



## Gender and social outcomes of WASH interventions: synthesis of research evidence

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## About this working paper

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**Suggested citation:** Macura, B., Dickin, S., Sharma Waddington, H., Liera, C., Soto, A., Orlando, A., Foggit, E., Pross, C., McArthur, J., Fadhila, A., Del Duca, L., Njoroge, G. (2023). Gender and social outcomes of WASH interventions: synthesis of research evidence, CEDIL Syntheses Working Paper 7, CEDIL, Oxford. Available at <https://doi.org/10.51744/CSWP7>

This project was funded by the Centre of Excellence for Development Impact and Learning (CEDIL), supported by UK Aid from the UK Government. The views expressed in this working paper do not necessarily reflect the UK Government's official policies.

Cover design: PhilDoesDesign

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# Gender and social outcomes of WASH interventions: synthesis of research evidence

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Note: This report includes three parts. Part 1 includes a systematic mapping of evidence on gender equality and social inclusion outcomes of WASH interventions and was written by Dr Biljana Macura. Part 2 includes a framework synthesis of violence-related outcomes in the context of WASH interventions and was written by Dr Sarah Dickin. Part 3 includes a quantitative synthesis of time use outcomes in the context of WASH interventions and was written by Dr Hugh Sharma Waddington.

Protocol: <https://onlinelibrary.wiley.com/doi/10.1002/cl2.1164?af=R>

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## Abbreviations

BA	Before after design
GESI	Gender equality and social inclusion
LMICs	Low- and middle-income countries
MHM	Menstrual hygiene management
MMAT	Mixed-methods critical appraisal tool
PSM	Propensity score matching
RCT	Randomised controlled trial
SDGs	Sustainable Development Goals
WASH	Water, sanitation, and hygiene
XS	Cross-sectional design

## Abstract

**Background.** Safely managed water, sanitation, and hygiene (WASH) are fundamental for human health and wellbeing and are thought to contribute to a range of positive outcomes related to education, livelihoods, dignity, safety, and gender equality. However, gender and other social categories (e.g. age, ethnicity, caste, disability, marital status) can mediate who benefits from WASH services and in which ways. As progress in gaining access to safe WASH services has not occurred equally, there has been a focus on mainstreaming gender equality and social inclusion (GESI) in interventions. Despite awareness in the sector of the importance of promoting gender and socially inclusive WASH services, evaluations of interventions focus largely on technical or health outcomes, while social outcomes are not included. This systematic evidence synthesis aimed to collate evidence on the impact of WASH interventions on GESI outcomes in low- and middle-income countries (LMICs). It also aimed to synthesise evidence on violence-related outcomes, and to advance understanding of barriers to, and facilitators of, change in violence-related outcomes in the context of WASH interventions.

**Methods.** We searched for both academic and grey literature. English-language searches were performed in multiple bibliographic databases. Searches were conducted in 53 specialist websites, in English and Spanish. Eligibility screening (with consistency checking) was conducted at two levels: title and abstract, and full text. We have meta-data-coded all eligible studies with regard to details about the intervention, population, outcome, and setting. We collated and described the evidence base on all GESI outcomes, and we conducted a qualitative synthesis of violence-related outcomes and a quantitative synthesis of time use outcomes in the context of WASH interventions. Specifically, after the initial evidence mapping, we proceeded to conduct a critical appraisal and framework synthesis of a subset of the evidence base related to violence to understand what the barriers to, and facilitators of, change in these outcomes are and to develop a conceptual framework and examine evidence that helps analyse the factors influencing outcomes. We then also collected and synthesised effect sizes on time use outcomes resulting from the WASH interventions.

**Results.** