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Systematic review: handwashing behaviour in low- to middle-income countries: outcome measures and behaviour maintenance

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Summary

OBJECTIVES To describe global approaches to handwashing research in low- and middle-income communities, schools and health care settings using behavioural outcome measurement and temporal study design.

METHODS Peer-reviewed and grey literature was screened for handwashing studies that evaluated behaviour change. Relevant articles were assessed by their research approach, including the investigator's selected outcome measure and time frame of various study components (e.g., formative research, intervention and evaluation).

RESULTS The initial search yielded 527 relevant articles. After application of exclusion criteria, we identified 27 unique studies (30 total articles). Of the 27 articles, most were focused in the community setting. Fifteen (56%) documented observed handwashing behaviour, while 18 (67%) used proxy measures (e.g., soap presence, diarrhoea) and 14 (52%) used self-reported behaviour. Several studies used multiple outcome measures. While all studies had an evaluation of behaviour change, there was a dearth of studies that evaluated long-term maintenance of behaviour change after the intervention's conclusion.

CONCLUSIONS While the literature is replete with a variety of handwashing studies in community, school and health care settings, none have been able to definitively document long-term behaviour change, thereby challenging the sustainability of various interventions. Additionally, there is a need to better understand which research approach is most effective in promoting long-term behaviour compliance in global low- and middle-income settings.

Keywords handwashing, behaviour, developing countries, programme sustainability, outcome measures

Introduction

Prevention and control of infectious disease transmission is an imposing challenge worldwide (Curtis & Cairncross 2003a). Numerous studies have established an association between rigorous infection control programmes and reduction in disease transmission (Haley *et al.* 1980), yet adoption of best practices has been far from universal (Curtis & Cairncross 2003b). Infection control in low- and middle-income countries (LMIC) can be particularly demanding because of poor hygiene and sanitation, lack of basic resources and personnel, and gaps in knowledge (Allegranzi & Pittet 2007; Raza *et al.* 2004). To address

these barriers, public health efforts need to focus on simple, sustainable solutions that can work in settings with limited resources (Luby 2001). Handwashing is a simple, low-cost method for preventing diarrhoeal and respiratory illnesses with demonstrated efficacy in both community and institutional settings (Luby *et al.* 2005). However, notwithstanding numerous studies documenting the efficacy of hand hygiene in reducing these diseases, implementing proper handwashing practices has been challenging and sustainability of results inconsistent (Luby 2001).

Handwashing adherence depends upon complex behavioural considerations that are poorly understood (Curtis & Cairncross 2003b; Jenner *et al.* 2002; O'Boyle

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et al. 2001; Trunnell & White 2005; Whitby *et al.* 2007). A recent review of community-based hand hygiene literature specific to diarrhoea risk confirmed the need for further research on understanding behavioural motivators for promoting handwashing within at-risk communities (Curtis & Cairncross 2003b). Despite this recognition, the extent to which behavioural interventions can improve adoption of handwashing practices in settings with limited resources is largely unknown.

In addition to understanding the efficacy of specific interventions, improving the evidence base for 'what works' in handwashing adherence in LMIC also involves examining the research approach to handwashing promotion, including an intervention's outcome measurement and temporal study design. This paper focuses upon this aspect with regard to studies undertaken in low- and middle-income communities, schools and health care settings. It also looks at each intervention's impact with regard to long-term behaviour change. The intent of this review is to describe the global handwashing literature, identify gaps and offer recommendations for future research in this area.

Methods

Search strategy

We searched titles and abstracts from all potentially relevant articles found in Ovid, Medline, PsycINFO, the Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases using the key search terms identified in Box 1. Grey literature was also searched as described in Box 1. We also searched references cited in reviewed papers and contacted experts in the field.

