



Behaviour change interventions to improve household sanitation and hygiene practices in urban settings: A systematic scoping review

Clara MacLeod^{a,*}, Katherine Davies^a, Mwamba M. Mwenge^b, Jenala Chipungu^b, Oliver Cumming^a, Robert Dreibelbis^a

^a Department of Disease Control, London School of Hygiene and Tropical Medicine, London, United Kingdom

^b Centre for Infectious Disease Research Zambia, Lusaka, Zambia

ARTICLE INFO

Keywords:

Behaviour change
Sanitation
Hygiene
Urban
Scoping review

ABSTRACT

Introduction: Behaviour change interventions have the potential to improve sanitation and hygiene practices in urban settings. However, evidence on which behaviour change interventions have successfully improved sanitation and hygiene practices in urban settings is unclear.

Methods: We performed electronic searches across five databases and one grey literature database to identify relevant studies published between January 1, 1990 and November 20, 2023 in English. Eligible study designs included randomised and non-randomised controlled trials with a concurrent control. Studies were eligible for inclusion if they reported a behaviour change intervention for improving sanitation and/or hygiene practices in an urban setting. Individual behaviour change intervention components were mapped to one of nine intervention functions of the capabilities, opportunities, motivations, and behaviour (COM-B) framework. Risk of bias was assessed for each study using an adapted Newcastle-Ottawa scale.

Results: After de-duplication, 8249 documents were screened by abstract and title, with 79 documents retrieved for full-text screening. We included 13 studies ranging from low- to high-quality. The behaviour change interventions had mixed effects on sanitation and hygiene practices in urban settings. Specifically, interventions improved latrine quality but not safe child faeces disposal. Interventions often improved handwashing with soap at key times and sometimes increased the presence of soap and water at the handwashing facility, used as a proxy measure for handwashing. There is limited evidence on food hygiene practices. Most behavioural outcomes were measured between 6 and 12 months after intervention implementation, which may undermine the sustainability of behaviour change interventions.

Conclusion: Despite overall mixed behavioural effects on sanitation and hygiene practices, behaviour change interventions can improve certain behaviours in urban settings, such as latrine quality improvements and handwashing with soap at the household or compound level. More ambitious behaviour change interventions are needed to reduce disparities in sanitation and hygiene access in urban areas globally.

1. Introduction

Addressing sanitation and hygiene in urban areas, particularly in informal settlements, is essential for achieving Sustainable Development Goal (SDG) targets on water, sanitation, and hygiene (WASH) (SDG target 6.2). Lack of access to sanitation and hygiene is associated with enteric (Wolf et al., 2022) and respiratory infections (Ross et al., 2023). In 2022, an estimated 36% of urban residents did not have access to safely managed sanitation, 25% of whom had access to basic sanitation, as defined by the WHO and UNICEF Joint Monitoring Programme (JMP)

(UNICEF and WHO, 2023). It was also estimated that 17% of urban residents did not have access to basic hygiene services (i.e., a handwashing facility with soap and water), with 10% having access to a limited hygiene facility (i.e., handwashing facility lacking soap and/or water) and 7% with no access at all in 2022 (UNICEF and WHO, 2023). However, urban coverage of safely managed sanitation and basic hygiene services varied between countries and regions. Access to basic hygiene services in urban areas was lowest in sub-Saharan Africa and Oceania and lowest in sub-Saharan Africa for access to safely managed sanitation (UNICEF and WHO, 2023). There are also marked

* Corresponding author.

E-mail address: clara.macleod@lshtm.ac.uk (C. MacLeod).

<https://doi.org/10.1016/j.ijheh.2025.114519>

Received 30 August 2024; Received in revised form 6 December 2024; Accepted 1 January 2025

Available online 6 January 2025

1438-4639/© 2025 The Authors. Published by Elsevier GmbH. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

sub-national disparities in access to sanitation and hygiene between high-income and low-income urban areas. For example, in the urban United States in 2019, almost one million persons lacked access to at least basic sanitation, especially among people experiencing homelessness and substandard housing (Capone et al., 2020). Additionally, informal settlements, where approximately one-quarter of the global urban population resides, often lack formal WASH services (Sinharoy et al., 2019; United Nations, 2018).

Safe sanitation and hygiene practices, such as latrine use, safe handling and disposal of faeces, handwashing with soap at key moments (e.g., after using the toilet, before food preparation), and hygienic food preparation and storage practices, are important for the prevention of communicable diseases, especially in urban areas where population densities are high. In addition to infectious disease reduction, high quality latrines, such as those that are safe, clean, and private, are important for mental well-being and quality of life (Ross et al., 2021). Two previous reviews found that behaviour change interventions achieved mixed results for improving WASH behaviours, such as safe faeces disposal and handwashing with soap (De Buck et al., 2017; Slesinski et al., 2019). However, these reviews did not disaggregate results between urban and rural settings. An understanding of behaviour change interventions that have been implemented specifically in urban settings can inform more effective future interventions, as well as identify areas for future research.

Behavioural frameworks and theories have been used to develop and design interventions to target sanitation and hygiene behaviours and understand the various factors that drive behaviour. For example, Michie et al. (2011) developed a behavioural framework, known as the capabilities, opportunities, motivations, and behaviour (COM-B) framework (Michie et al., 2011), widely used in behaviour change programming. The COM-B framework identifies nine intervention functions that can be used to identify determinants of behaviour (Michie et al., 2011).

The aim of this systematic scoping review is to evaluate the behavioural effectiveness of behaviour change interventions on household-level sanitation and hygiene practices in urban settings. The objectives are to: 1) identify household-level behaviour interventions targeting sanitation and hygiene practices in urban settings, 2) map the intervention components to the COM-B framework intervention functions, 3) assess their behavioural effectiveness, and 4) identify evidence gaps for future research.

2. Methods

This systematic scoping review follows the five steps for scoping reviews outlined by Arksey and O'Malley (2005). The five steps are summarised below in relation to this review. A scoping review, as opposed to a systematic review, was selected to explore the breadth of available literature and to iteratively search and review documents and extract relevant data. The protocol for this scoping review was pre-registered on OSF registries (<https://osf.io/qghfj>). We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA_{ScR}) guidelines (Tricco et al., 2018). A PRISMA_{ScR} checklist is included in the Supplementary Information (Table A1).

2.1. Step 1: Specify the research question

This systematic scoping review seeks to answer the following question: “*what behaviour change interventions targeting household-level sanitation and hygiene practices have been implemented in urban settings?*” The research question is deliberately broad to allow for a comprehensive mapping of behaviour change interventions to sanitation and hygiene behavioural outcomes.

2.2. Step 2: Identify the relevant literature

We searched five databases to identify peer-reviewed literature: 1) PubMed, 2) Medline, 3) Global Health, 4) Cochrane Library, and 5) Web of Science. The grey literature search was conducted in the World Bank e-library database. Search terms related to behaviour change, sanitation and hygiene, and urban settings were combined with Boolean operators to search the databases, with search strategies adapted for each database. An example search strategy is published in the Supplementary Materials (Table A2). Searches were conducted on November 20, 2023. The search was limited to studies published in English from January 1, 1990 onwards. The publication cut-off date was selected based on the introduction of the Millennium Development Goals in 1990 (MDG7: “To ensure access to drinking water and sanitation for all”). The reference lists of included studies and similar systematic reviews (De Buck et al., 2017; Heijnen and Greenland, 2015; Slesinski et al., 2019) were also hand-searched to identify additional relevant references.

