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How community participation in water and sanitation interventions impacts human health, WASH infrastructure and service longevity in low-income and middle-income countries: a realist review

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ABSTRACT

Objective To understand how, and under what circumstances community participation in water and sanitation interventions impacts the availability of safe water and sanitation, a change in health status or behaviour and the longevity of water, sanitation and hygiene (WASH) resources and services.

Design Realist review.

Data sources PubMed, Web of Science and Scopus databases were used to identify papers from low-income and middle-income countries from 2010 to 2020.

Eligibility criteria for selecting studies Criteria were developed for papers to be included. The contribution of each paper was assessed based on its relevance and rigour (eg, can it contribute to context, mechanism or outcome, and is the method used to generate that information credible).

Analysis Inductive and deductive coding was used to generate context–mechanism–outcome configurations.

Results 73 studies conducted in 29 countries were included. We identified five mechanisms that explained the availability, change and longevity outcomes: (1) accountability (policies and procedures to hold communities responsible for their actions and outcomes of an intervention), (2) diffusion (spread of an idea or behaviour by innovators over time through communication among members of a community), (3) market (the interplay between demand and supply of a WASH service or resource), (4) ownership (a sense of possession and control of the WASH service or resource) and (5) shame (a feeling of disgust in one's behaviour or actions). Contextual elements identified included community leadership and communication, technical skills and knowledge, resource access and dependency, committee activity such as the rules and management plans, location and the level of community participation.

Conclusions The findings highlight five key mechanisms impacted by 19 contextual factors that explain the outcomes of community water and sanitation interventions. Policymakers, programme implementers and institutions should consider community dynamics, location,

Strengths and limitations of this study

► The size of the review allowed for diverse context–mechanism–outcome configurations to be explored and understood from a variety of contexts from 29 countries.
► The paper identified 19 contextual factors that explain the outcomes of community water and sanitation interventions.
► The papers selected for this review were limited to those available in English, peer-reviewed and available online through a database search but did not include grey literature.
► Most of the papers identified focused on outcomes over a short time period, with only a few looking over 5 years. The short time frames are usually insufficient for behaviour change or water, sanitation and hygiene resource/service longevity to be observed.
► The review only included papers that looked at communities' natural resource management and interventions linked to water, it only included papers where an external party such as an nongovernmental organisation or government was involved in the water natural resource management and/or intervention/s.

resources, committee activity and practices and nature of community participation, before introducing community water and sanitation interventions.

INTRODUCTION

Access to water and sanitation is fundamental for human health.[1] Water, sanitation and hygiene (WASH) interventions continue to be implemented to improve the availability and services, especially in low and middle-income countries (LMICs). This paper examines a range of WASH interventions including hardware interventions such as

new latrines and water supply systems and their operation and maintenance and software interventions such as the introduction of WASH or water committees and health promotion and education programmes and training. The literature shows mixed effects of these interventions—some display positive impacts, with others showing no impact.[2 3] In an effort to understand why WASH interventions fail, there is an expanding body of research seeking to examine the contexts (environmental, sociocultural, institutional, economic) into which the interventions are introduced.[4–7] This research emphasises the importance of understanding the influence of context on the success (or failure) of community WASH interventions and highlights that no single strategy can be successful in all contexts and circumstances.[1 8 9]

WASH interventions can be designed to take into account a broad range of factors such as cultural traditions,[10 11] resource dependency,[12] service quality and satisfaction[2] and the rules and procedures used by a community.[13] Furthermore, the resources required for long-term maintenance of WASH interventions are often limited in LMICs, leading to their failure.[1] Failure of WASH interventions can occur for several reasons, such as a lack of community participation in design,[14 15] a lack of community ownership,[16 17] the abuse of funds or poor financial management,[18] a lack of willingness of community members to contribute,[17–19] a lack of communication and connectedness[20] and no ongoing support and acknowledgement of behaviour change.[21–23]

Current literature shows multiple benefits of community participation; for example, participation is a vehicle for cultural exchange and the building of knowledge among the implementing partners, and it is useful for ensuring that interventions are relevant to local priorities.[7 24] Also, the literature shows that communities (particularly Indigenous communities) have developed knowledge structures by place, space and relationality over generations that are passed from one generation to the next, which provide information on how to use water resources to promote their longevity.[7] Without participation, issues can arise such as communities may have beliefs that do not align with the intervention.[25] Lack of community participation is often seen as a hindrance in collaborative action.[26]

The definition and manifestation of community participation in WASH interventions vary significantly across articles and studies.[4] In rural areas, community participation involves the active engagement of users in water service management.[4] It can also mean the involvement of community members in the planning, construction, decision-making and ongoing management of their water system.[27] Community participation also refers to enabling communities to initiate project ideas, make decisions about technology type and facility location that best suits their needs.[18] In the context of this paper, community participation is defined as community members having a role in planning, design, construction, decision-making, delivery or management

(including financial, operations and maintenance) of WASH interventions.[4 18 24 27]

Understanding the impact of contextual factors is important for designing and implementing long-lasting WASH services within communities, given the vast heterogeneity of community contexts.[6] Some literature reviews have been conducted to examine the impact of specific contextual factors or a single water or sanitation intervention,[4–7] but none have examined contextual factors and interventions in LMICs generally. Our realist review has been undertaken to address this gap in the literature. The aim of the review is to determine how and under what circumstances community participation in water and sanitation interventions impacts the availability of safe water and sanitation, a change in health status or WASH behaviour or the longevity of water resources, infrastructure and services.

MATERIALS AND METHODS
Rationale for using a realist approach
The realist approach was chosen as this approach aims to understand and unpack the mechanisms through which an intervention works or fails in different contexts and settings.[28] It is a theory-driven approach that can help explain why an intervention works in one setting and not in another.[28] The realist approach begins with the understanding that interventions are complex because of their reliance on the interpretation, reasoning and actions of social agents to bring about change[29 30] and that the human agency of these social agents is in turn influenced by the socioeconomic, geographical, institutional structures in which they exist (ie, context).[28] In realist synthesis, an outcome of an intervention is shaped by the interaction between these contextual factors and the intervention, which triggers action or inaction among social agents as determined by their reasoning, which then results in some kind of change (or not). Context–mechanism–outcome (CMO) configurations summarise explanations of how contextual factors (C) influence the production of outcomes (O), by triggering human agency in the form of mechanisms (M). 'Mechanism' refers to the combination of reasoning and resources that influence the actions of participants and stakeholders in an intervention. The mechanism may only be activated under the right contextual conditions.[31] Therefore, WASH interventions may change how a community receives or responds to an intervention, and this is dependent on the context in which they live.

Search strategy
In preparation for the realist review, we conducted preparatory sessions by reading a variety of WASH literature. This helped us identify possible outcomes, contexts and mechanisms to guide the literature search and the best keywords to use. We conducted preliminary searches to see what type of papers were identified and the breadth and depth of WASH interventions covered. This process

guided the final review question as it highlighted gaps in documented knowledge and, in turn, shaped the interventions we focused on, that is, 'new' interventions that were endogenous or exogenous in origin.