Box 1 Search strategy

We systematically searched Ovid Medline (1950 to August week 2, 2009), PsycINFO (1806 to August week 2, 2009), Cumulative Index to Nursing and Allied Health Literature (CINAHL) (1982 to August week 2, 2009) databases using the following search terms:

'hygiene' or 'hand hygiene' or 'handwashing' or 'hand washing' or 'hand-washing'

AND

'behaviour change' or 'behavior change' or 'behavior' or 'behaviour' or 'behaviors' or 'behaviours' or 'community mobilization' or 'community mobilization' or 'social marketing' or 'motivational interviewing' or 'role modelling' or 'adoption' or 'observation'

Additional key words identified by CINAHL were searched with the top 500 relevant articles reviewed.

To assess grey literature, the following sources were utilized using the search terms 'handwashing', 'hand hygiene', 'hygiene' AND 'behavior', 'hygiene AND behaviour' through August 2009

Cochrane Library including Cochrane reviews, clinical trials, technology assessments, economic evaluations, methods studies

Computer Retrieval of Information on Scientific Projects (CRISP)

OAIster

Open System for Information on Grey Literature in Europe (Open SIGLE)

PAHO publications

World Health Organization publications

Inclusion/exclusion criteria

We restricted our search to studies conducted in countries classified as low- or medium-income according to the Human Development Index categories (United Nations Human Development Report 2008) and only reviewed manuscripts that explicitly evaluated the impact of behaviour in hand hygiene interventions. Examples of hand hygiene intervention papers that did not meet our inclusion criteria were knowledge, attitude and practice surveys that lacked a behavioural intervention, research methodology manuscripts, editorials, observational studies of behaviours with no intervention, formative research with no intervention and economic analyses. Of the papers identified, we abstracted summary information as described in Table 1.

Approach

Our review assessed measurement of handwashing adherence and temporal study design. Regarding handwashing adherence, we categorized each study's outcome measures into self-report, proxy indicator(s) and/or direct observation. We define 'direct observation' as occurring when the investigators witness individuals in the process of handwashing as opposed to observing a target population demonstrating knowledge of handwashing practices. With regard to temporal study design, we describe the length of formative research, intervention and evaluation for each paper. We subsequently calculated the mean length of time for each stage of research design. In cases where the time frame was considered to be <1 month, 4 weeks were used to calculate the length. Studies without a defined time frame were excluded from the calculation.

Table 1 Summary of abstracted handwashing papers

	Study characteristics			Outcome measures			
	Authors	Study type	Intervention/ comparison group	Baseline	Proxy	Self-report	Observation
Community setting	Ahmed <i>et al.</i> 1993/Ahmed & Zeitlin 1994	Quantitative	X	X	Diarrhoea, weight for age, cleanliness of hands	X	
	Bajracharya 2003	Quantitative		X		X	
	Cairncross <i>et al.</i> 2005	Quantitative		X			X
	Curtis <i>et al.</i> 2001	Quantitative	X	X	Diarrhoea	X	X
	Haggerty <i>et al.</i> 1994	Quantitative		X		X	X
	Jagals <i>et al.</i> 2004	Quantitative		X		X	X
	Luby <i>et al.</i> 2009	Quantitative	X	X	Diarrhoea, soap purchasing, presence of handwashing facilities	X	X
	Metwally <i>et al.</i> 2007	Mixed		X			X
	Pinfold & Horan 1996/Pinfold 1999	Quantitative/Qualitative Mixed	X	X	Fingertip contamination, diarrhoea	X	
	Rajapaksa 2003	Quantitative		X	Diarrhoea, weight changes	X	
School setting	Rhee <i>et al.</i> 2008	Quantitative		X	Mortality	X	
	Schneider <i>et al.</i> 2009	Quantitative		X		X	
	Scott <i>et al.</i> 2008	Mixed	X	X		X	
	Stanton & Clemens 1987	Quantitative/Qualitative		X			X
	Waterkeyn & Cairncross 2005	Quantitative Mixed	X	X	Diarrhoea Presence of handwashing facilities	X	X
	Wilson <i>et al.</i> 1991/Wilson & Chandler 1993	Quantitative/Qualitative Mixed	X	X	Diarrhoea, soap presence	X	
	Bowen <i>et al.</i> 2007	Quantitative	X		Absenteeism, illness symptoms		
	Dongre <i>et al.</i> 2007	Mixed			Cut/clean nails		X
	O'Reilly <i>et al.</i> 2006	Quantitative/Qualitative Quantitative		X	Absenteeism, handwashing demonstration	X	
	Onyango-Ouma <i>et al.</i> 2005	Quantitative		X	Presence of handwashing facilities	X	X