2.3. Step 3: Study selection

Only studies with a behavioural intervention that sought to change sanitation and/or hygiene practices that were evaluated against a concurrent control group were included. The comparison was between the behaviour change intervention and no behaviour change intervention. Eligible study designs were randomised controlled trials (RCTs), including cluster-RCTs, quasi-RCTs, and non-randomised controlled trials and pre-post studies. There was no restriction on target population. We included individual, household, and community-level interventions with the specific aim to improve sanitation and/or hygiene practices in urban settings.

We relied on author-reported definitions of an urban setting. An urban setting is broadly characterised by high population density, the concentration of administrative bodies, infrastructure and services, and income generation activities (European Commission, 2021). The specific criteria for what constitute an urban setting varies by country and is usually defined by national governments. Urban areas include informal settlements (United Nations Statistics Division, 2021), slums (United Nations Statistics Division, 2021), as well as people experiencing homelessness in unsheltered urban locations (Capone et al., 2020).

In this systematic scoping review, we used the COM-B framework intervention functions to identify and classify the behaviour change components reported in the included studies. The COM-B framework includes three domains and nine intervention functions, as defined by Michie et al. (2011). The first domain, capability, is defined as having the necessary physical ability, stamina, skills (physical capability), or knowledge (psychological capability) to engage in the activities involved in performing a behaviour. Second, opportunity relates to factors that lie outside the individual and that influences one's ability to perform a behaviour, such as physical opportunity (i.e., resource availability) or social opportunity (i.e., social norms). Third, motivation refers to the “brain processes that energize and direct behaviour” and can be triggered by fear or disgust, for example. The nine intervention functions, or broad categories of strategies to change behaviour, include: i) education, ii) persuasion, iii) incentivisation, iv) coercion, v) training, vi) restriction, vii) environmental restructuring, viii) modelling, and ix) enablement (Table 1) (Michie et al., 2011).

The two primary behavioural outcomes of this review were household sanitation and hygiene practices. Relevant sanitation behavioural outcomes included latrine use, latrine quality, latrine construction or rehabilitation, building a septic tank, lining a pit, safe faeces handling and disposal (including child faeces), connecting to a piped sewer network, formal safe pit emptying. Hygiene behavioural outcomes were categorised into hand hygiene and food hygiene. Hand hygiene behavioural outcomes included those related to handwashing with soap, handwashing with soap at key times (e.g., before eating, before food preparation, after visiting the toilet, after children's faeces disposal or

Table 1
Intervention function description developed by [Michie et al. \(2011\)](#).

Intervention function	Definition	Relevant COM-B domain(s)
Education	Increasing knowledge and understanding by informing, explaining, showing and correcting	Capability & motivation
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Motivation
Incentivisation	Creating an expectation of reward	Motivation
Coercion	Creating an expectation of punishment or cost	Motivation
Training	Increasing psychological or physical skills, or habit strength by explanation, demonstration, practice, feedback and correction	Capability & motivation
Restriction	Constraining behaviour by setting rules	Opportunity
Environmental restructuring	Constraining or promoting behaviour by shaping the physical or social environment	Opportunity
Modelling	Showing examples of the behaviour for people to imitate	Capability & motivation
Enablement	Providing support to improve ability to change in a variety of ways not covered by other intervention functions e.g. through medication, surgery, encouragement, moral support	Capability

cleaning the baby's bottom, or other key times defined in the studies), and handwashing facility construction. Food hygiene behavioural outcomes included boiling or reheating food before eating, using safe drinking water to prepare food, and hygienic storage of food (e.g., food covered with lid or refrigeration).

All documents retrieved from electronic searches were transferred to Endnote for de-duplication. To identify relevant documents, three reviewers (CM, KD, and MM) screened documents by title and abstract, excluding only clearly irrelevant documents, i.e., not related to sanitation and hygiene behaviour change interventions and urban settings. Full texts of all potentially eligible documents were then retrieved and independently assessed for inclusion by one reviewer (CM). Two other reviewers (KD and MM) split the full text screening to complete double-assessment. Any disagreement between reviewers about eligibility following title and abstract screening was resolved through discussion to build consensus. Disagreement was resolved through discussion with a fourth reviewer (RD) where consensus could not be reached.

2.4. Step 4: Extract, map, and chart the data

Study characteristics and results from included studies were double-extracted independently by two reviewers using a standardised data extraction template in MS Excel and then cross-checked for accuracy. One reviewer (CM) independently extracted data for all studies and two other reviewers (KD and MM) split the studies to complete double extraction. As with inclusion, a fourth reviewer (RD) provided arbitration if agreement on data extraction could not be reached. The data extraction form included information on study characteristics, such as author, publication date, study design, study dates, study location and urban setting, target population, and sample size. We also extracted data on behaviour change intervention components and sanitation and hygiene behavioural outcomes (Supplementary Materials [Table A3](#)). For all studies, we reported results for each intervention arm that included a sanitation and/or hygiene behaviour change component compared to the control group. For studies that included multiple intervention arms, we reported results for each intervention arm and control comparison separately. Intervention arms that did not include a sanitation or hygiene component were not included in this review.

2.5. Step 5: Summarise, synthesise, and report results

First, intervention components for each intervention arm were mapped to one of the nine intervention functions of the COM-B framework ([Michie et al., 2011](#)). Second, we recorded the measure of effect, 95% confidence interval, and p-value for each behavioural outcome. Third, we summarised the results of the included studies to describe the behavioural effect of the behaviour change interventions on the sanitation and hygiene practices. Finally, we identified evidence gaps.

2.6. Risk of bias (quality) assessment

We assessed risk of bias in individual studies using an adapted Newcastle-Ottawa scale, as used in previous systematic reviews ([Michie et al., 2011](#); [Ross et al., 2023](#); [Wolf et al., 2022](#)). The scale considered seven areas of bias: selection, response, follow-up, misclassification, outcome assessment, outcome measurement, and analysis bias (Supplementary Materials [Table A4](#)). Each study received a score of up to nine, a higher score indicating a smaller risk of bias. Risk of bias was assessed by one reviewer (CM) for each study with a subset of scores reviewed by a second reviewer (KD). Any discrepancies between the two reviewers were resolved by a third reviewer (RD).

3. Results

3.1. Search results

Electronic searches were conducted on November 20, 2023, identifying 9771 records. After removing duplicates, 8218 records were screened by abstract and title. Thirty-one additional documents were identified through reference screening. Most documents were excluded at this stage because they were either not related to sanitation and hygiene behaviour change interventions or urban settings. Seventy-nine documents were sought for retrieval for full text screening. Finally, thirteen documents were included in the review ([Fig. 1](#)). The 65 documents excluded during full text screening are listed with reasons for exclusion in the Supplementary Materials ([Table A5](#)). Most studies excluded during full text review were either conducted in rural settings or did not have a control group.

3.2. Description of included studies

The 13 included studies consisted of 12 peer-reviewed studies and 1 grey literature report ([Table 2](#)). Study designs included five cluster-randomised controlled trials (RCTs), three RCTs, three non-randomised trials, and two quantitative process evaluations. The two process evaluations were a controlled before-and-after study ([Bick et al., 2021](#)) and a cRCT ([Simiyu et al., 2023](#)). All studies were published between 2002 and 2022, with most studies published after 2015. Almost all studies were conducted in either sub-Saharan Africa ($n = 6$) (1 in Côte d'Ivoire, 1 in Tanzania, 1 in Zambia, 1 in Uganda, 1 in Mozambique, and 1 in Kenya) or South Asia ($n = 6$) (Bangladesh $n = 3$, Pakistan $n = 2$, and Nepal $n = 1$). One study was conducted in Latin America (Peru, $n = 1$). Eleven studies were in lower-middle-income countries (Bangladesh, Côte d'Ivoire, Tanzania, Kenya, Zambia, Pakistan, and Nepal), while two studies were in low-income countries (Mozambique and Uganda) and one in an upper-middle-income country (Peru), as defined by the World Bank ([World Bank, 2020](#)). Nine studies were implemented in low-income urban areas, also called informal settlements, slums, or shanty towns among the included studies. One study was conducted in a commune within the city, while three were in peri-urban areas.