Two literature searches of PubMed, Web of Science and Scopus were conducted to identify peer-reviewed papers on how community participation in water and sanitation interventions impacts the availability of safe water and sanitation, a change in health status or behaviour and the longevity of water resources and service outcomes in LMICs. The search terms used were 'water', 'WASH', 'water resource', 'hygiene', 'sanitation', 'community participation', 'demand driven', 'community led', 'community engage*', 'community based', 'community manage', 'sustain*' and 'health'. The search strategy was developed with the assistance of a research librarian. Filters were applied to exclude reviews. Only English papers were considered. Only articles from 1 January 2010 to 3 April 2019 were considered in the first search conducted in April 2019, and only articles from 1 January 2019 to 31 December 2020 were considered in the second search conducted in March 2021. The 10-year time period was chosen because given the breadth and depth of the work in the field prior to 2010, the number of papers included would otherwise be so large as to preclude an in-depth, realist review.[32 33] Papers were identified and exported into Zotero. Duplicates were identified and removed. In conducting and reporting this realist synthesis, we followed the Realist and Meta-narrative Evidence Syntheses: Evolving Standards (RAMESES) synthesis production and quality standards,[32] realist review training materials[33] and other examples of realist reviews.[29 34]

After screening the abstracts, full papers were assessed on the intervention, the outcome of interest, community role, study type and location. Interventions were considered endogenous if initiated by community members, and exogenous if initiated by external organisations, for example, government or non-governmental organisations (NGOs). To be included, the intervention had to have an intended outcome linked to water, sanitation, health or resource/service longevity. Second, the community had to participate in one or more of the following ways: (a) community had the full authority in decision-making, autonomy of the management or delivery of the water resource or intervention, (b) community had the majority of authority in decision-making, management or delivery of the water resource or intervention, whether it was endogenous or exogenous in origin or (c) community members (eg, leaders, community health workers) were involved in the design and/or delivery of an intervention by an external agent, (d) community had a role through participation, consultation or engagement in activities and actions of an intervention by an external agent. Third, the study needed to be conducted in countries considered to be LMICs according to World Bank definitions[35]; finally the paper needed to include primary data. In planning the review, we were aware that community

members may have had varying degrees of autonomy in their work and decision-making power; and the levels of decision-making power of community members could vary and may be low and easily overruled by an external agent.

Formal quality appraisal was not carried out for individual papers as each paper could contribute to a different element of the CMO configurations, and exclusion of papers reduces the ability of a realist review to achieve in-depth understanding.[28] The contribution of sections of each paper was assessed based on relevance (ie, whether it can contribute to emerging CMO configurations) and rigour (ie, whether the method used to generate each piece of data relevant to the CMO configurations is credible).

Data extraction and categorisation

The first database searches found 595 entries from PubMed, 1010 from Web of Science and 1449 from Scopus (figure 1). The searches from each database were merged, and 1346 duplications were removed. A further 30 publications were removed based on their format, as they were a book or a review. After review of the remaining titles and abstracts, 1523 were excluded, reducing the selection to 155 publications. These 155 papers were read and assessed according to the inclusion and exclusion criteria by reviewers (SN and DD, in consultation with SA) on their relevance and rigour. Judgements on inclusion and exclusion were based on two criteria: relevance (does the paper contribute to the understanding of how community participation in WASH interventions impacts any outcome of interest) and rigour (whether the paper is trustworthy, reliable and valid, for example, appropriate statistical tests were conducted for the data used when quantitative, or there is evidence of triangulation and decision-making trail when qualitative). The second database searches found 739 entries from PubMed, 460 from Web of Science and 528 from Scopus (figure 1). The same data extraction and categorisation steps were carried out, resulting in 73 papers being added to the review.

We followed the stepwise approach used by Abimbola et al[29] (table 1). Five papers were randomly selected, and iterative data extraction was conducted independently by three of the authors (SN, DD and SA) to determine the categories into which data would be extracted and to determine the consistency of the extraction process across authors. Data from the papers were extracted into an excel spreadsheet into the following categories: study population, country, community role, intervention, water, sanitation or hygiene linkage, study type and context, mechanism and outcome components. The extraction process guided the initial development of preliminary understandings of what was involved in behaviours, actions, social phenomena and reasonings that connected outcomes with contexts in each paper. These preliminary understandings contributed to the
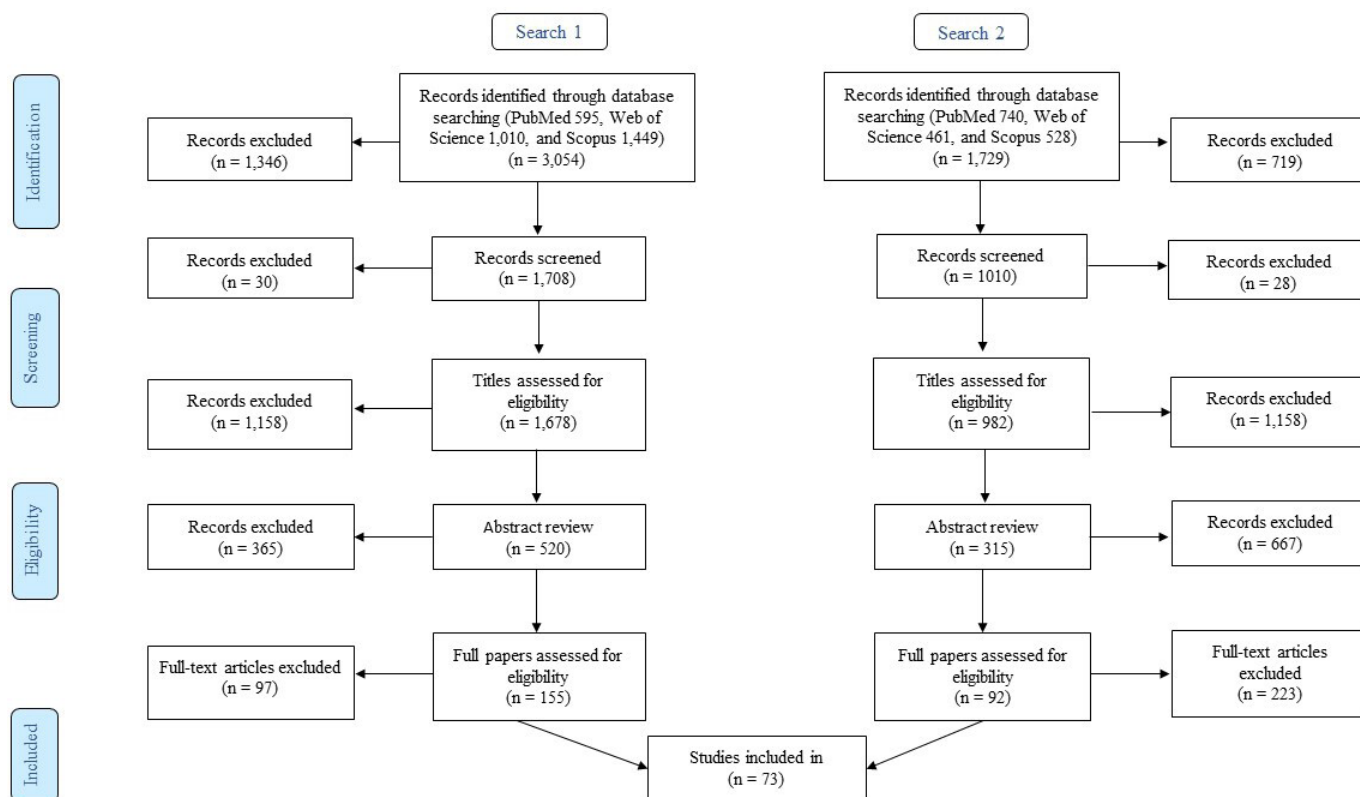
Figure 1 Results taken in the literature search.

creation of mechanisms. It was not always possible to extract data about the outcome, context and mechanism from each paper.

By synthesising the information in each paper, we identified five mechanisms that explain the outcomes from the papers: accountability, diffusion, market, ownership and shame. Individual papers revealed multiple mechanisms. Across the five mechanisms, three sets of outcomes were identified:

1. Availability of resources and services such as clean water and sanitation at an individual or community level.
2. Behaviour change to prevent disease, such as a reduction in open defecation and increase the use of handwashing, altering health status, for example, reduction in disease levels or in health status such as diarrheal rates at an individual or community level.
3. Longevity of water and sanitation infrastructure, services and resources, including factors that impact on their long-term use, such as the technical capacity to repair, operate and maintain infrastructure, resource or service.