Table 1 Continued

Health care setting	Authors	Study characteristics			Outcome measures		
		Study type	Intervention/ comparison group	Baseline	Proxy	Self-report	Observation
Health care setting	Brown <i>et al.</i> 2003	Quantitative		X	Nosocomial infections		X
	Cortez & Berroa 2008	Quantitative			Nosocomial infections		X
	Duerink <i>et al.</i> 2006	Quantitative	X	X			X
	Moongrui <i>et al.</i> 2000	Quantitative	X	X			X
	Nguyen <i>et al.</i> 2008	Quantitative		X	Nosocomial infections, microbiological samples, hospital stay length		X
	Parker <i>et al.</i> 2006	Quantitative			Soap presence	X	
	Samuel <i>et al.</i> 2005	Mixed Quantitative/Qualitative		X	Soap presence		X

Results

Our initial search yielded 527 relevant articles in addition to grey literature documents. After removal of duplicative articles and application of exclusion criteria, 30 (5.7%) studies remained. Nineteen (63%) papers described interventions in community settings, 4 (13%) described interventions in school settings, and 7 (23%) described interventions in health care settings (Figure 1). Three researchers (Ahmed *et al.* 1993; Ahmed & Zeitlin 1994; Pinfold & Horan 1996; Pinfold 1999; Wilson *et al.* 1991; Wilson & Chandler 1993) had a follow-up study related to the original intervention; therefore, we considered the total of unique studies to be 27.

Of the 30 papers reviewed, all described a behavioural strategy as part of the intervention (e.g., health education, social marketing, observational learning through role modelling or a combination of approaches). Nineteen (70%) of the 27 unique studies obtained baseline data before launching their intervention; 10 (37%) used intervention and comparison groups. Twenty (74%) studies used a quantitative study design and 7 (26%) used a mixed quantitative-qualitative design. None of the papers used a purely qualitative design. With regard to documenting outcome measures, 18 (67%) unique studies used proxy measures, such as the presence of soap and/or handwashing facilities in the home, 15 (56%) documented observed handwashing behaviour and 14 (52%) used self-reported behaviour. Some of the studies used more than one type of outcome measure (Table 1). The average intervention length in community settings was 3.5 times longer than in schools and nearly seven times longer than in health care settings.

These studies, which are grouped by setting (i.e., community, school, health care institution), are described by their use of outcome measures and temporal study design. Information regarding each study's characteristics and outcome measures is detailed in Table 1.

Community setting

Outcome measures

Methods for verifying hand hygiene adherence included self-report, assessment of proxy indicators and/or direct observation. Several researchers used a combination of outcome measures as part of their evaluation. Fourteen of the 19 community handwashing papers used self-report to assess behaviour change. Although Cairncross *et al.* (2005) incorporated family pocket voting, whereby individuals within families report handwashing practices by voting on practiced behaviour, we considered this method a variation of self-report. Bajracharya (2003) described findings from a survey aimed at assessing the effectiveness of various