3.3. Types of interventions

We identified 12 unique combinations of intervention functions across 16 intervention arms ([Table 2](#)). The individual intervention

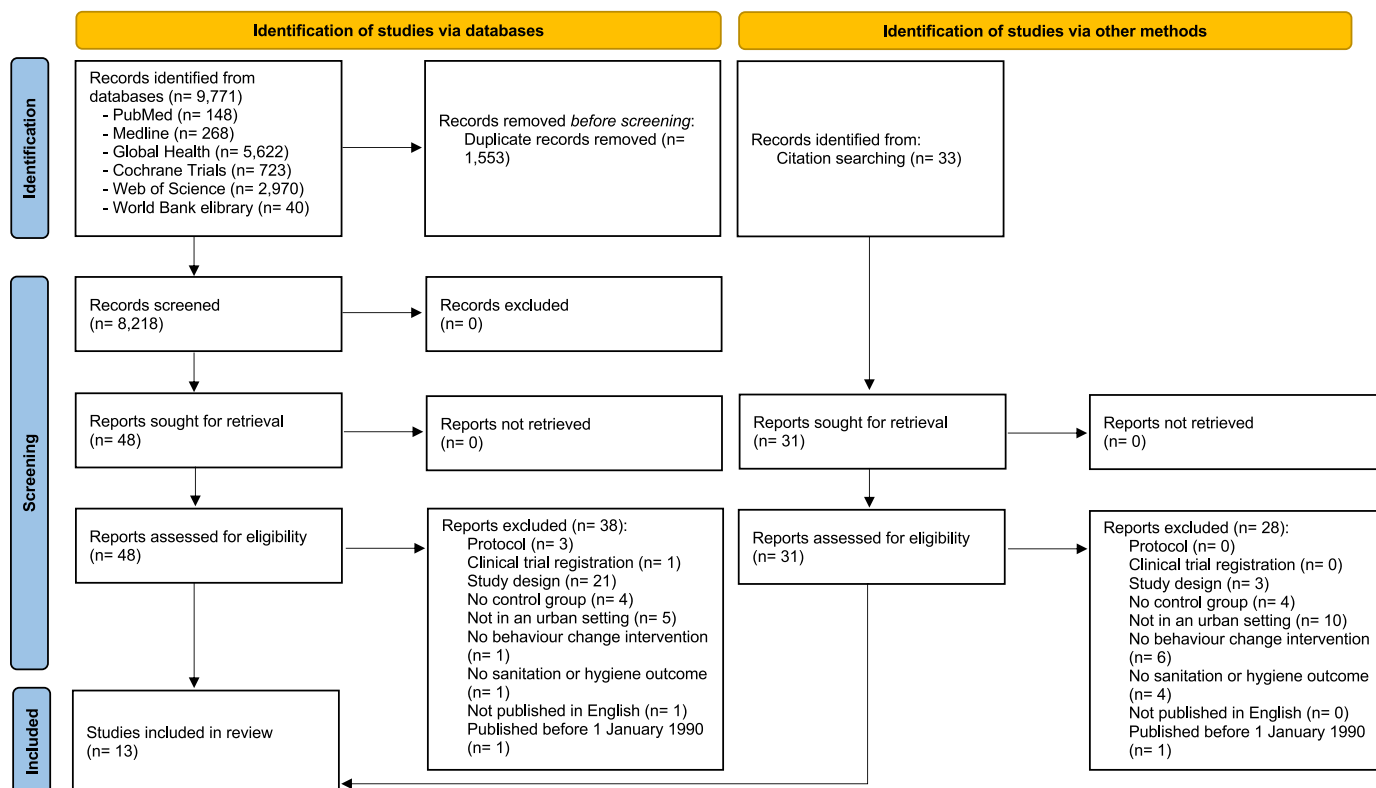


Fig. 1. PRISMA flow chart.

functions that featured the most across the intervention arms were environmental restructuring (n = 10), education (n = 10), and persuasion (n = 8) (Table 2). However, intervention functions were almost always implemented in combination. The most common intervention function combinations included environmental restructuring, education, and persuasion (n = 3 studies) (Bowen et al., 2013; Simiyu et al., 2023), environmental restructuring, persuasion, and modelling (n = 2) (Amon-Tanoh et al., 2021; Biswas, 2012), and environmental restructuring and education (n = 2 studies) (Alam et al., 2017; Bick et al., 2021). Environmental restructuring was almost always implemented in combination with intervention functions, such as with education (n = 5), persuasion (n = 3), modelling (n = 2). Environmental restructuring, education, and incentivisation were the only intervention functions implemented individually in a study arm (Amon-Tanoh et al., 2021; Tumwebaze and Mosler, 2015; Yeager, 2002). Two studies developed their intervention based on psychosocial theory, such as RANAS (Tidwell et al., 2019; Tumwebaze and Mosler, 2015).

Interventions equally targeted the individual and household level. The interventions targeted the individual level (54%, n = 7), such as users of shared sanitation or caregivers of children, and the household level (46%, n = 6), for example, households with unimproved sanitation facilities. Most studies compared interventions to a control group only (n = 10), while three studies compared two intervention arms to one another and to a control group. Four studies included an intervention arm that combined a sanitation and hygiene component with a non-sanitation and hygiene component. For example, in addition to receiving a sanitation and hygiene behaviour change component, intervention households also received a cholera vaccine (Biswas, 2012), household water treatment supplies (Bowen et al., 2013; Luby et al., 2009), and water quality test results (Davis et al., 2011).

3.4. Outcomes

We identified 36 sanitation and hygiene behavioural outcomes

reported among the 13 included studies. Fourteen behavioural outcomes related to sanitation and 21 to hygiene. Thirteen sanitation behavioural outcomes targeted latrine quality (Alam et al., 2017; Bick et al., 2021; Tidwell et al., 2019; Tumwebaze and Mosler, 2015) and only one targeted safe child faeces disposal (Yeager, 2002). Of the 21 behavioural outcomes related to hygiene, 19 were on hand hygiene and two were on food hygiene. Hand hygiene behavioural outcomes included handwashing with soap and at various key moments (e.g., after using the toilet or before eating) (n = 13) (Amon-Tanoh et al., 2021; Bowen et al., 2013; Guiteras et al., 2015; Langford and Panter-Brick, 2013; Luby et al., 2009; Simiyu et al., 2023) or the presence of soap and water at the household handwashing facility (n = 6) (Bick et al., 2021; Biswas, 2012; Bowen et al., 2013; Davis et al., 2011; Guiteras et al., 2015). The two food hygiene behavioural outcomes were using clean utensils for infant feeding and hygienic storage of leftover food (Simiyu et al., 2023).

Behavioural outcome definitions and measurement timepoints varied across the studies. Latrine quality was measured as either latrine cleanliness, such as no visible faeces in pan (Alam et al., 2017), having a rotation cleaning system (Bick et al., 2021; Tidwell et al., 2019), and cleaning frequency (Tumwebaze and Mosler, 2015), or latrine privacy, measured as having an indoor and outdoor lock (Bick et al., 2021; Tidwell et al., 2019). Sanitation-related behavioural outcomes relied on both fieldworker observations (n = 8) and self-reporting (n = 5). Hygiene behavioural outcomes included either observed handwashing with soap (n = 12), self-reported handwashing with soap (n = 1), observed presence of a handwashing facility with soap and water (n = 6), and observed food hygiene practices (n = 2). Each study measured handwashing with soap differently and often before or after different key moments. For example, one study reported daily handwashing rates (Davis et al., 2011), while another study reported the proportion of occasions participants washed their hands with soap after using the toilet (Amon-Tanoh et al., 2021). The observed presence of a handwashing with soap, often used as a proxy measure for handwashing, was measured consistently across studies, though measured at different

Table 2
Characteristics of included studies.