We identified factors (socioeconomic, geographical, institutional) that enabled or hindered outcomes, and these were categorised as context. Concurrently, a list of potential midrange theories that could help explain our interpretations of relationships among identified contexts, WASH interventions and outcomes of interest was drawn from the literature and team discussions. The list was refined until five theories could coherently explain the identified outcomes of community participation in WASH interventions.

These five theories are broad in their potential application. For this reason, they were only a starting point for the development of the CMO configurations. Through a process of retroductive analysis,[36] the five theories produced five mechanisms: social accountability became 'accountability' (eg, policies and procedures to hold communities and committees responsible for their actions and outcomes of an intervention), diffusion of innovation became 'diffusion' (eg, the spread or adoption of the behaviour or action due to leaders or influential community members making the change earlier), demand theory became 'market' (the interplay between demand and supply of a service or resource to ensure its availability or longevity), Arnstein's Ladder became 'ownership' (eg, the level of individual or community participation impacts the degrees of control and sense of possession over a service or resource and this impacts the outcomes of interest) and, finally, social comparison became 'shame' (eg, a feeling of disgust in one's behaviour or actions as they are not seen as desired or do not comply with other people's behaviours in the community).

RESULTS

Overall, 73 papers were identified and presented data from 29 countries (figure 2), with different WASH

Table 1	Steps taken in the realist analysis
Step	**Process**
Step 1: Identifying outcomes (description)	This involved reading and rereading the papers, first to gain familiarity with the studies, and second to identify outcomes that occur because of community WASH interventions, for example, how community engagement in water and sanitation interventions impact the availability (of safe water and sanitation), a change (in health status or behaviour) and the longevity (of WASH resources).
Step 2: Identifying contextual components of outcomes (abduction)	This involved further reviewing of papers to find enabling and hindering factors from the identified outcomes. These included skills and knowledge (including financial capabilities and technical abilities for operation and maintenance), social cohesion and connectedness, communication, willingness to pay, leadership, diverse involvement in the intervention (of women and at different stages of design, planning and implementation), community characteristics and location.
Step 3: Theoretical redescription (abduction)	This step involved exploring the selected outcomes and their contextual components within the theories to better understand what they represent. Five theories informed our analysis. 1. Social accountability holds people in place to achieve actions because of fear of exposure, professional or public reprisal or cost of reputation leads to responsiveness by following a certain behaviour or idea.[34] We adapted this theory to include formal accountability mechanisms such as policies, procedures and rules to hold communities and committees responsible for their actions and outcomes of an intervention. 2. Diffusion of innovation theory is the spread or adaption of an idea or a behaviour through a process that people adopt over time.[36] The idea or behaviour spreads through innovators (those who try and idea or behaviour first) and early adopters (opinion leaders who enjoy leadership roles and embrace change opportunities) who influence and change ideas or behaviours throughout the community.[36] We used this theory to explain leaders and key people in the community being innovators who shape and influence WASH behaviours within the community. 3. Demand theory is an economic theory that is the interplay between demand and supply of a good or service (it is a balanced supply and the price that people are willing to pay for it).[37] There is an important dynamic to ensure that the market system does not fail, because of changes in price or demand. This theory was adapted to focus on the supply and demand for water resources and a community's or individuals' willingness to pay for them and other factors that influence the supply and demand balance. 4. Arnstein's ladder of participation proposes that increased meaningful community participation correlates with more power in the decision-making process and, thus, more control over the change it may bring, leading to a sense of ownership.[45] With this mechanism, we focused on how a sense of ownership within resources or service related to WASH such as water can help build a sense of value and lead communities or individuals to manage the resources or service better. The idea being a stronger sense of ownership means that they are more likely to protect it and use it effectively. 5. Social comparison theory purports humans' need to compare themselves and evaluate their opinions and abilities of themselves and evaluate their abilities and opinions through comparing themselves with other people.[56] The influence of social comparison and desire to fit into a specific situation can cause changes in verbal and non-verbal behaviour to fit the situation. Comparison can have negative impacts on behaviours. We adapted this theory to focus on the element of shame as a form of social comparison, for people to conform to an appropriate socially accepted WASH behaviour.
Step 4: Identifying mechanisms (retroduction)	This step involved examining the identified outcomes with their hindering or enabling contextual factors with the aim of creating processes and systems that resulted from observed patterns across LMICs. This involved moving back and forth between primary data theories created in this review to develop explanations for the outcome and contextual linkages.

WASH, water, sanitation and hygiene.

intervention focus (figure 3). We identified five mechanisms made possible by WASH interventions: accountability, diffusion, market, ownership and shame, with 19 contextual factors (table 2). The analysis focused on mechanisms, rather than the country, as we concentrated on community-based interventions and each community intervention and context contributes to a piece of the development of the mechanism. As the country and the type of intervention were not specifically named in the findings, a separate table concerning these has been included in the online supplemental appendix.

The next section commences with a detailed description of each mechanism. This is followed by a description of each mechanism based on the individual outcome and the key contextual factors identified in the review (table 3 provides a summary).

ACCOUNTABILITY

Accountability is more likely to be achieved when the community is easily accessible, opportunities are present to share information and there is a strong and functional
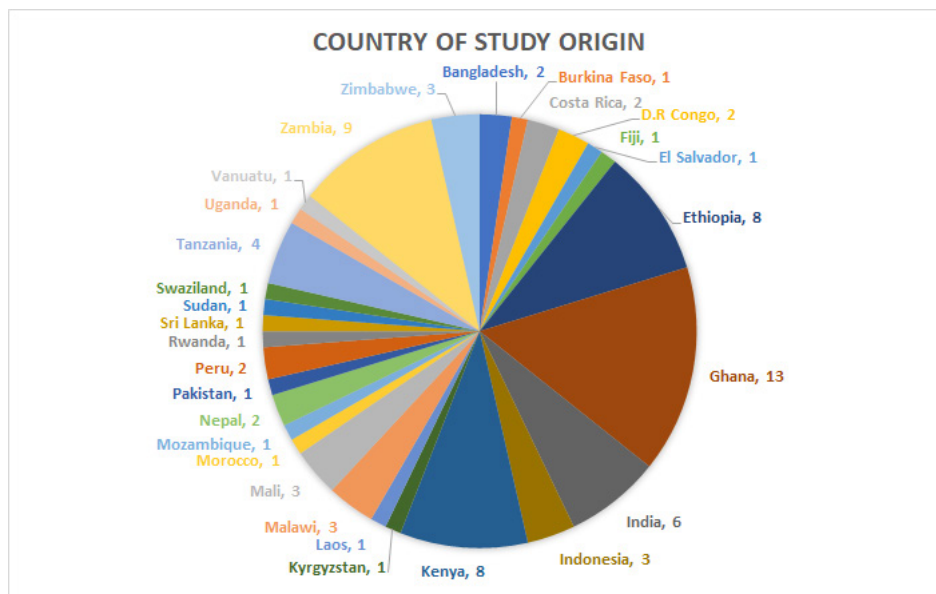
Figure 2 The study country origin.

water committee as it is easier to uphold and enforce rules, procedures and policies. The three outcomes identified were availability, change and longevity.