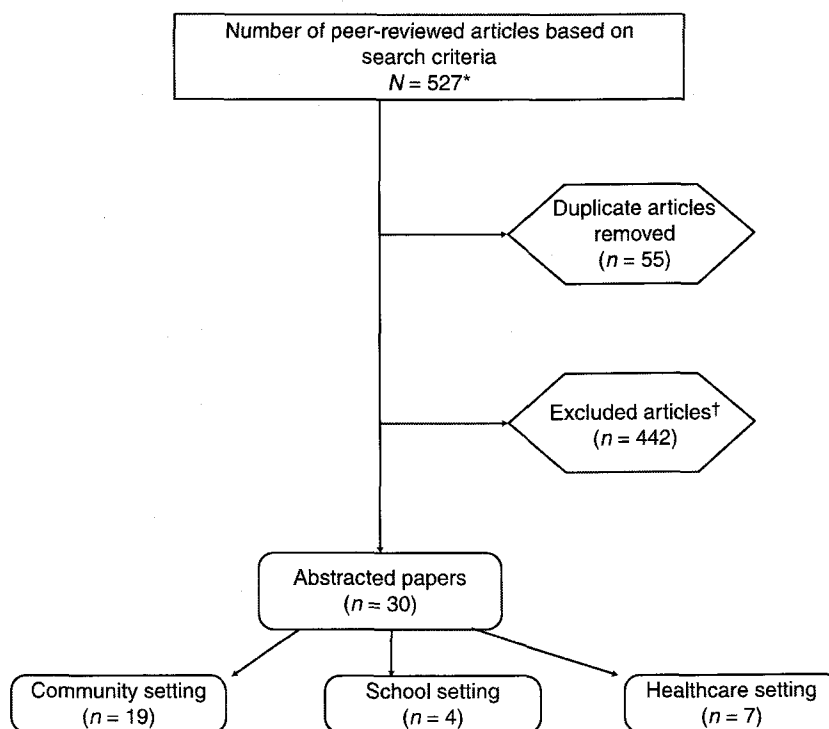


Figure 1 Literature review results. *Total number of articles initially identified is in addition to grey literature. †Excluded articles met the search criteria but did not focus on low- to middle-income countries and/or were not germane to the paper's focus (e.g., obsessive-compulsive disorder-related hand washing). Papers that did not include a behavioural intervention and evaluation were also excluded.

hygiene programme activities in Myanmar; Schneider *et al.* (2009) conducted an HIV risk factor survey in India, which included questions on hand hygiene practices. Scott *et al.* (2008) used a questionnaire during face-to-face interviews in Ghana to assess handwashing behaviour.

Nine authors adopted a proxy measurement for measuring behaviour change. Proxy measures included determining bacterial colony counts from fingertip imprints on agar plates (Pinfold & Horan 1996; Pinfold 1999), observing handwashing facilities within the home (Luby *et al.* 2009; Waterkeyn & Cairncross 2005) and observing cleanliness of children, mothers and play areas (Ahmed *et al.* 1993; Ahmed & Zeitlin 1994). Rhee's investigation (2008), which introduced handwashing interventions to community-based birth attendants, used the proxy measurement of neonatal mortality as an outcome indicator. Several community studies included diarrhoea assessment as part of their evaluation (Table 1). Haggerty *et al.* (1994) conducted a randomized controlled trial encompassing 18 geographically separate village clusters in the Democratic Republic of Congo. A 12-week period of collecting detailed baseline information on diarrhoeal morbidity coupled with structured observations of hygiene practices guided the handwashing messages of the intervention.

Three papers ascertained handwashing behaviour through a series of well-defined, structured direct observations in the home (Curtis *et al.* 2001; Haggerty *et al.* 1994; Metwally *et al.* 2007). Curtis's intervention (2001), which was based on formative research of childhood diarrhoeal disease, was followed by structured observations of young children and their caretakers. Metwally's observation (2007) of handwashing practices followed the launch of a water, environment and sanitation community promotion within four Egyptian districts. His method included monitoring the progress of communities' behaviour change over a 3-year period. During the first phase (year one), baseline surveys provided a benchmark for measurement. The second phase mid-term evaluation survey was conducted at the end of year two. In year three, the final evaluation of community behaviour practices included structured observation based on checklists, which served as the instruments for data collection.

Temporal study design

Of the 16 unique community-based investigations, the average length of formative research was 4.8 months. The average length of community handwashing interventions was 17.2 months, and the average length of evaluation was

9.6 months (Figure 2). Only four of the 16 studies evaluated community maintenance of handwashing behaviour greater than 6 months post-intervention (Cairncross *et al.* 2005; Luby *et al.* 2009; Pinfold 1999; Wilson & Chandler 1993). Of these, Cairncross's assessment (2005) had the longest 'look-back' period. His cross-sectional study in Kerala, India assessed community hygiene behaviour 9 years after a multi-faceted hygiene promotion intervention concluded.

