portuguese.
7) **Types of data reported**: must report on primary data (not an in-depth case study of an individual).

Exclusion criteria: full-text screening

Exclusion criteria were applied to full reports of articles whose titles and/or abstracts did not provide sufficient information to judge whether inclusion was warranted. Exclusion criteria were (in order of application):

1) **WASH focus**:
    i. not about a WASH intervention, WASH behaviours and/or WASH behaviour change.
    ii. study focuses on vector control or oviposition (for example: Seng, CM *et al.* 2008. Community-based use of the larvivorous fish *Poecilia reticulata* to control the dengue vector *Aedes aegypti* in domestic water storage containers in rural Cambodia. *Journal of Vector Ecology*, 33[1], pp.139–44.)
2) **Population and study scope**: study conducted in a health facility, school, daycare centre, restaurant or other public or private sector institutional setting and/or primarily focused on the behaviours of healthcare workers, teachers or other employees of an institution or business.
3) **Date**: study published before 1990.
4) **Geographical location**: study not conducted in a low- or middle-income country (see Appendix 2.1 in the the full systematic review.
5) **Outcomes**: (i) does not report on behavioural outcomes associated with a specific WASH technology (for example, reports of microbial efficacy of WASH technologies), or (ii) reports on behavioural outcomes but does not report on at least one of the following:
    i. knowledge, attitudes or beliefs (that is, 'views') of primary users of specific WASH technologies;
    ii. specific individual/population characteristics (socio-demographic, behavioural or psychological) associated with use or adoption of specific WASH technologies; or
    iii. outcome and/or process evaluations of interventions that included behavioural outcomes of adoption or sustained adoption of WASH technologies either as an end-goal or as part of a larger health or development impact study.
6) **Language**: study published in a language other than English, French, Spanish or Portuguese.
7) **Types of data reported**:
    i. study does not report on primary data (such as editorials, policy documents, review articles);
    ii. study is an in-depth case study of a single individual.

Summary of included studies

Table A2: Studies assessing more than one WASH technology

Handwashing and water treatment	11	Whiteford *et al.*, 1996; Bolt *et al.*, 2003; Bendahmane, 2004; Parker *et al.,* 2006; Academy for Educational Development Inc, 2007; Unicef, 2008; Arnold *et al.*, 2009; Abt Associates Inc, 2010; Sijbesma *et al.*, 2011a; Bowen *et al.*, 2013
Handwashing and sanitation	23	Whiteford *et al.*, 1996; Bolt *et al.*, 2003; Bendahmane 2004; Cairncross and Shordt 2004; SEUF, 2004; Shordt and Cairncross 2004; Torres 2004; Cairncross *et al.*, 2005; Shordt 2005; Choudhury and Hossain 2006; Development Alternatives Inc., 2006b; Academy for Educational

		Development Inc, 2007; Govindan, 2007; Kamal and Kumar, 2007;Unicef, 2008; Wicken *et al.*, 2008; Akter *et al.*, 2011; Sijbesma *et al.*, 2011a; Whaley and Webster 2011; Kapur, 2012; Beyene and Hailu, 2013
Water treatment and sanitation	10	Bahardjo and O'Brien 1994; Niewoehner and Afonso, 1995; Whiteford *et al.*, 1996; Bolt *et al.*, 2003; Bendahmane, 2004; Academy for Educational Development Inc, 2007; Unicef, 2008; Fuchs and Mihelcic, 2011; Sijbesma *et al.*, 2011a;
ALL 3	7	Whiteford *et al.*, 1996; Bolt *et al.*, 2003; Bendahmane, 2004; Academy for Educational Development Inc, 2007; Unicef, 2008; Sijbesma *et al.*, 2011a;

The following studies were included for in-depth review. In total there were 44 unique studies; note that seven studies assessed more than one type of WASH technology.

Table A3: Studies selected for in-depth synthesis and review

Handwashing (n=12)	Water treatment (n=23)	Sanitation (n=16)
Studies assessing only handwashing: Wilson and Chandler, 1993 Shordt and Cairncross, 2004 Devine and Koita, 2010 O'Brien and Favin, 2012 Bowen *et al.*, 2013 **Studies assessing handwashing + other WASH interventions:** SEUF, 2004 Cairncross and Shordt, 2004 Cairncross *et al.*, 2005 Parker *et al.*, 2006 Arnold *et al.*, 2009 Whaley and Webster, 2011 Eder *et al.,* 2012	**Studies assessing only water treatment:** Parker, 1997 Hoque *et al.*, 2004 Brown *et al.*, 2007 Ngai *et al.*, 2007 Altherr *et al.*, 2008 Brown *et al.*, 2009 Tamas *et al.*, 2009 DuBois *et al.*, 2010 Aiken *et al.*, 2011 Christen *et al.*, 2011 Kraemer and Mosler, 2011 Mosler and Kraemer, 2012 Mosler *et al.*, 2013 Tamas and Mosler, 2011 Casanova *et al.*, 2012 Freeman *et al.*, 2012 Kraemer and Mosler, 2012 Peletz *et al.*, 2012 Wood *et al.*, 2012 Inauen *et al.*, 2013 Wheeler and Agha, 2013 **Studies assessing water treatment + other WASH interventions:** Parker *et al.*, 2006 Arnold *et al.*, 2009	**Studies assessing only sanitation:** Simms *et al.*, 2005 Waterkeyn and Cairncross, 2005 Choudhury and Hossain, 2006 Diallo *et al.*, 2007 Qutub *et al.*, 2008 Roma *et al.*, 2010 Devine and Sijbesma, 2011 Kullman and Ahmed, 2011 Ross *et al.*, 2011 Malebo, 2012 Barnard *et al.*, 2013 **Studies assessing sanitation + other WASH interventions:** SEUF, 2004 Cairncross and Shordt, 2004 Cairncross *et al.*, 2005 Whaley and Webster, 2011 Eder *et al.*, 2012