Study	Year	Country	City	Urban setting	Study design	Follow up time point	Arms	Intervention functions (COM-B framework) by study arm	Intervention level	Number of participants (I/C)	Sanitation (behavioural outcome)	Hygiene (behavioural outcome)	Risk of bias score
Alam et al.	2017	Bangladesh	Dhaka	Informal settlement	cluster RCT	6 months	2	A) Environmental restructuring + education B) No intervention	Household	1214 households (609/605)	Latrine quality		7
Amon-Tanoh et al.	2021	Côte d'Ivoire	Abidjan – Koumassi	City	cluster RCT	5 months	3	A) Environmental restructuring + persuasion B) Environmental restructuring only C) No intervention	Compound	73 compounds (23/25/25)		HW with soap	7
Bick et al.	2021	Mozambique	Maputo	Informal settlement	Process evaluation	12 months	2	A) Environmental restructuring + education B) No intervention	Compound	556 individuals (279/277)	Latrine quality	HW with soap	4
Biswas	2012	Bangladesh	Dhaka	Informal settlement	cluster RCT	11 months	2	A) Environmental restructuring + persuasion + modelling B) No intervention	Household	400 households (100/200/100)		HW with soap	6
Bowen et al.	2012	Pakistan	Karachi	Informal settlement	cluster RCT	5 years	2	A) Environmental restructuring + persuasion + education B) No intervention	Household	461 households (160/141)		HW with soap	5
Davis et al.	2011	Tanzania	Dar es Salaam	Peri-urban area	Non-randomised trial	Not stated	2	A) Education + persuasion B) Education (comparison)	Household	248 households (79/84/90/81)		HW with soap	2
Guiteras et al.	2015	Bangladesh	Dhaka	Informal settlement	RCT	3.5 months & 7 months	3	A) Education + persuasion + coercion B) Environmental restructuring + modelling C) Education (comparison)	Compound	420 compounds (210/214)		HW with soap	3
Langford and Panter-Brick	2013	Nepal	Kathmandu	Informal settlement	Randomised trial	6 months	2	A) Environmental restructuring + education + enablement B) No intervention	Household	88 households (45/43)		HW with soap	4
Luby et al.	2009	Pakistan	Karachi	Informal settlement	cluster RCT	18 months	2	A) Environmental restructuring + persuasion + education B) No intervention	Household	390 households (195/195)		HW with soap	5
Simiyu et al.	2022	Kenya	Kisumu	Peri-urban area	Process evaluation	2 months & 3.5 months	2	A) Environmental restructuring + persuasion + education B) No intervention	Individual	723 individuals (387/336)		HW with soap + food hygiene	4
Tidwell et al.	2019	Zambia	Lusaka	Peri-urban area	RCT	6 months	2	A) Persuasion + education + modelling + incentivisation + enablement B) No intervention + elements of psychosocial theory	Individual	928 individuals (474/454)	Latrine quality		4
Tumwebaze and Mosler	2015	Uganda	Kampala	Informal settlement	Non-randomised trial	Not stated	3	A) Incentivisation B) Incentivisation + enablement C) No intervention + elements of psychosocial theory	Household	119 households (38/41/40)	Latrine quality		2
Yeager et al.	2002	Peru	Lima	Informal settlement	Non-randomised trial	12 months	2	A) Education B) No intervention	Individual	578 individuals (285/293)	Safe child faeces disposal		3

timepoints after intervention implementation. Over half of behavioural outcomes were measured between 6 months and 12 months after baseline (54%, $n = 7$). Two studies measured behavioural outcomes less than six months after baseline (Amon-Tanoh et al., 2021; Simiyu et al., 2023) and two studies measured behavioural outcomes 18 months and 5 years post-intervention (Bowen et al., 2013; Luby et al., 2009). Two studies did not state when they measured behavioural outcomes (Davis et al., 2011; Tumwebaze and Mosler, 2015).

3.5. Intervention effectiveness

There are mixed results on the behavioural effect of behaviour change interventions on sanitation and hygiene practices in urban settings (Table 3). Interventions were associated with improved sanitation and hygiene practices in 28 out of the 36 behavioural outcomes, while there was no effect on 8 outcomes. Interventions had a positive behavioural effect on 13 out of 14 behavioural outcomes related to sanitation. However, intervention behavioural effects on handwashing were mixed as 14 out of 20 behavioural outcomes had a positive effect and 6 out of 20 behavioural outcomes had no behavioural effect. The only two food hygiene behavioural outcomes included in this review had mixed results (Table 4).

3.5.1. Sanitation practices

Behaviour change interventions improved latrine quality (Alam et al., 2017; Bick et al., 2021; Tidwell et al., 2019; Tumwebaze and Mosler, 2015), but did not improve safe child faeces disposal (Yeager, 2002) (Table 3). Alam et al. (2017) found that compounds that received a latrine cleaning intervention were significantly more likely to have cleaner toilets (e.g., no visible faeces on latrine pan) after the intervention compared to controls (Alam et al., 2017). Tidwell et al. (2019) found that intervention households were more likely to have a rotation cleaning system in place (e.g., tenants alternating weekly responsibility for cleaning the shared sanitation facility), inside and outside latrine locks, and toilets with simple covers or water seals (Tidwell et al., 2019). In Tumwebaze and Mosler (2015) shared toilet users that received either one of two latrine cleaning interventions were significantly more likely to clean their shared latrine (Tumwebaze and Mosler, 2015). Bick et al. (2021) found that compounds receiving an improved sanitation intervention were much more likely to be private, almost twice as likely to be observably clean, and twice as likely to be well-maintained. In addition, individual cleaning frequency was significantly higher and frequent collective cleaning was reported more often by intervention respondents. However, intervention compounds were unlikely to have and adhere to a formal rota for cleaning shared latrines (Bick et al., 2021). Yeager et al. found that intervention respondents were not more likely to practice safe child faeces disposal than control respondents (Yeager, 2002) (see Table 4).

3.5.2. Hygiene practices

Behaviour change interventions had mixed results on improving hygiene practices in urban settings (Table 3).

3.6. Observed presence of soap and water at the latrine

Behaviour change interventions sometimes increased the observed presence of soap and water at the handwashing facility. In Dhaka, Bangladesh, Biswas et al. (2012) found that intervention respondents were significantly more likely to have water and soap or soapy water present at the hand washing place than control respondents (Biswas, 2012). In another study in Dhaka, Bangladesh, one intervention arm (environmental restructuring and modelling) increased the presence of soap and water at the latrine, while another intervention arm (education, persuasion, coercion) did not (Guiteras et al., 2015). In Karachi, Pakistan, Luby et al. (2009) followed up participants 18 months after a behaviour change intervention ended (Luby et al., 2006) and found that

mothers in households originally assigned to the intervention were 1.5 times more likely to have a handwashing facility with soap and water (Luby et al., 2009). Five years after the same intervention followed up by Luby et al. (2009), Bowen et al. (2013) reported that intervention households were 3.4 times more likely to have a handwashing station with soap and water than control households (Bowen et al., 2013). Bick et al. (2021) found that few intervention latrines had signs of soap use at the household handwashing facility with no difference from control latrines in Maputo, Mozambique (Bick et al., 2021).