School setting

Outcome measures

Two studies (Bowen *et al.* 2007; O'Reilly *et al.* 2006) of the four school-based interventions assessed programme impact using absentee data. The remaining studies (Dongre *et al.* 2007; Onyango-Ouma *et al.* 2005) relied on qualitative evaluations of student handwashing, observation of home handwashing facilities (Onyango-Ouma *et al.* 2005) and student interviews with home observation (Dongre *et al.* 2007). In O'Reilly's study (2006), Kenyan teachers taught students about handwashing. Students and parents were evaluated 9 months later for self-reported handwashing rates and presence of soap at home. School absenteeism, which in many developing countries is linked to diarrhoeal disease, was a proxy measurement for adherence and compared to absenteeism in neighbouring schools. Household soap ownership increased significantly, student and parent handwashing behaviour increased and absenteeism declined by 35%, although it is unclear whether this change was statistically significant.

Bowen *et al.* (2007) evaluated a school-based handwashing promotion programme among Chinese students. In addition to soap provision and classroom instruction in germ theory and handwashing, some schools also enlisted a student as a handwashing champion to assist peers with handwashing technique and remind them of handwashing opportunities. In-class illness and absence rates were used as proxies. Schools with handwashing champions and a continuous soap supply experienced significantly less student absenteeism.

Onyango-Ouma *et al.* (2005) focused on qualitative reports of student hygiene questionnaires, the presence of handwashing facilities in student homes and structured observations of handwashing. His findings document improved student personal hygiene scores and an increased number of handwashing stations 14 months into the intervention. Both O'Reilly *et al.* (2006) and Onyango-Ouma *et al.* (2005) used quantitative and qualitative methods to measure translation of handwashing knowledge and behaviour to students' households, suggesting that children can be change agents in the home. While

community-focused, Pinfold and Horan (1996) also included a school intervention that emphasized school children as potential influencers in their homes.

Dongre's handwashing intervention (2007) comprised one component of a broad-based, integrated approach to intestinal parasite reduction among school-age children. The research approach included two phases: a formative assessment for hygiene education followed by an intervention phase with health message dissemination and evaluation of school children's hygiene behaviours. Outcome measures included student interviews and home observations.

Temporal study design

Of the four studies documented, Dongre was the only investigator who incorporated formative research as part of the study design; however, a specific timeline was not provided. The average length of school-based handwashing interventions was 4.8 months, and the average length of evaluations was 5 months (Figure 2). None of the four studies conducted a long-term 'look-back' evaluation following the intervention to ascertain whether handwashing practices were maintained. While Bowen *et al.* (2007) began collecting illness and absentee data 7 days after the intervention began and weekly thereafter for a period of 5 months, O'Reilly's 1-month evaluation began immediately upon concluding the intervention. Dongre (2007) and Onyango-Ouma's (2005) evaluation also occurred immediately upon ending the intervention; however, Onyango-Ouma's evaluation lasted over 1 year.

Health care setting

Outcome measures

Six of the seven studies (86%) measured intervention impact through direct observation of health care worker hand hygiene practices (Brown *et al.* 2003; Cortez & Berroa 2008; Duerink *et al.* 2006; Moongtui *et al.* 2000; Nguyen *et al.* 2008; Samuel *et al.* 2005). Four of the health care studies (57%) included the use of alcohol-based hand gel as an essential component to their handwashing promotion intervention (Brown *et al.* 2003; Duerink *et al.* 2006; Nguyen *et al.* 2008; Samuel *et al.* 2005). Three of the studies (43%) relied on provider education (Cortez & Berroa 2008; Parker *et al.* 2006) and a peer feedback programme alone (Moongtui *et al.* 2000).