Limitations of study methodology

The studies identified in this review represent a diverse range of programmatic designs, outcome definitions, and measurement methodologies, as well as the level of detail provided on all these steps. This heterogeneity makes it extremely difficult to make conclusions about sustained WASH adoption, as there is no standardised outcome or reporting format. To address this issue of diverse definitions of sustainability and sustained WASH behaviour practice, we used a flexible, mixed methods review methodology (Harden and Thomas 2005). The general methodological quality of many studies leaves much to be desired.

In our review of the evidence base for sustained adoption of WASH practices, we selected only articles that directly report on sustained adoption of WASH technologies over several months or years. Though sustained adoption was a specific priority for this review, there is substantial evidence published on factors influencing behaviour change over much shorter periods of time – weeks to months – that may relate to factors of sustained adoption. The mapping section of this review provides detailed summaries of the available literature, and should be considered in research and practice on this topic.

We recognise that information available to us in reports and published literature is limited to the priorities of the research groups, funding agencies and implementing organisation. Assessments may have been made of factors associated with sustained adoption, but presentation of these factors has not been included in the final published reports. Likewise, institutional knowledge gained from long-term implementation projects may show evidence of sustained adoption that is not available in accessible, published form.

Table A4: The integrated behavioural model for WASH

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

Publications in the 3ie Systematic Review Series

The following reviews are available at
http://www.3ieimpact.org/evidence-hub/systematic-review-repository

Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries, 3ie Systematic Review 1. Waddington, H, Snilstveit, B, White, H and Fewtrell, L (2009)

Interventions to promote social cohesion in Sub-Saharan Africa, 3ie Systematic Review 2. King, E, Samii, C and Snilstveit, B (2010)

Community-based intervention packages for reducing maternal morbidity and mortality and improving neonatal outcomes, 3ie Systematic Review 5. Lassi, ZS, Haider, BA and Langou, GD (2011)

Willingness to pay for cleaner water in less developed countries: systematic review of experimental evidence, 3ie Systematic Review 6. Null, C, Hombrados, JG, Kremer, M, Meeks, R, Miguel, E and Zwane, AP (2012)

The impact of daycare programs on child health, nutrition and development in developing countries, 3ie Systematic Review 7. Leroy, JL, Gadsden, P and Guijarro, M (2011)

Behaviour change interventions to prevent HIV among women living in low and middle income countries, 3ie Systematic Review 8. McCoy, S, Kangwende, RA and Padian, NS (2009)

Interventions to reduce the prevalence of female genital mutilation/cutting in African countries, 3ie Systematic Review 9. Berg, RC and Denision, E (2013)

The impact of export processing zones on employment, wages and labour conditions in developing countries, 3ie Systematic Review 10. Cirera, X and Lakshman, R (2014)

Farmer field schools: from agricultural extension to adult education, 3ie Systematic Review Summary 1. Waddington, H and White, H (2014)

Why targeting matters: examining the relationship between selection, participation and outcomes in farmer field school programmes, 3ie Systematic Review 11. Phillips, D, Waddington, H and White, H (2015)

What factors affect sustained adoption of safe water, hygiene and sanitation technologies? 3ie Systematic Review Summary 2. Hulland, K, Martin, N, Dreibelbis, R, DeBruicker, V and Winch, P (2015)

Safe water, sanitation and hygiene (WASH) behaviours, such as treating drinking water, washing hands at key times or using a latrine rather than defecating in open spaces, are cornerstones of building strong, healthy communities and reducing mortality due to diarrhoea and other preventable diseases. Many studies have shown the health benefits of WASH, and factors that affect initial adoption of short-term WASH use. Few have assessed the determinants of long-term, sustained WASH practice. Drawing on a full systematic review, this summary reviews the evidence on factors that motivate sustained adoption of WASH technologies.

The authors found that individual psychosocial factors, such as perceived benefit and self-efficacy, as well as interpersonal factors like social norms, strongly affect continued WASH behaviours.

Age and gender were strong determinants of continued WASH practice, particularly in latrine use and handwashing practice. An individual's broader context was also found to be highly influential. Cost and durability were the two most important factors related to technology. Influential programme factors associated with sustainability include frequent, personal contact with a health promoter and sustained accountability. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

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