Availability

Triggered by internal or external monitoring, accountability may result in improved community availability to a WASH resource or service. The focus of such monitoring may be progress towards achieving a goal. The goal may be about the availability of a service—eg, to ensure that sanitation facilities are in place,[10 21 37–43] that facilities meet the needs of people with disabilities[44] or that water is accessible.[45 46] The goal may also be resource preservation (safety and/or accessibility), so that water is available to be accessed as desired—eg, to check water samples for faecal or arsenic contamination[14 47–50] or to assess the level of groundwater available for agriculture throughout the year.[51] Internal monitoring can be conducted by a chief or village headman,[10 21 38] locally trained volunteers,[48] community members[40 51] or by the community's health, water or community—total led sanitation committee.[37 39 41 45 46 48 50] External monitoring can be

conducted by NGO facilitators,[40 44] health workers[39 43 52] or political leaders and council officials.[37]

Opportunities and platforms for regular communication and meetings involving community members, service users and health or water committees help build a sense of trust and connection among all parties and help to hold everyone accountable.[44 47 48] This is reinforced where community leadership is transparent and has open channels for communicating with community members,[10 21 38 45] communities make plans to change, that is, display of stickers to show the commitment to build latrines,[42] and the use of technology allows up-to-date monitoring.[38 50] Government guidelines can reinforce safe standards and monitoring of resources, egfor example, water.[37 53] Accountability is also strengthened where there is a functional, long-standing water or health committee whose members are active, motivated and committed and have clear roles and responsibilities.[45 46] These roles and responsibilities can be reinforced through committee trainings.[50] A gender-balanced committee opens up the space for accountability, as more opinions and views are considered on what factors are important and need consideration.[41 45 46 49 54 55] There can be challenges in accepting the involvement of women in a gender-balanced committee.[41]

Change

Ongoing external monitoring can hold communities accountable for changing their health, hygiene and sanitation behaviours,[37 39–41 44 52 56 57] leading to improved health of children as seen in height and weight changes and diarrhoea occurrence.[41 56] Without ongoing internal or external monitoring, loss of momentum for change can occur, halting behaviour change progress.[22 37] Ongoing monitoring is enabled by regular meetings and sharing of information to enforce behaviour change.[24 41 48] However,
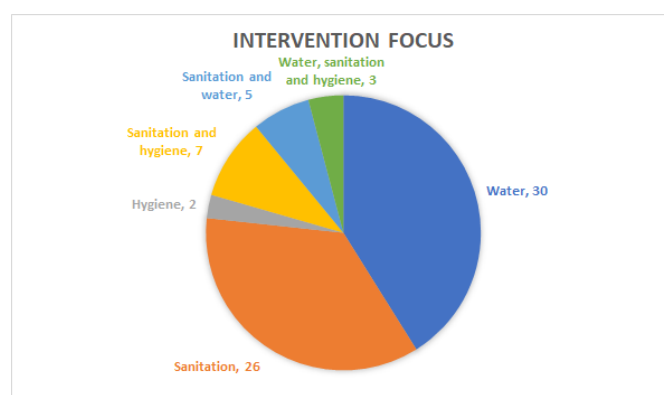

Figure 3 Intervention focus.

Table 2 Contextual factor examples

	Contextual factor	Examples
1	Community location	Easily accessible location and community layout and size with reliable transport[37 45 56]
2	Communities with similar characteristics	Communities with similar values and homogenous characteristics such as socioeconomic status[38 58 83 96]
3	Communication	Regular communication and places to share information, for example, meetings between communities, committees or organisations[10 16 19 21 27 37–39 44 45 47 48 59 72 76 99]
4	Leadership	Community or committee leadership lead and help enforce change in behaviours or standards of services[10 11 38 40 58 65 66 68–71 73 80 95 97]
5	Fines or penalties	Fines or penalties in communities when people do not conform to the desired behaviour or their sanitation facility is not up to the appropriate standard[10 24 37 47]
6	Seasonality	Variation in weather over different times of the year[49 62]
7	Resource dependency	Communities' need the water resource for their health, livelihood or income[15 18 48 54 74 75]
8	Access to resources and funding	The communities or committees' ability to access funds through user fees or funds from the community or government[20 37 39 41 47 48 53 78 80]
9	Financial and technical skills and knowledge	Community or committee ability to manage money and make financial decisions. Technical skills to operate and maintain WASH services or infrastructure over time or when issues arise[17–20 23 37 45 56 61 77 80 83 90 95 98]
10	Ongoing support and acknowledgement of change	External or government support for communities with the resources they need; and acknowledgement of changes in behaviour.[21–23 98]
11	Community connectedness and social cohesion	Ongoing interaction and linkages in communities and cooperation as people engage and work together.[8 20 37 51 58 77 128] These can be through collective action or mobilisation of resources to work as a community[27 74 79 81 128]
12	Community willingness to pay	Communities' willingness to pay user fees or provide money to invest in resources or services for use or operations and maintenance[16–18 20 50 53 62–64 80]
13	Committees with followed and understood responsibilities	Committee with clear responsibilities that are followed and understood by its members[24 45 46]
14	Rules and management plans	Structures and processes in place that guide actions for operation and maintenance of resources, services and behaviours of the community or committee[14 16 18 20 24 46–48 50 53 58 61]
15	Active committees that include women	Committees that are active and inclusive in communities with decision-making, maintaining resources and services[15 18–20 24 27 41 45 46 49 51 54 55 75]
16	Community/committee involvement in the design, planning or implementation of the intervention	Community and committee involvement including women and those with disabilities with design, planning or implementation of the intervention to ensure the needs of all people are considered and met[14 15 18 50 60 61 87–89 91 92 94]
17	Monitoring (including reports)	Ongoing monitoring of communities and committees including reports by internal or external parties to ensure availability and longevity of resources or services and behaviour change occurs[10 14 21 37–46 48–52 57]
18	Trust	Trust in, by or among members of communities, committees, and organisations inspires confidence that allow people to comply with paying fines,[17 24 47] take action or change their behaviour.
19	Incentives and rewards	Communities rewarded through internal or external parties, for example, through prizes or sharing success stories in the newspaper[10 38 43 45 56 76]

WASH, water, sanitation and hygiene.

limited availability to communities due to a remote location, inadequate or unreliable transport, violence and large community size and layout or understaffed organisations are barriers to ongoing external monitoring.[37 45 56] Accountability can also influence behaviour change when triggered by fines (eg, money, goat or chicken) imposed as a penalty for not conforming to the desired behaviour.

For example, penalties can be used to enforce standards for latrines,[24] for not constructing a latrine and for open defecation,[10 37] and fines given for not abiding by water use limits.[47] Trust is an essential contextual factor for such penalties—tensions arise when a community does not trust the person or committee collecting the fines and what they will do with the fines.[17 24] Trust depends on the

Table 3 Enabling context–mechanism–outcome configurations

Context	Mechanism	Outcome
► Easily accessible community (eg, size and location) to allow access for monitoring visits. ► Having opportunities to share information (eg, meetings) between users and committee members for internal monitoring. ► Having active and functional community committees for internal monitoring. ► Committees with clear responsibilities, rules and management plans that are followed and understood (eg, written working plans for system breakdowns). ► Having consequences for not conforming to change (eg, fines).	Accountability	► Availability of a WASH service or a water resource, for example, to ensure that sanitation facilities are in place or to assess the levels of groundwater. ► Changes in behaviour or health outcomes, for example, reduction of open defecation, improvements in children's height and weight. ► Longevity of water resources and services.
► Having strong leaders or committees to help share the spread of ideas and initiate change. ► Having higher levels of social cohesion and connectedness in small rural and remote communities to help create supportive environment for change and influence new social norms. ► Having regular communication among peers to build and share knowledge.	Diffusion	► Availability of resources or services, for example, latrines, handwashing facilities and water. ► Changes in behaviour or health outcomes, for example, reduction of open defecation, water purification and waterborne diseases. ► Maintenance and longevity of latrines and water access/systems.
► Having community or committee knowledge or skills, for example, technical—the ability to repair hardware. ► Having resource dependency to ensure community investment in supply and ongoing maintenance and operational costs. ► Having a resource or services that are not impacted by the weather.	Market	► Availability of resources, for example, water. ► Longevity of water services or latrine quality.
► Having community or committee knowledge or skills, for example, technical—the ability to repair hardware. ► Having resource dependency to ensure community investment in supply and ongoing maintenance and operational costs. ► Community involvement (including women and those with disability) in the design, planning or implementation to promote accessibility, equitable access and the desire to maintain the resource. ► Having opportunities to communicate about the state of the resource or service to help maintenance.	Ownership	► Availability of resources or services, for example, water and latrines. ► Longevity of the water system or service.
► Small, cohesive and isolated communities with high social cohesion and connectedness help the conformity of behaviour. ► Having community involvement allows understanding of the impacts of the behaviour and the benefits of change. ► Shame initiated by leaders and people known within the community helps acceptance, monitoring and enforcement. ► Community technical or financial capabilities allow the ability to conform to change. ► Ongoing support and acknowledgement of change for community motivation to maintain changes.	Shame	► Availability of WASH resources, for example, individual or household ownership of latrines and handwashing facilities. ► Change in behaviour or health outcomes, for example, reduction in open defecation, handwashing with soap, reduction in roundworm infestation and stunting.