Several investigators assessed multiple outcome measures. For example, Brown *et al.* (2003) utilized a combination of direct observation and the proxy indicators of nosocomial pathogen colonization plus alcohol-based hand gel and antibiotic usage among health care workers to assess impact. Samuel's study (2005) combined

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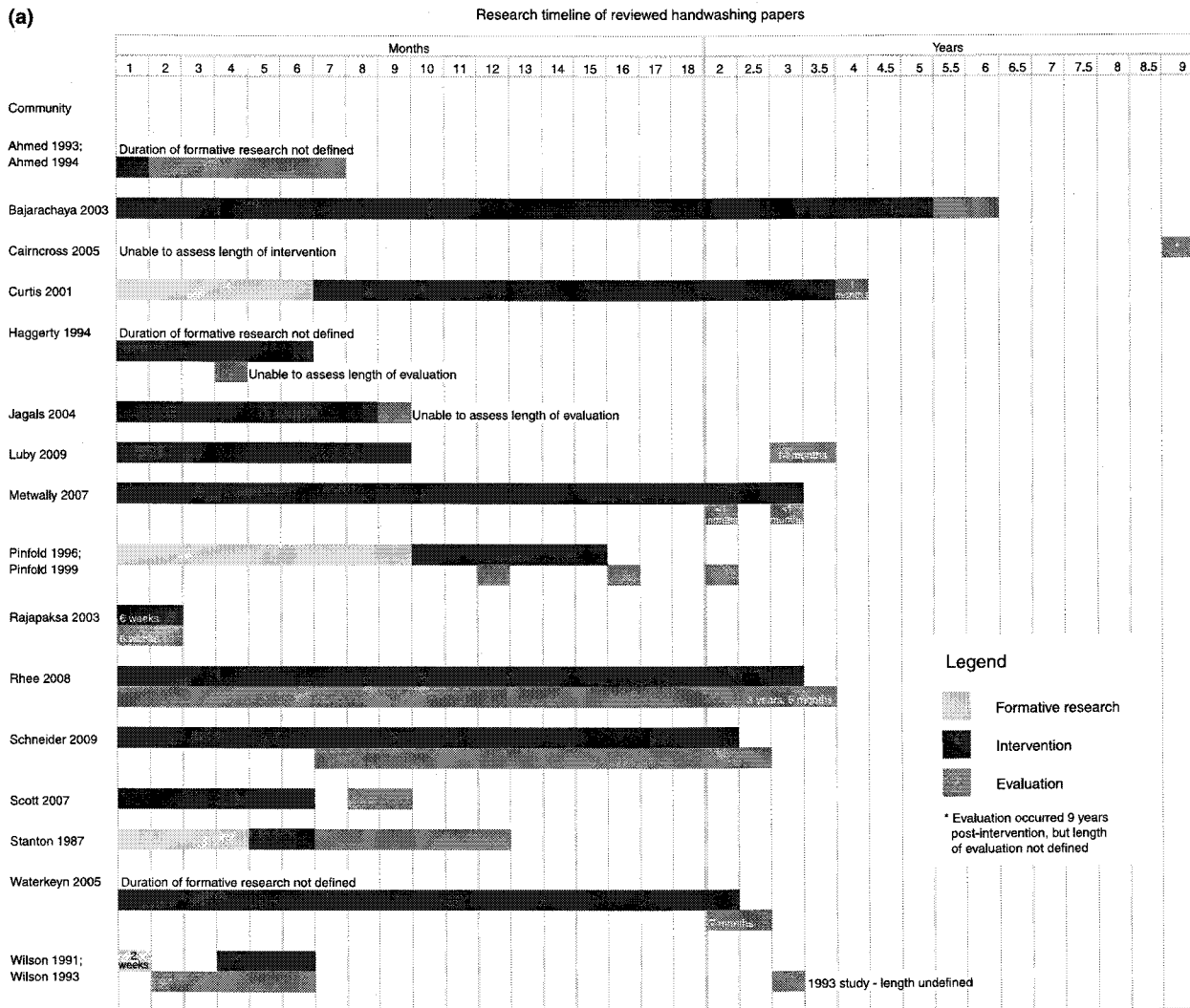


Figure 2 (a) Timeline in community settings. (b) Timelines in schools and health care settings.

observation feedback and a post-test intervention to ascertain increased provider behaviour and knowledge gains. Duerink *et al.* (2006) installed handwashing stations, provided alcohol-based hand gel and conducted a 3-week education course as part of his intervention; his study reported a 31–40% increase in hand hygiene adherence.

One health care study adopted a unique approach to assessing behaviour change and knowledge gains among health care providers (nurses) staffing an outpatient maternal-child health clinic and their patients. Parker *et al.* (2006) used post-tests and self-report to evaluate changes in nursing knowledge and behaviour. She then ascertained changes in patient behaviour and knowledge through self-report and proxy measurement (i.e., presence of soap and hand basins and handwashing demonstrations)

during 2-week follow-up home visitations. Parker *et al.* (2006) revealed that 93% of patient homes had hand soap and wash basins with 44% of patients correctly performing all six handwashing steps and 81% performing four of the six handwashing steps correctly. A random home visit 1 year later revealed that 31% of patients who received handwashing instruction in the maternal-child health clinic correctly performed all six handwashing steps; 98% correctly performed at least four handwashing steps.

Temporal study design

Samuel *et al.* (2005) were the only researchers who included formative research in their approach. The average length of the intervention was 2.5 months, and the average

Discussion

In our review of 527 peer-reviewed manuscripts and grey literature, we found 30 studies that explicitly implemented handwashing interventions followed by assessment of behaviour change in LMIC. Handwashing interventions in these studies targeted communities, schools or health care institutions as pictured in Figure 3. Each setting provides opportunities and challenges for handwashing interventions and evaluation of impact. Community-based studies vary greatly in scope and effectiveness and are uniquely challenging and complex to implement for a variety of reasons including difficulty with objectively assessing behaviour change.

In schools, handwashing interventions have the potential to reach a large, concentrated group of students and encourage appropriate behaviour at a young age. School-based studies in our review demonstrated potential for influencing handwashing behaviour through membership in safe water clubs (O'Reilly *et al.* 2006), peer-to-peer teaching (Bowen *et al.* 2007), classroom sessions with focused training materials (Bowen *et al.* 2007; O'Reilly *et al.* 2006) and role-playing or songs (Onyango-Ouma *et al.* 2005). These studies demonstrate that while teachers can successfully transfer knowledge to students, educated students can also influence family members by sharing this information, which in turn may effect behaviour change at the community level (Onyango-Ouma *et al.* 2005; O'Reilly *et al.* 2006). Related, three community studies also found students played a major role in handwashing education (Curtis *et al.* 2001; Dongre *et al.* 2007; Pinfold 1999).

Health care settings offer a unique opportunity for targeting populations – either health care providers or patients – for behaviour change. The evidence base documents short-term improvement in hand hygiene adherence among health care providers in low- to middle-income health care facilities through peer education (Brown *et al.* 2003; Duerink *et al.* 2006; Parker *et al.* 2006; Santana *et al.* 2007), role modelling (Brown *et al.* 2003; Parker *et al.* 2006) and performance feedback (Duerink *et al.* 2006). Similar to teachers transferring knowledge to their students, Parker *et al.* (2006) demonstrated that nurses can influence handwashing behaviours among patients, who in turn can maintain these behaviours at home. Although reported in only one study, provider influence on patient hand hygiene behaviour merits replication and further assessment because of its potential impact in increasing the adoption of handwashing practices beyond a patient encounter into the community at large. Because Parker's evaluation 1-year post-intervention assessed patient behaviour in the home, there is currently no information as to whether health care provider hand-

washing practices were sustained long after conclusion of the intervention.