3.7. Observed hygiene practices

Most behaviour change interventions improved observed handwashing with soap at key moments. Amon-Tanoh et al. (2021) found that the 'environmental restructuring, persuasion, and enablement' intervention was effective at increasing handwashing with soap after toilet use, while environmental restructuring alone (provision of handwashing stations) had little effect (Amon-Tanoh et al., 2021). In Langford and Panter-Brick (2013), mothers in the intervention group were significantly more likely to wash hands with soap in four out of five key junctures compared to the control group: after cleaning a baby's bottom, before cooking, feeding the baby, and eating (Langford and Panter-Brick, 2013). In Simiyu et al. (2023), the intervention improved caregiver handwashing with soap before food preparation but had no effect on caregivers' handwashing practices before infant feeding (Simiyu et al., 2023). Bowen et al. (2013) found intervention households more commonly reported handwashing before cooking and before meals than control households five years after the intervention. In another study, one intervention arm (environmental restructuring and modelling) increased handwashing after last defecation, while another intervention arm (education, persuasion, and coercion) did not (Bowen et al., 2013). The only study that investigated food hygiene practices found that the intervention improved observed hygienic feeding of infants (i.e., using a utensil) but had no behavioural effect on caregiver hygienic food storage practices (Simiyu et al., 2023) (Table 3).

3.8. Reported hygiene practices

Only one study reported on handwashing behaviour. The study found no significant differences between the intervention and control groups in reported handwashing behaviours (Davis et al., 2011).

3.9. Risk of bias

The risk of bias ranged from high to low for sanitation and hygiene behavioural outcomes (Table 2). In most studies, participants and those collecting the data could not be blinded to intervention allocation, but randomised study design, low loss to follow up, and blinding of data analysts contributed to higher Newcastle-Ottawa Scale scores. The self-reported or observation of behavioural outcomes, as well as high rates of loss to follow up, led to lower scores. Three studies were not randomised and seven had a loss to follow up >10%. Most sanitation and hygiene behavioural outcomes were observed. The full assessment is in the Supplementary Materials (Table A6).

4. Discussion

This scoping review included 13 studies evaluating the behavioural effect of behaviour change interventions on sanitation and hygiene practices in urban settings. The results suggest that behaviour change interventions can improve certain sanitation and hygiene practices, such as latrine quality and handwashing with soap at key moments. There is mixed and limited evidence on the effectiveness of behaviour change interventions on other behavioural outcomes, such as safe child faeces disposal and food hygiene practices. The 13 studies were implemented in 10 countries and primarily in urban informal settlements in sub-

Table 3
Description of study results.

Author	Intervention function by arm	Comparison	Behavioural outcome	Description of behavioural outcome	Effect measure	Results (95% CI and p-value where relevant)	Interpretation of results
Sanitation							
Alam et al. (16)	A) Environmental restructuring + education	No intervention	Latrine quality	Visible faeces inside the pan (observed)	DID	-13% (95% CI -19%, -5%)	Compounds that received the intervention were significantly more likely to have cleaner toilets after the intervention.
Tidwell et al. (24)	A) Persuasion + education + modelling	No intervention	Latrine quality	Having a rotation cleaning system in place (reported)	RR	1.16 (95% CI 1.05–1.30) (p = 0.0011)	Plots that received the intervention were significantly more likely to have higher quality toilets across all four dimensions of quality improvement.
				Having inside lock (observed)	RR	1.34 (95% CI 1.10–1.64) (p = 0.00081)	
				Having outside lock (observed)	RR	1.27 (95% CI 1.06–1.52) (p = 0.0028)	
				Toilets with simple covers or water seals (observed)	RR	1.25 (95% CI 1.04–1.50) (p = 0.0063)	
Tumwebaze et al. (25)	A) Incentivisation	No intervention	Latrine quality	Shared sanitation users' cleaning behaviour (reported)	F-value (time)	13.84 (p < 0.005)	Shared toilet users that received either intervention were significantly more likely to have improved cleaning behaviour.
	B) Incentivisation + restriction			F-value (time)	14.71 (p < 0.005)		
Bick et al. (14)	A) Environmental restructuring + education	No intervention	Latrine quality	Have and adhere to a latrine cleaning rota (reported)	χ^2	6.1 (p = 0.013)	Intervention compounds were unlikely to have and adhere to a formal rota for cleaning shared latrines. However, individual cleaning frequency was significantly higher among intervention respondents compared to control respondents and frequent collective cleaning was reported more often by intervention respondents. In addition, intervention latrines were much more likely to be private, almost twice as likely to be observably clean, and twice as likely to be well-maintained.
				Individual cleaning frequency (twice/week)	χ^2	14 (p < 0.001)	
				Frequent collective cleaning (latrine cleaned on daily basis)	χ^2	19 (p < 0.001)	
				Private latrine (working door and inside lock) (observed)	χ^2	500 (p < 0.001)	
				Observably clean latrine (observed)	χ^2	150 (p < 0.001)	
				Well-maintained latrine (slab/floor in good condition) (observed)	χ^2	240 (p < 0.001)	
Yeager et al. (26)	A) Education	No intervention	Safe faeces disposal	Safe child faeces disposal (observed)	Est diff	0.002	Intervention respondents were not more likely to practice safe child faeces disposal than control respondents.
Hygiene							
Biswas et al. (18)	A) Environmental restructuring + persuasion	No intervention	Presence of soap and water	Presence of water and soap or soapy water at HWF (observed)	Proportion test	60% [102/171] vs. 31% [28/90] (p < 0.001)	Intervention respondents were significantly more likely to have water and soap or soapy water present at the hand washing place than control respondents.
Davis et al. (20)	A) Education + persuasion	B) Education (comparison)	Handwashing with soap	Handwashing rates (times per day) (reported)	t	0.48 (0.34)	No significant differences between the intervention and control groups were observed in reported handwashing behaviours.
Bick et al. (14)	A) Environmental restructuring + education	No intervention	Presence of soap and water	Presence of a HWF with soap and water (observed)	X ²	0.12 (p = 0.729)	Few intervention latrines had signs of soap use at an HWF with no difference from control latrines.
Amon-Tanoh et al. (17)	A) Environmental restructuring + persuasion + enablement	No intervention	Handwashing with soap	Proportion of occasions during which hands washed with soap after using the toilet (observed)	aRR	2.68 (95% CI 1.65–4.34)	The environmental restructuring, persuasion, and enablement intervention was effective at increasing handwashing with soap after toilet use, while environmental restructuring alone (provision of handwashing stations) had little effect.
	B) Environmental restructuring				aRR	1.89 (95% CI 1.16–3.08)	
Guiteras et al. (21)	A) Education + persuasion + coercion	Education	Handwashing with soap	Handwashing after last defecation (used soap and water, both hands) (observed)	Est difference	0.009	The environmental restructuring and modelling intervention increased handwashing after last defecation and the presence of soap and water at the latrine. The education, persuasion,

(continued on next page)

Table 3 (continued)