WASH, water, sanitation and hygiene.

person or committee's record of financial management, and whether they have clear rules about the use of such penalties. Lack of trust from external organisations can also prevent change in communities' behaviours.[47]

Longevity
Accountability within community committees can facilitate their continued activities, therefore promoting the longevity of WASH resources and services for which they are responsible. This requires that committees have internal feedback systems, take minutes and set agendas with written working plans, demonstrate high self-organising capabilities and a sense of obligation among committee members to attend meetings and take action to manage and maintain resources, thus contributing to the longevity of water and sanitation interventions.[16 24 46 48 53 58] Accountability to government entities

(eg, water boards) for reports and abiding by government policies can promote longevity as this can hold committees and communities responsible for funds to maintain WASH resources and services.[14 16 53 59 60] Communication with the broader community holds committees accountable for their roles and responsibilities concerning water and sanitation infrastructure in a community.[16 27 59] Communication can also help enable the diffusion of efforts to change the landscape of governance within local communities, check the progress of actions and the enforcement of rules.[10 19 47]

Committee accountability is enabled when committees have clear roles, responsibilities, rules and procedures (which they understand) on responding to system breakdowns and managing ongoing maintenance and missing parts, with direct implications for the longevity of water availability and WASH infrastructure.[20 24 46 50 53 61] The longevity of resources and services is facilitated by a committee's ability to make funds available or having bank accounts for operational and maintenance costs and by the committee having rules and procedures for fund management (eg, having an educated treasurer who manages and collects funds within the community) or by having the community participate actively in monitoring committee finances.[14 18 20 46 47] Issues with longevity can also arise when there has been abuse of funds or poor financial management, and, therefore, community members are less willing to contribute.[17–19] Transparency in committee activities and community trust can help address this.[47] Committee activity and social participation play key roles in managing maintenance and operation of water and sanitation systems and can assist in the management of funds ensuring continued service provision.[15 54 61–63] This can promote good governance and practice.[15] While committee activity and social participation is an enabling factor, this alone is not enough to ensure the longevity of community water and sanitation infrastructure.[64]

DIFFUSION

This mechanism captures the processes by which an idea, technology or behaviour that is perceived as new (ie, they are considered innovations in a community) spreads and is adopted by individuals or a community. Our interpretation of how the diffusion of innovation theory works to bring about change was guided by the LMIC contexts from which we drew our review data. Diffusion of ideas in communities was observed as mostly unplanned, horizontal and peer-mediated spread;[30] however, in cases where the innovation was endogenous, it was more likely (when compared with exogenous interventions) that adoption was actively promoted,[65] this difference can be explained by the effect of a sense of ownership, which is explained in the mechanism ownership.

The diffusion mechanism underscores that strong and stable social relations are essential for wide and sustained adoption of WASH interventions in communities and

illustrates the importance of *who* introduces new ideas, behaviours or technologies (exogenous WASH interventions) or champions homegrown new ideas, behaviours or technologies (endogenous WASH interventions). Champions are identified as 'innovators' (ie, individuals who are the first to develop and try out new ideas) and 'early adopters' (ie, opinion leaders who enjoy leadership roles and embrace change opportunities) who over time through their influence and their existing relationships and communication with members of the community[66 67] can encourage adoption of new ideas, both passively and actively. Innovators and early adopters in a community include teachers,[68 69] leaders,[10 21 37 38 66 68–71] healthcare workers[52 68 69 72 73] and community committees.[20 58 74 75] This mechanism is triggered primarily by contexts of strong social relations, and our analysis resulted in availability, change and longevity outcomes.

Availability

In communities lacking provision of basic WASH infrastructure by governments, availability to services can be obtained through external agencies such as NGOs or by internal innovation. In both cases, availability of services is not instantaneous and depends on motivation, organisation and negotiation; the successes of which are in turn shaped by the character of social relations within a community, the more cohesive the better. In this way, availability of resources such as latrines,[8 11 37–39 42 58 65 70 71 76 77] water infrastructure such as pipes[27 75 78 79] and handwashing facilities[37 39 65 76] can be driven by diffusion; when these facilities or the idea of them are new, the collective action necessary to build or obtain them depends on the extent to which appreciation for their value spreads in the community.

Additionally, information on community-led interventions that reflect the needs of the community take root more readily than interventions introduced by external sources, as they often do not address community needs accurately or at all. Information about the need for the WASH infrastructure or service can diffuse more readily where people have similar experiences of need and importantly high levels of social cohesion and sense of connectedness. Social cohesion and connectedness refer to the extent of ongoing interaction and linkages in communities and cooperation as people engage and work together.[8 37 58 77] This builds on social constructs such as social capital and collective action, where individuals' shared knowledge and trust can promote cooperation through self-organisation, action and information sharing.[20 58] Communities with greater cooperation, shared norms and values can act more collectively.[51 58 77] This means that people may be more concerned about others, may be more likely to cooperate, communicate and work with one another and agree on community priorities and goals. Attainment of WASH resources is made easier if a significant number of people believe in its benefit and value. Social cohesion helps to promote infrastructure or resource attainment and ultimately

change in access to WASH, as without it, early adopters are not be able to build the necessary momentum, enthusiasm and confidence.[8 42 58 77] In communities of high social cohesion, innovators can draw on the existing influence of leaders to set new social norms,[11 38 42 70] and early adopters draw on the existing skills within the community to work on a resource or intervention.[27 38 58 75] The success, respect and acceptance of the early adopters can provide the rest of the community confidence to adopt the new social norm.[37 42] Diffusion can also occur within sections of the community such as among women and other community groups, as within these smaller groups, they may have different sets of social norms and acceptable behaviours.[11 75] Locally accessible resources enable availability.[37 39]

Change

Diffusion can occur through communication among peers, which leads to shared understanding, therefore reinforcing the adoption of new behaviour at an individual or community level.[38 58 68 79] Examples of diffusion influencing behaviour change include reduction of open defecation,[10 37 39 57 60 65 66 69 80] water purification,[79] disposal of rubbish and care of animals[57] and sanitation and hygiene behaviours such as handwashing and safe disposal of faecal material,[41 65 71 75] which may lead to improved health outcomes such as a reduction in diarrhoea rates, waterborne diseases and respiratory infections.[37 41 52 72 75] Behaviour change is enabled by diffusion in communities with high levels of social cohesion and connectedness by enabling communication among peers, to build and share knowledge, that is, through community and marketing events or radio shows,[37 39 58 65 72 76] and as highly regarded leaders influence the spread of new behaviour and create new social norms through their endorsement.[11 19 65 66 69] Higher levels of social cohesion in small rural and remote communities can also help sustain long-term behaviour change (eg, reduction in open defecation), especially where people stick together to create a supportive environment for long-lasting change. In these contexts, the focus is on behaviour change at the community rather than at an individual's level.[57 69] Increased latrine quality and cleanliness can reinforce behaviour change.[39 41]

Longevity

The longevity of resources such as water pumps or piping infrastructure has often been difficult to achieve in LMICs, where resources and technical expertise required for their maintenance are not readably available. However, if the value of the resource, through demonstrated health benefit, for example, has diffused and taken root in a community, this can assist in the mobilisation of efforts to maintain the resource or service. Strong social bonds among community members characterised by shared goals and trust help facilitate the spread of information about the benefit of new ideas and encourage their adoption.[27 58 68 70] The perceived need to collectively mobilise resources to address water or sanitation problems is shared by committees and within communities.[27 74 79 81 82] The willingness of community members to help one another further leads to longevity of resources such as latrines[8 76] and water access,[74 79] through the maintenance of the resources.[27] Gender-balanced committees or the active involvement of women facilitates the spread of ideas within the community, especially about resources such as water systems that women are particularly involved in using and managing daily.[19 20 46 51 75]

MARKET

The market mechanism operates through the balance of demand and supply, determining the price of a good or service. It is a mechanism that allows the distribution of resources; however, the dynamic balance between supply and demand can easily be thrown out of balance and cause failure. Typically, when a good or service becomes more readily available and supply increases, prices tend to fall, and when the demand for a good or service reduces, prices tend to increase. The continued presence of a market system is important as it is also a way that communities and people support themselves. Supply and demand of resources, especially in relation to WASH, is influenced by contextual factors such as community or committee knowledge and skills, resource dependency and use in the community, ability to access resources for operation and maintenance and a weather resilience system. These factors influence the want and need for WASH services and resources. Market systems need to be resilient and adaptable to address fluctuations in supply and demand to ensure that there are continued WASH resource or service availability and longevity for communities.