Three methods of outcome measurement were characterized in this review: self-report, proxies and direct observation, each with its inherent benefits and limitations. Self-report offers the most risk of bias as there is an abundance of evidence documenting over-reporting of 'correct' behaviours. Stanton *et al.* (1987 *Bulletin WHO*) conducted a study showing that responses to sanitation and hygiene questionnaires did not correlate with observed household practices and therefore should not be surrogates for direct observation. Manun'Ebo *et al.* (1997) similarly found over-reporting of behaviours. Given that self-reported outcome measures are considered so unreliable, we were impressed to discover that 17 of the 30 (57%) studies we reviewed used some element of self-report. The true meaning of these results may be debated; however, as 14 of these 17 studies additionally used either a proxy measure or direct observation, we believe the results may be more meaningful than if they had used self-report alone. For direct observation to be effective, it must be performed by adequately trained observers. The Hawthorne effect can significantly influence evaluation data; therefore, attempts to minimize this effect are critical (Adair 1984). For example, in studies of handwashing and alcohol-based hand gel, there was a 55% increase in compliance among intensive care unit health care workers when there was overt observation (Eckmanns *et al.* 2006; Kohli *et al.* 2009). There may also be variation in behaviour depending on the gender of the known observer (Manun'Ebo *et al.* 1997). Direct observation measurements can also be associated with higher study costs as repeated observations may be necessary to truly characterize intervention effects (Cousens *et al.* 1996). Insofar as using proxy measurements, there is minimal discussion in the literature as to their validity for ascertaining behaviour change. For example, school absenteeism may be related to diarrhoeal disease secondary to poor hand hygiene; however, other factors may also contribute to absenteeism (i.e., other illnesses or outbreaks, transportation issues, weather, etc.). Thus, further assessment of the reliability of this method and development of simple proxy measures is needed.

Of the 30 studies reviewed, nearly every paper reported successful results; however, few were able to demonstrate behaviour change lasting more than 1-year post-intervention. Only four of 30 studies (13%) assessed behaviour maintenance (Cairncross *et al.* 2005; Luby *et al.* 2009; Parker *et al.* 2006; Wilson & Chandler 1993) 1–3 years after the intervention ended. Although one study (Cairncross *et al.* 2005) reported maintenance of handwashing behaviour up to 9 years after a community hygiene promotion intervention, our findings underscore

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the dearth of handwashing studies capable of assessing long-term handwashing behaviour change. While long-term follow-up evaluations are necessary to characterize sustained behaviour change, confounding factors must be acknowledged and controlled for with longer time gaps between intervention and evaluation.

This review has the following limitations. First, we searched only publications written in English, and thus, our results may not accurately represent all handwashing studies conducted in some settings. Second, our review may have benefited from the inclusion of a behavioural or social scientist who could have provided more detail regarding behavioural intervention strategies; however, the intent of this paper was to describe approaches to handwashing behaviour research by outcome measurement and temporal study design. Lastly, as documented in Figure 2, there were some studies in which the intervention and evaluation time frames were ambiguously worded resulting in a less precise depiction of the temporal study design.

Recommendations

The main recommendations from this review are the following:

- Regardless of the setting – communities, schools and health care institutions – there should be more focus on long-term evaluation of behaviour change in the years following an intervention's conclusion. As these studies may be costly and difficult to fund, post-evaluation assessments of prior interventions targeting behaviour maintenance should be considered.
- Handwashing research should further evaluate outcome measures (e.g., direct observation, self-report, proxy measures) and determine the most appropriate application for assessing behaviour change. Fifty-seven percent of the studies we reviewed used self-report as an outcome measure, which is known to be unreliable with frequent over-reporting. While direct observation is a more valid indicator of behaviour change when performed correctly (e.g., by trained personnel and minimization of Hawthorne effect), these studies are often more time consuming and costly. The use of simple proxy measurements that provide a valid assessment of behaviour change may be useful, but also require further evaluation.
- Researchers should consider multidisciplinary approaches to handwashing intervention and/or evaluation. Protocols may benefit from inclusion of social science disciplines coupled with clinical, biological, chemical, engineering and epidemiological approaches. This is especially true in low-income

settings where behaviour change is further challenged by environmental obstacles.

Conclusion

The purpose of this review was to assess handwashing research approaches in LMIC and understand their impact with regard to long-term behaviour adoption. Our findings determined that the evidence base regarding successful, behaviourally based handwashing approaches is inadequate. While handwashing adherence is recognized as a foundation of health maintenance in communities and institutional settings, global health initiatives frequently overlook its importance and the need to support studies capable of determining the most effective approach for measuring and promoting its long-term adoption. This review provides a summary of the scientific literature regarding behaviourally influenced handwashing studies in LMIC. Based on our findings, it is clear that more work is required to determine the best approaches for promoting successful adoption of a simple, effective and potentially sustainable intervention.

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