Author	Intervention function by arm	Comparison	Behavioural outcome	Description of behavioural outcome	Effect measure	Results (95% CI and p-value where relevant)	Interpretation of results
Simiyu et al. (15)	B) Environmental restructuring + modelling	No intervention	Presence of soap and water	Presence of soap and water at latrine (observed)	DID	-0.068	coercion intervention did not increase handwashing after last defecation nor the presence of soap and water at the latrine.
			Handwashing with soap	Handwashing after last defecation (used soap and water, both hands) (observed)	Est difference	0.048 (p < 0.01)	
	A) Environmental restructuring + persuasion + education	No intervention	Presence of soap and water	Presence of soap and water at latrine (observed)	DID	0.540 (p < 0.01)	The intervention improved handwashing with soap before food preparation and hygienic feeding of infants (i.e., using a utensil). However, the intervention had no effect on caregivers' handwashing practices before infant feeding and caregiver hygienic food storage practices.
			Handwashing with soap	HWS before infant food preparation (observed)	OR	1.38 (95% CI 1.02–1.87) (p = 0.035)	
Food hygiene	HWS before infant feeding (observed)	OR	0.92 (95% CI 0.68–1.25) (p = 0.6)				
Hygienic food storage (observed)	OR	3.5 (95% CI 1.91–6.56) (p = 0.00)					
Luby et al. (23)	A) Environmental restructuring + persuasion + education	No intervention	Presence of soap and water	Presence of soap and water at latrine (observed)	RR	79% vs. 53% (p = 0.001)	Mothers in households originally assigned to the intervention were 1.5 times more likely to have a place with soap and water to wash hands 18 months after the intervention.
Bowen et al. (19)	A) Environmental restructuring + persuasion + education	No intervention	Handwashing with soap	HWS before cooking (observed)	RR	1.2 (95% CI 1.0–1.4)	Intervention households more commonly reported handwashing before cooking and before meals than control households five years after the intervention.
			Handwashing with soap	HWS before eating or feeding others (observed)	RR	1.7 (95% CI 1.3–2.1)	
	B) Persuasion	Presence of soap and water	Presence of soap and water at latrine (observed)	Chi-square test	97% [293/301] vs. 28% [45/159] (p < 0.0001)	Intervention households were 3.4 times more likely to have a handwashing station with soap and water than control households five years after the intervention. ^a	
Langford et al. (22)	A) Environmental restructuring + education	No intervention	Handwashing with soap	HWS after visiting the toilet (observed)	Chi-square test	100% [45/45] vs. 91% [39/43] (p = 0.053)	Mothers in the intervention group were significantly more likely to wash hands with soap in four out of five key junctures: after cleaning a baby's bottom, before cooking, feeding the baby, and eating compared to the control group.
			Handwashing with soap	HWS after cleaning baby's bottom (observed)	Chi-square test	100% [45/45] vs. 84% [36/43] (p = 0.005)	
			Handwashing with soap	HWS before cooking (observed)	Chi-square test	71% [32/45] vs. 2% [1/43] (p < 0.001)	
			Handwashing with soap	HWS before feeding the baby (observed)	Chi-square test	62% [28/45] vs. 19% [8/43] (p < 0.001)	
Handwashing with soap	HWS before eating (observed)	Chi-square test	60% [27/45] vs. 0% [0/43] (p < 0.001)				

HWS = handwashing with soap; RR = relative risk; aRR = adjusted relative risk; OR = odds ratio; DID = difference in difference.

^a Results for both intervention arms are reported as one result versus the control.

Saharan Africa and South Asia. No studies were conducted in high-income countries where disparities in access to sanitation and hygiene remain in urban areas. We also note that two excluded studies were implemented in both urban and rural settings but did not disaggregate results by setting (Freeman et al., 2022; Greenland et al., 2016). Compared to sanitation and hygiene interventions targeting rural areas, the evidence base is much more limited for the urban setting. Evidence specific to behaviour change interventions in urban settings is important for addressing the sanitation and hygiene challenges in this context.

Most studies included at least two intervention functions in their behaviour change interventions, thereby limiting the ability to tease out the specific behavioural effect from each intervention component. Almost all studies related to hand hygiene relied on environmental restructuring in combination with more traditional forms of

interpersonal communication (e.g., persuasion, education, modelling). Among the environmental modification interventions, the majority focused on hardware provision, specifically providing an improved handwashing station to households. Nudges or environmental cues, which have generally shown to improve behavioural outcomes (Dreibelbis et al., 2016; Grover et al., 2018; Tzikas and Koulierakis, 2023), warrant further exploration in urban settings. Other behaviour change approaches, such as community mobilisation, social marketing, advocacy, and financial incentives also warrant further exploration. For example, several studies have reported that willingness-to-pay for sanitation products and services is well under market prices in low-income urban areas (Delaire et al., 2021; Peletz et al., 2020; Tomoi et al., 2024). Financial incentives, such as income- or area-based subsidies, may bridge the gap between cost and willingness to pay for

Table 4

The behavioural effect of intervention functions, alone or in combination, on specific sanitation and hygiene behavioural outcomes. Each circle represents one outcome reported in an individual study. A white circle with blue outcome indicates a negative or no behavioural effect on the reported behavioural outcome, while a blue filled circle indicates a positive behavioural effect on the reported behavioural outcome.

Studies	Intervention functions	Latrine quality	Safe child faeces disposal	Observed HW proxy measures	Observed HW behaviour	Reported HW behaviour	Food hygiene
Alam et al. (2017) & Bick et al. (2021)	Environmental restructuring + education	●●●●●●●●		○			
Tidwell et al. (2019)	Persuasion + education + modelling + incentivisation + enablement	●●●●					
Tumwebaze (2015)	Incentivisation	●					
Tumwebaze (2015)	Incentivisation + enablement	●					
Yeager et al. (2022)	Education		○				
Amon-Tanoh et al. (2021) (A) & Biswas (2012)	Environmental restructuring + persuasion + modelling			●	●		
Amon-Tanoh et al. (2021) (B)	Environmental restructuring				○		
Davis et al. (2011)	Education + persuasion					○	
Guiteras et al. (2016)	Education + persuasion + coercion			○	○		
Guiteras et al. (2016)	Environmental restructuring + modelling			●	●		
Simiyu et al. (2022) & Luby et al. (2009) & Bowen et al. (2012)	Environmental restructuring + education + persuasion			●●	●●●○		●○
Langford et al. (2013)	Environmental restructuring + education + enablement				●●●●○		

HWS = handwashing with soap

improved sanitation and safe emptying services (Delaire et al., 2021).

The interventions targeted a narrow range of sanitation and hygiene behaviours. Latrine quality improvements were the most targeted sanitation-related behaviour. While sanitation quality can be an important predictor of sanitation use (Ross et al., 2021), latrine quality improvements alone may have limited impact for reaching SDG targets. Only one study evaluated safe child faeces disposal, and no studies targeted the use of latrines, safe pit emptying, or faecal sludge management. In addition, no studies evaluated the use of novel sanitation technologies designed for the urban marketplace, such as container-based sanitation (CBS). Handwashing with soap was the most targeted hygiene behaviour. Only one behaviour change intervention targeted food hygiene behaviours, which highlights an important evidence gap.

Behavioural outcome definitions and measurement timepoints varied significantly across the studies, thus making it difficult to compare results. For example, handwashing with soap was either measured via structured observation, self-reported behaviour, or proxy measures. Most included studies used structured observations of handwashing behaviour, often considered the gold standard for measuring behaviour., though more resource-intensive (Schmidt et al., 2019). Alternatively, some studies used the presence of a handwashing facility with soap and water as a proxy measure for handwashing behaviour. While this method allows for rapid and low-cost data collection, it's accuracy may be limited (Arnold et al., 2014). In addition, one study relied on self-reporting handwashing, which is prone to recall bias (Schmidt et al., 2019). Behavioural outcome measurement time points ranged from 6 to 12 months post-intervention, with only one study investigating long-term intervention effect. The findings suggest that behaviour change interventions were overall effective at improving certain sanitation and hygiene practices, but it is unclear whether they are effective long-term.

We note the limited scope of robust, large-scale interventions addressing sanitation and hygiene at the municipal or community-level. All interventions included in this review focused on household- or compound-level improvements. We considered compound-level interventions as household interventions as the interventions were delivered to a relatively small sample of households within clusters of compounds. No studies explicitly addressed community-level behaviour or behaviour change nor did they focus on connecting to municipal water or sewerage systems. With recent emphasis of urban sanitation programmes on Citywide Inclusive Sanitation (Gambrell et al., 2020), rigorous evaluation of efforts to improve urban sanitation are needed. While consistent water supply is necessary for safe sanitation and effective hygiene behaviours, only one included study adjusted for water supply in their analysis (Tidwell et al., 2019) and only one study provided information on water supply at baseline (Alam et al., 2017).