Availability

Knowledge mediates relations between supply and demand, and lack of knowledge results in an imbalance between supply and demand. Without knowledge, the availability of a WASH resource or service may remain low, even when it is available at an affordable price. Hence, to lead to improved use, efforts to increase and improve the quality of supply (eg, through training to increase the skills of local artisans on well design) require complementary efforts to increase household knowledge (eg, through social media and public demonstrations).[83]

Where communities have alternatives to a safer water supply that they perceive as meeting their needs and protecting their health, they may be less willing to invest in the longevity of the safe water resource/service. Hence, a greater perceived need for WASH resources (eg, high levels of need for clean, safe, drinkable water for domestic purposes) means it is more likely that a community will invest in its supply (eg, by promoting local development of skills required to maintain hardware), thus, helping to maintain or increase the availability of water.[15 18 48 54 74 75]

Longevity

Varying levels of demand for a WASH resource or service due to seasonality can influence longevity. For example, water kiosk services are viable during the dry season when people are willing to pay for water because of limited rain and availability of water. Market failure occurs for water kiosks during the wet season as there is increased water supply with cheaper options, and the service becomes unviable in the long term.[62] Willingness to pay for a water system[16–18 20 62] and community water supply project costs[50 63 64] often determines a system's reliability or longevity, and this is linked to demand, affordability and financial capacity in a community. The ability to access resources and funding is important when communities lack knowledge and skills, and the ability to pay for such skills is lacking.[48]

User fees are often imposed when there is limited internal or external financial support, and the WASH resource or service requires ongoing maintenance and operational costs. User fees can help to regulate demand and promote the responsible use of resources, promoting longevity,[48 53 63] although this requires enforcement to pay fees.[47] Low levels of willingness to pay (sometimes reflecting low levels of need or capacity to pay) can be a barrier to operation and maintenance and longevity of the water service and latrine quality.[15 18 20 48 63] Where willingness exists in conjunction with the inability to access funds, resources or need from external funding availability to water and latrines is compromised.[20 53 80] Willingness to pay may also depend on satisfaction with and quality of the service, which in turn depends on how well a service is operated or maintained.[18]

OWNERSHIP

Endogenous interventions (interventions initiated by community members) are better at reflecting and meeting a community's needs compared with interventions that are brought into the community by external agents with minimal or without community consultation and involvement. These are two extremes of a spectrum of community involvement captured in Arnstein's Ladder of Citizen Participation,[84] which proposes that increased meaningful community participation correlates with more power in the decision-making process and, thus, more control over the change it may bring. Control of an object, process or idea is considered a key characteristic of the phenomenon of ownership.[85] Examples of total ownership are rare in the literature yet are common in day-to-day practice within communities. However, well-planned collaboration between communities and external agents, which engage communities in coplanning, coproduction and comanagement[86] or maintenance can achieve 'citizen control' and build an effective sense of ownership while overcoming barriers of access posed by lack of resources. Meaningful participation as coproduction is important as people often feel that they own something they create, shape or produce.[85] A secure sense of ownership over a water resource, water infrastructure or hardware is crucial as it promotes investment and commitment to its preservation at individual and community levels. Community involvement and inclusion, power and control are all necessary for an individual or community to feel a sense of ownership over WASH infrastructure, and this sense of ownership has a significant impact on shaping outcomes availability and longevity of WASH interventions.

Availability

The need for the resource can help promote ownership, as the communities have a dependency on it and take greater steps to ensure the availability of resources such as water and latrines.[37 38 47 49 51 76] Ownership can be initiated by need or want of a resource: such that as a community plays a role in obtaining an intervention, their sense of ownership can be increased when the intervention is in place, thus creating a self-reinforcing loop between availability and ownership. The extent to which community members feel a sense of ownership towards a resource can influence whether they seek external or draw on internal technical and financial support to ensure that the resources (eg, water and sanitation facilities) are in place.[20 27 41 48 58 69 87] High level of social cohesion and connectedness is an enabler of efforts to access external funds or mobilise community resources.[20 27 47 58 87] Access to loans and grants can help promote ownership.[41 47] The involvement of a broad range of community members in water and sanitation interventions can promote a collective sense of ownership, which, in turn, can facilitate social cohesion and connectedness by providing opportunities for a community to share a common goal.[8 88 89] Promoting community ownership of a resource, involving community members in capacity building (eg, in managing the resource) and involving women, leaders and people with disabilities (eg, in decision-making) can ensure availability, and access is equitable and safe.[37 38 44 46 47 51 59 68 76 89 90]

Ownership by a range of community members, including those who are often underrepresented in positions of power and control, can increase availability for these community members as with ownership comes the opportunity for people to alter what they own, therefore satisfying their needs.[85]

Longevity

Ownership is enabled by the involvement of communities in the codesign, coplanning and coimplementation of hardware, increasing the likelihood that the resource reflects the community needs,[14 88] the costs are appropriate and affordable,[15 18] the community has the appropriate information for operations and maintenance,[18 50 61 91] and the community is willing and able to commit to bear hardware costs and ongoing operational and maintenance costs,[15 60 92 93] thus becoming self-sufficient.[15 18 87] In the absence of this, a community may need to rely on external sources for the longevity of resources.[17 49 63 91 92] Ownership is enabled when communities are allowed or granted decision-making authority

in operations and have responsibility for the maintenance of hardware.[17 94] Taking ownership requires a leader or committee to champion action,[16 34 48 50 87] especially when a leader or committee has to manage the hardware (eg, in terms of speed and adequacy of repair) and to raise and manage funds necessary to maintain the hardware (eg, their water system) in the long term.[46 48 50 55 61 74 78 87] Financial management ability can be hampered when communities have low budget resources or communities are unable to afford the service and the committee receives limited funds to maintain a water system, impacting the longevity of the water service.[14 48 49]

The capacity to manage WASH hardware can promote a sense of ownership.[16 20 50 51 63 88] Therefore, retention of human resources and committee members can lead to resource/service longevity as knowledge and skills are retained in communities.[20 45 61 95] Having a broad variety of members (including women) on such committees can promote buy-in from the community, and diverse voices in decisions can lead to a greater sense of ownership and desire to maintain the resource.[15 18 24 27 45 46 49] Men typically manage the operations and maintenance of water systems, and women manage the collection and domestic uses. This leads to women facing a greater burden in maintaining water quality and supply. Women may need to travel further to collect the same volume of water or to care for ill family members. Because of this burden, it is important for women to have a voice in decision-making. Involvement of women can increase their sense of ownership and enable them to independently fund, plan, build and maintain water systems,[75] allowing them to gain status, take on leadership roles and support younger women in the community.[15 75] Women can communicate with the committees about system breakdowns, and without this, such information sharing that leads to repair may not occur.[27] Such active communication reflects ownership and indicates a willingness to work together and build connections within the community, which promotes longevity by facilitating ongoing response to maintenance issues.[20 51 74 79] Lack of ownership of hardware can occur in communities with low socioeconomic status as they may have other priorities, or where the need for the hardware is limited, which in turn limits commitment to its maintenance.[16]

SHAME

Shame is based on the theory of social comparison where others compare themselves to those around them to determine their own self-worth. This comparison can trigger disgust, disappointment or embarrassment in one's behaviour or actions. Shame is activated by individuals comparing themselves with others. The shame of not conforming to the appropriate (handwashing) or undesirable WASH behaviours (open defecation) leads communities or individuals to change their behaviour or action to become more socially acceptable. Shame can be leveraged as a feature of interventions that seek to reset community norms, for example, community members can be educated that open defecation and not washing hands is disgusting and is harmful to the whole community. Comparison between individuals, between households and between communities can lead to shame as it brings out elements of competition and can result in shame from the loss. Capturing shame may manifest by the introduction of incentives (eg, prizes and rewards) to motivate communities to achieve a water or sanitation goal in comparison to others.[10 38 43 45 56 76] Contextual factors such as socioeconomic status, location, leadership, resources and social capital enable and reinforce the appropriate and desired behaviour or action. Availability and behaviour change are the two outcomes associated with the shame mechanism.

Availability

Without external support, shame can promote the availability of and individual/household ownership of latrines[21 37–40 42 44 65 69 71 73 76 80 90 96–98] and handwashing facilities.[37 39 43 65 68 76] These outcomes are limited in communities and households with financial and technical challenges.[23 37 56 77 80 90 98] Enablers include initiating shame by leaders and people known within the community, which helps the acceptance, monitoring and enforcement of new norms.[21 38 40 65 69 71 73 76 97] For example, effective leadership in smaller homogenous communities may be more likely to achieve behaviour change, because people have closer relationships and are mindful of the impact of their behaviours on others.[38]

Social cohesion and connectedness are important enablers of household latrine construction because cooperation and collective action can help overcome the inequality in resources and skills necessary to build latrines.[11 22 37 58 66 68 70 77] Together, social cohesion and connectedness can promote friendship and community respect, and an appreciation of social benefit of private goods that may help reduce open defecation.[76] Collectively they can also enable shame to be transmitted throughout a community. However, when communities lack technical or financial capabilities,[23 80 90] availability may be compromised by the lack of privacy and safety (eg, in the construction of low standard latrines),[90] although when the new social norm is sufficiently established, communities may seek to repair or rebuild such facilities.[69 80] The shame of losing in a competition can have a negative effect on the non-winners who may be demotivated as a result.[76] Improvements in the availability of latrines and handwashing facilities[43 76] may occur as a result of the motivation of winning prizes (eg, motorcycles) or simply the right of a leader to claim they 'won' by their community being first to become open defecation free.[38 43]

Change

Efforts to avoid shame can result in a change in sanitation behaviour (ie, reduction in open defecation, increase latrine use, appropriate disposal of excreta material and

clean facilities)[10 11 23 37 38 40 45 56 65 66 68 71 80 83 96–99] and an increase in levels of overall hygiene behaviour, including handwashing[23 24 65 96] and safe drinking water and storage.[23 71] These changes impact health outcomes such as a reduction in childhood diarrheal disease, roundworm infestation and stunting.[38 56 71 77 80 97] Behaviour change for sanitation and handwashing is limited where prior beliefs about the negative impact of open defecation are weak,[97] where open defecation solves a cultural problem such as men and women not being allowed to share a toilet,[10 11] where there is a focus on latrine construction over utilisation,[96] where there is a lack of water for latrine cleaning and handwashing facilities close to latrines[80] or where the latrine is full.[98] Slippage in behaviour change for safe drinking water and storage could be due to fatigue or loss of motivation, for example, refusing to cover stored drinking water[23] or because of affordability issues.[71]

Shame may be a better mechanism situated in smaller, cohesive and isolated communities with shared views, as people want to fit in and conform to social norms,[83 96] or where effective leadership and community involvement help reinforce a change in social norms[10 40 68 80] or where high social cohesion and connectedness makes people more likely to conform for the benefit and social well-being of the community,[8 37 77] especially as social pressure mounts and community tolerance for undesirable behaviour decreases.[11 21 77] Latrine quality and cleanliness can help ensure people use latrines and feel safe.[40] Increased respect and social acceptance for latrine ownership can help the shift social norms.[37] Celebration by village members and local media coverage of open defecation free status can reinforce the undesirable behaviour and shame of those not conforming to the social norm.[40]

Effective leadership is an important enabler of reduced levels of open defecation in communities, as it helps reinforce changes in social norms.[10 65 68 80] High rates of latrine ownership and availability can indicate a change in social norms and the acceptance of the new behaviour.[69] Communities with a lead role in an intervention can help identify the impacts of their behaviour and help individuals understand the importance of change in behaviour, leading to a paradigm shift to promote sanitation facilities and stop open defecation.[80] However, an increase in latrine ownership does not always guarantee their sustained use, nor link to an increase in handwashing or reduction in open defecation.[10 23 69 80] Without ongoing support, acknowledgement of change and loss of messaging impact, behaviour change is unlikely to be sustained as there is a tendency for fatigue or loss of motivation within communities.[21–23 98]

DISCUSSION

In this realist review, we investigated how (mechanisms) and under what circumstances (context) community efforts and decisions regarding WASH interventions promote health and resource or service longevity (outcomes) in LMICs. We identified 5 mechanisms:

accountability, diffusion, market, ownership and shame and 19 contextual factors (table 2) that may lead to positive and negative outcomes for availability, behaviour change, health and resource or service longevity in both external and internal interventions in a community setting.

Our findings are similar to those of Jiménez et al,[4] Loevinsohn et al,[5] Novotný et al[6] and Stefanelli et al[7] who reported that community cohesion and connectedness, community participation or empowerment and skills and knowledge are enabling factors. Other factors that these papers found to influence availability and longevity of WASH interventions were access to adequate and timely information,[4] and limited transparency and accountability which can lead to inequalities in services.[5] These other findings reflect the need for awareness of the key contextual factors we identified such as leadership and diverse involvement to be considered when establishing interventions. These contextual factors were shown to have positive and negative outcomes. Of the 19 contextual factors, social cohesion and connectedness, leadership and diverse involvement in the intervention (including of women and at different stages of design, planning and implementation) stood out as being common across successful interventions. Other evidence highlights limitations in existing WASH interventions aimed at reducing infections and suggests the need for greater intensity (eg, through frequent contact between promoters and community members) to facilitate and track behaviour change.

Monitoring is a major component of the accountability mechanism, and it can be conducted through multiple forms, including reports and follow-up visits. The wider health literature shows other forms that monitoring takes including sentinel surveillance, syndromic surveillance, surveillance by proxy, environmental monitoring or event-based surveillance.[100–103] There are several downsides of ongoing monitoring including expense, time-consumption, labour and resource-intensivity, and an increased frequency can induce reactivity from subjects.[104 105] Outsider reporting of activities and changes may also not be accurate.[104] The length of time involved in monitoring and observation may be inconvenient for households and communities and may change their routines.[105] While there are downsides, increased focus on the utilisation of monitoring is an important tool in WASH interventions and should be prioritised. Monitoring can also be used further as a tool to help guide decisions, for disease prevention and resource allocation.[102 106]

Diffusion of innovation has been widely identified as a mechanism in public health and not just in the WASH sector, for example, in the adoption of new health policies and technologies and the use of new drugs.[107] Our findings are in line with studies showing the use of diffusion of innovation in sanitation interventions,[108 109] and add to the new growing body of literature of the use of diffusion in water interventions.[110] While diffusion of innovation is

an important mechanism, it is important to acknowledge the psychological and physical health benefits of what is being adopted,[111] and new behaviours may need to be adapted to meet the cultural needs of the target population[107 111] before adoption. A downside of the diffusion mechanism is that blame can be put on an individual and on those of lower social economic status who are unable to confirm or adopt an innovation or new behaviour due to financial barriers.[111] These are important components to consider while planning WASH interventions to prevent unintended consequences such as creating further taboo and increased inequalities that can grow and create divisions within communities. If diffusion of innovation is used as a mechanism, then steps need to be taken such as funding and support to ensure all members of a community can engage in the new WASH behaviour.