This scoping review has several limitations. First, our search was limited to English and may have missed relevant documents published in other languages. Second, we searched one grey literature database and may have missed additional relevant grey literature published elsewhere. Third, the behavioural outcomes amongst the included were too heterogeneous to conduct a meta-analysis. We also did not evaluate publication bias. Fourth, due to the nature of the interventions, blinding of participants and enumerators was often not possible, which may lead to outcome measurement bias. Results included in the review may also have been biased due to self-reporting of sanitation and hygiene behavioural outcomes. Finally, only one study evaluated food hygiene, which limits the generalisability of results.

5. Conclusion

Our results suggest that behaviour change interventions have the potential to improve sanitation and hygiene practices in urban settings, such as latrine cleanliness and handwashing with soap at the household or compound level. However, more ambitious interventions should be evaluated to increase their impact. Opportunities for future interventions include evaluating community-level behaviour change interventions, connecting households to water or sewerage networks where available, CBS acceptability, uptake and use, and food hygiene practices. Nonetheless, this review highlights that behaviour change is an important component of interventions for sanitation and hygiene in urban settings.

CRedit authorship contribution statement

Clara MacLeod: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Katherine Davies:** Writing – review & editing, Investigation. **Mwamba M. Mwenge:** Writing – review & editing, Investigation, Data curation. **Jenala Chipungu:** Writing – review & editing, Conceptualization. **Oliver Cumming:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Robert Dreibelbis:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

Funding statement

This research was funded by the United Kingdom’s Foreign, Commonwealth and Development Office (grant code 301186). The funder had no role in study design, data collection and analysis, decision to publish.

Declaration of competing interest

The authors declare they have no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijheh.2025.114519>.

References

- Alam, M., Winch, P.J., Saxton, R.E., Nizame, F.A., Yeasmin, F., Norman, G., Masud, A., Begum, F., Rahman, M., Hossain, K., Layden, A., Unicomb, L., Luby, S.P., 2017. Behaviour change intervention to improve shared toilet maintenance and cleanliness in urban slums of Dhaka: a cluster-randomised controlled trial. *Trop. Med. Int. Health* 22, 1000–1011. <https://doi.org/10.1111/tmi.12902>.
- Amon-Tanoh, M.A., McCambridge, J., Blon, P.K., Kouamé, H.A., Nguipod-Djomo, P., Biran, A., Cousens, S., 2021. Effects of a social norm-based handwashing intervention including handwashing stations, and a handwashing station-only intervention on handwashing with soap in urban Côte d'Ivoire: a cluster randomised controlled trial. *Lancet Glob Health* 9, e1707–e1718. [https://doi.org/10.1016/S2214-109X\(21\)00387-9](https://doi.org/10.1016/S2214-109X(21)00387-9).
- Arksey, H., O'Malley, L., 2005. Scoping studies: towards a methodological framework. *Int. J. Soc. Res. Methodol.* 8, 19–32. <https://doi.org/10.1080/1364557032000119616>.
- Arnold, B., Briceno, B., Chase, C., Colford, J., Gertler, P., Orsola Vidal, A., Ram, P., Sahli, M., 2014. Validity of Rapid Measures of Hand Washing Behavior: An Analysis of Data from Multiple Impact Evaluations in the Global Scaling up Hand Washing Project. Washington DC.
- Bick, S., Buxton, H., Chase, R.P., Ross, I., Adriano, Z., Capone, D., Knee, J., Brown, J., Nalá, R., Cumming, O., Dreibeibis, R., 2021. Using path analysis to test theory of change: a quantitative process evaluation of the MapSan trial. *BMC Publ. Health* 21, 1411. <https://doi.org/10.1186/s12889-021-11364-w>.
- Biswas, S., 2012. Uptake of hand washing with soap or soapy water from a large-scale cluster randomized community trial in urban Bangladesh. *Health and Science Bulletin* 10.
- Bowen, A., Agboatwalla, M., Ayers, T., Tobery, T., Tariq, M., Luby, S.P., 2013. Sustained improvements in handwashing indicators more than 5 years after a cluster-randomised, community-based trial of handwashing promotion in Karachi, Pakistan. *Trop. Med. Int. Health* 18, 259–267. <https://doi.org/10.1111/tmi.12046>.
- Capone, D., Cumming, O., Nichols, D., Brown, J., 2020. Water and sanitation in urban America, 2017–2019. *Am J Public Health* 110, 1567–1572. <https://doi.org/10.2105/AJPH.2020.305833>.
- Davis, J., Rogers, K., Boehm, A.B., Mamuya, S., Pickering, A.J., 2011. The effects of informational interventions on household water management, hygiene behaviors, stored drinking water quality, and hand contamination in peri-urban Tanzania. *Am. J. Trop. Med. Hyg.* 84, 184–191. <https://doi.org/10.4269/ajtmh.2011.10-0126>.
- De Buck, E., Van Remoortel, H., Hannes, K., Govender, T., Naidoo, S., Avau, B., Veegaete, A., Vande, Musekiwa, A., Lutje, V., Cargo, M., Mosler, H., Vandekerckhove, P., Young, T., 2017. Approaches to promote handwashing and sanitation behaviour change in low- and middle-income countries: a mixed method systematic review. *Campbell Systematic Reviews* 13, 1–447. <https://doi.org/10.4073/csr.2017.7>.
- Delaire, C., Peletz, R., Haji, S., Kones, J., Samuel, E., Easthope-Frazier, A., Charreyron, E., Wang, T., Feng, A., Mustafiz, R., Faria, I.J., Antwi-Agyei, P., Donkor, E., Adjei, K., Monney, I., Kisiangani, J., MacLeod, C., Mwangi, B., Khush, R., 2021. How much will safe sanitation for all cost? Evidence from five cities. *Environ. Sci. Technol.* 55, 767–777. <https://doi.org/10.1021/acs.est.0c06348>.
- Dreibeibis, R., Kroeger, A., Hossain, K., Venkatesh, M., Ram, P., 2016. Behavior change without behavior change communication: nudging handwashing among primary school students in Bangladesh. *Int J Environ Res Public Health* 13, 129. <https://doi.org/10.3390/ijerph13010129>.
- European Commission, 2021. *Applying the Degree of Urbanisation – A Methodological Manual to Define Cities, Towns and Rural Areas for International Comparisons – 2021 Edition*.
- Freeman, M.C., Delea, M.G., Snyder, J.S., Garn, J.V., Belew, M., Caruso, B.A., Clasen, T. F., Sclar, G.D., Tesfaye, Y., Woreta, M., Zewudie, K., Gobezeayehu, A.G., 2022. The impact of a demand-side sanitation and hygiene promotion intervention on sustained behavior change and health in Amhara, Ethiopia: a cluster-randomized trial. *PLOS Global Public Health* 2, e0000056. <https://doi.org/10.1371/journal.pgph.0000056>.
- Gambrill, M., Gilsdorf, R.J., Kotwal, N., 2020. Citywide inclusive sanitation—business as unusual: shifting the paradigm by shifting minds. *Front. Environ. Sci.* 7. <https://doi.org/10.3389/fenvs.2019.00201>.
- Greenland, K., Chipungu, J., Curtis, V., Schmidt, W.P., Siwale, Z., Mudenda, M., Chilekwa, J., Lewis, J.J., Chilengi, R., 2016. Multiple behaviour change intervention for diarrhoea control in Lusaka, Zambia: a cluster randomised trial. *Lancet Glob Health* 4, e966–e977. [https://doi.org/10.1016/S2214-109X\(16\)30262-5](https://doi.org/10.1016/S2214-109X(16)30262-5).
- Grover, E., Hossain, M.K., Uddin, S., Venkatesh, M., Ram, P.K., Dreibeibis, R., 2018. Comparing the behavioural impact of a nudge-based handwashing intervention to high-intensity hygiene education: a cluster-randomised trial in rural Bangladesh. *Trop. Med. Int. Health* 23, 10–25. <https://doi.org/10.1111/tmi.12999>.
- Guiteras, R., Levine, D., Luby, S., Polley, T., Khatun-e-Jannat, K., Unicomb, L., 2015. Disgust, shame, and soapy water: tests of novel interventions to promote safe water and hygiene. *J Assoc Environ Resour Econ* 3.
- Heijnen, M., Greenland, K., 2015. Level of behaviour change achievable by handwashing with soap interventions: a rapid review. https://doi.org/10.12774/eod_hd_apri12015.heijnenmetal.
- Langford, R., Panter-Brick, C., 2013. A health equity critique of social marketing: where interventions have impact but insufficient reach. *Soc. Sci. Med.* 83, 133–141. <https://doi.org/10.1016/j.socscimed.2013.01.036>.
- Luby, S.P., Agboatwalla, M., Bowen, A., Kenah, E., Sharker, Y., Hoekstra, R.M., 2009. Difficulties in maintaining improved handwashing behavior, Karachi, Pakistan. *Am. J. Trop. Med. Hyg.* 81, 140–145.
- Luby, S.P., Agboatwalla, M., Painter, J., Altaf, A., Billhimer, W., Keswick, B., Hoekstra, R. M., 2006. Combining drinking water treatment and hand washing for diarrhoea prevention, a cluster randomised controlled trial. *Trop. Med. Int. Health* 11, 479–489. <https://doi.org/10.1111/j.1365-3156.2006.01592.x>.
- Michie, S., van Stralen, M.M., West, R., 2011. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement. Sci.* 6, 42. <https://doi.org/10.1186/1748-5908-6-42>.
- Peletz, R., MacLeod, C., Kones, J., Samuel, E., Easthope-Frazier, A., Delaire, C., Khush, R., 2020. When pits fill up: supply and demand for safe pit-emptying services in Kisumu, Kenya. *PLoS One* 15, e0238003. <https://doi.org/10.1371/journal.pone.0238003>.
- Ross, I., Bick, S., Ayieko, P., Dreibeibis, R., Wolf, J., Freeman, M.C., Allen, E., Brauer, M., Cumming, O., 2023. Effectiveness of handwashing with soap for preventing acute respiratory infections in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet* 401, 1681–1690. [https://doi.org/10.1016/S0140-6736\(23\)00021-1](https://doi.org/10.1016/S0140-6736(23)00021-1).
- Ross, I., Cumming, O., Dreibeibis, R., Adriano, Z., Nala, R., Greco, G., 2021. How does sanitation influence people's quality of life? Qualitative research in low-income areas of Maputo, Mozambique. *Soc. Sci. Med.* 272, 113709. <https://doi.org/10.1016/j.socscimed.2021.113709>.
- Schmidt, W., Lewis, H., Greenland, K., Curtis, V., 2019. Comparison of structured observation and pictorial 24 h recall of household activities to measure the prevalence of handwashing with soap in the community. *Int. J. Environ. Health Res.* 29, 71–81. <https://doi.org/10.1080/09603123.2018.1511772>.
- Simiyu, S., Aseyo, E., Anderson, J., Cumming, O., Baker, K.K., Dreibeibis, R., Mumma, J. A.O., 2023. A mixed methods process evaluation of a food hygiene intervention in low-income informal neighbourhoods of Kisumu, Kenya. *Matern. Child Health J.* 27, 824–836. <https://doi.org/10.1007/s10995-022-03548-6>.
- Sinharoy, S.S., Pittluck, R., Clasen, T., 2019. Review of drivers and barriers of water and sanitation policies for urban informal settlements in low-income and middle-income countries. *Util. Policy* 100957. <https://doi.org/10.1016/j.jup.2019.100957>.
- Slesinski, C., Bryant, C., Diez Roux, A., Ezeh, A., Gnilo, M., Stricker, J., 2019. Systematic Review of Interventions and Evidence: Behavior Change Interventions for Water, Sanitation, and Hygiene in Urban Settings.
- Tidwell, J.B., Chipungu, J., Bosomprah, S., Aunger, R., Curtis, V., Chilengi, R., 2019. Effect of a behaviour change intervention on the quality of peri-urban sanitation in Lusaka, Zambia: a randomised controlled trial. *Lancet Planet. Health* 3, e187–e196. [https://doi.org/10.1016/S2542-5196\(19\)30036-1](https://doi.org/10.1016/S2542-5196(19)30036-1).
- Tomoi, H., MacLeod, C., Moriyasu, T., Simiyu, S., Ross, I., Cumming, O., Braun, L., 2024. Determinants of willingness to pay for fecal sludge management services and knowledge gaps: a scoping review. *Environ. Sci. Technol.* 58, 1908–1920. <https://doi.org/10.1021/acs.est.3c06628>.
- Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D., Moher, D., Peters, M.D.J., Horsley, T., Weeks, L., Hempel, S., Akl, E.A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M.G., Garrity, C., Lewin, S., Godfrey, C.M., Macdonald, M.T., Langlois, E.V., Soares-Weiser, K., Moriarty, J., Clifford, T., Tunçalp, Ö., Straus, S.E., 2018. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann. Intern. Med.* 169, 467–473. <https://doi.org/10.7326/M18-0850>.
- Tumwebaze, I.K., Mosler, H.-J., 2015. Effectiveness of group discussions and commitment in improving cleaning behaviour of shared sanitation users in Kampala, Uganda slums. *Soc. Sci. Med.* 147, 72–79. <https://doi.org/10.1016/j.socscimed.2015.10.059>.
- Tzikas, A., Koulierakis, G., 2023. A systematic review of nudges on hand hygiene against the spread of COVID-19. *J Behav Exp Econ* 105, 102046. <https://doi.org/10.1016/j.jsocec.2023.102046>.
- Unicef, W.H.O., 2023. *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2022: Special Focus on Gender*. New York.
- United Nations, 2018. *Report of the Special Rapporteur on Adequate Housing as a Component of the Right to an Adequate Standard of Living, and on the Right to Non-discrimination in This Context*. Geneva, Switzerland.
- United Nations Statistics Division, 2021. *SDG Indicator Metadata - Indicator 11.1.1: Proportion of Urban Population Living in Slums, Informal Settlements or Inadequate Housing*.
- Wolf, J., Hubbard, S., Brauer, M., Ambelu, A., Arnold, B.F., Bain, R., Bauza, V., Brown, J., Caruso, B.A., Clasen, T., Colford, J.M., Freeman, M.C., Gordon, B., Johnston, R.B., Mertens, A., Prüss-Ustün, A., Ross, I., Stanaway, J., Zhao, J.T., Cumming, O., Boisson, S., 2022. Effectiveness of interventions to improve drinking water, sanitation, and handwashing with soap on risk of diarrhoeal disease in children in low-income and middle-income settings: a systematic review and meta-analysis. *Lancet* 400, 48–59. [https://doi.org/10.1016/S0140-6736\(22\)00937-0](https://doi.org/10.1016/S0140-6736(22)00937-0).
- World Bank, 2020. *World Bank Country and Lending Groups*. Data (Basel).
- Yeager, B., 2002. An intervention for the promotion of hygienic feces disposal behaviors in a shanty town of Lima, Peru. *Health Educ. Res.* 17, 761–773. <https://doi.org/10.1093/her/17.6.761>.