The market mechanism builds on the economic theory of demand. For this mechanism to be sustained, there needs to be a delicate balance between supply, demand and pricing of the resource.[112] The downside of markets is that they may not be sensitive to the cultural and social dimensions involved in the use of water and sanitation services or resources.[113 114] To address this, pilot programmes should include consideration of relevant cultural and social dimensions in their assessment of acceptability. Furthermore, the market mechanism does not take into consideration the effects of climate change and the changing population demands.[113 114] Climate change is an important component that needs to be prioritised and considered in designing for market systems but may require changes in planning and costing. The incorporation of climate change into market systems could help create more resilient adaptable WASH systems and wider environmental benefits, without the need for major policy changes.[115 116] The market mechanism could also be applied at a global scale to help address the growing pressure on global water resources.

The finding that ownership is a key component for health intervention sustainability, has also been reported in Sub-Saharan Africa,[117] and in successful water supply and sanitation interventions in LMICs in other regions.[118] Ownership can be difficult to achieve, especially so it is characterised by equality and fairness within a community, particularly as privilege and socioeconomic status impact who has a voice, whose voice is listened to, who has the power or influence within the community to be involved in decision-making and negotiations.[119] In other research, the literature that was used to inform the development of ownership mechanisms and a focus on coproduction was based on examples in high-income contexts where priorities and the power of communities and individuals are different to those in LMIC settings. Further research is required to better understand the relationship of ownership and power in LMIC settings.

The shame mechanism was found to be woven into many behaviour change sanitation interventions and has been employed by community-led total sanitation since the 1990s.[120] However, recent arguments in global

health emphasise that shame should never be employed as a mechanism to drive improved health outcomes,[121] because it can lead to psychological harm especially among poor households who cannot afford to make the required changes and because it can be a direct attack on a person's identity or dignity and be detrimental to their self-esteem.[19 122 123] A focus on shame could create further taboo in WASH behaviours and potentially limit discussions and acceptance of interventions in communities. Before using this mechanism, detailed discussions with community leaders and members need to occur to highlight the potential downside of focusing on shame and whether alternative mechanisms are more appropriate.

Further work is needed to refine our five proposed mechanisms and CMO configurations in empirical studies. We recognise that there are alternative theories that could be used to explain the outcomes in the identified studies. For example, nudge theory would provide an alternative explanation to accountability where positive nudges within the community such as monitoring or meetings act as a positive reinforcement for their behaviour change or actions. Ongoing meetings and monitoring may also be seen as positive nudges for people to perform the socially acceptable behaviour or action. On the other hand, fines for defaulting act as negative nudges and reinforce the appropriate actions and behaviours.[124] The transtheoretical (or 'stages of change') model also offers an alternative explanation for behaviour change at the community level with a key contextual factor being the selection of natural leaders who can help guide and influence communities through the stages of behaviour change.[125] The transtheoretical model can be linked to shame, as actions taken to provide information about others' approval for a behaviour such as a walk of shame to indicate open defecation behaviour in a community.[125] Indeed, shame itself may represent a negative nudge. Persuasion theory is yet another theory that could explain changes in behaviour around water use and open defecation.[126] In smaller communities, monitoring, strong leadership and communication in the community can be used to persuade people to change their behaviour as they understand the consequences. Greater knowledge and understanding of the impact of the change and social influence can persuade people to achieve a more desirable behaviour. While these alternative theories offer potential explanations, they were not chosen as they do not include the diversity of contextual factors and are mainly linked to behaviour change outcomes. The five guiding theories that were selected are flexible and well studied in the literature, enabling us to build a detailed understanding of mechanisms, contextual factors and outcomes in the WASH sector.

Based on these review findings, the diverse involvement of community members to participate in the design and plan of an intervention is one of the most important enabling factors for resource or service availability, longevity and behaviour change. For water resource-focused interventions where the goal is to promote

availability or longevity of the resource, the accountability, market and ownership mechanisms are particularly important, but these mechanisms depend on a broad range of community-level contextual factors. To achieve behaviour change, the mechanisms of shame and diffusion were shown to be particularly effective and are most effective in smaller homogenous communities. Before initiating any intervention, it is important to understand the contextual factors within each community and to tailor the intervention accordingly. For example, interventionists who want to consider using the accountability mechanism to achieve desired outcomes will do well to ask themselves if the communities in which they seek to intervene have the necessary contextual factors (eg, easy geographical accessible community location to allow monitoring visits, community-level platforms that facilitate internal monitoring, etc) as shown in table 3. If not, whether to consider another mechanism or support their target communities to develop favourable contextual factors before or while introducing an intervention.

Strengths and limitations

This review involved a thorough detailed search, which identified 73 papers, from 29 countries for inclusion. The size of the review allowed for diverse CMOs to be explored and understood. However, one paper from Small Island Developing States (SIDS) and five from the Latin American region were included in the review. Most papers included in the study were from the African and Asian LMICs. Due to this, it is unreasonable to generalise the findings to all contexts, we would need to include papers from a wider range of contexts and varied locations. This is an important factor to consider as SIDS and Latin America have different priorities and challenges for water and sanitation in comparison to Asian and African countries. Research should be conducted within SIDS and Latin America to further refine the CMO configurations identified in this review and to develop further CMO configurations, which can be used to explain multiple outcomes around water and sanitation interventions in these settings, as the literature has tended to only look at one or the other.

The papers selected for this review were limited to those available in English, peer-reviewed and available online through a database search. We also only looked at published articles and did not include grey literature such as NGO and government reports. Given the ten-year limit in the search strategy, we may have missed work looking at these issues in 1990s and early 2000s after the Water Decade and the start of the Millennium Development Goal (MDG) period.[127] As only papers published in English were included, we may have missed experiences of francophone and lusophone Africa or Latin America. However, it is worth noting that these sets of omissions are consistent with the realist approach to evidence synthesis. The goal is to identify, if tentatively, CMO configurations, which may subsequently be enriched through primary research or further reviews. In addition, also consistent

with the realist approach to evidence synthesis,[32 33] no formal quality appraisal was conducted on the papers included in this study.

Among the papers included in the study, it was difficult to identify 'physical' and 'social' contextual factors, as often very limited relevant information was provided. If additional information was available, then the types of contextual factors may have been found to play a more substantial role than we identified. Finally, we did not include papers that looked at communities' natural resource management and interventions except those associated with water for a health connection, and we only included papers where an external party such as NGO or government was involved in the water natural resource management and interventions. Further research needs to be conducted to identify the mechanisms involved in such interventions.

CONCLUSION

This study brings together the knowledge generated from 73 WASH interventions in LMICs, where communities are involved. Health, behaviour change, infrastructure and resource/service longevity-related outcomes are influenced by five mechanisms. The mechanisms are (1) accountability (policies and procedures to hold communities and committees responsible for their actions and outcomes of an intervention), (2) diffusion (spread of an idea or behaviour by innovators over time through communication among members of a community), (3) market (the interplay between demand and supply of a WASH service or resource), (4) ownership (sense of possession and control of a WASH service or resource) and (5) shame (a feeling of disgust in one's behaviour or actions). Nineteen contextual factors include leadership, monitoring and rewards that impact these mechanisms. These contextual factors can be used by policymakers, programme designers and implementers and NGOs in the development of interventions. They can also help improve the likelihood of success for targeted outcomes and infrastructure and service longevity. The results also provide a framework for analysing and understanding the performance of WASH interventions retrospectively.

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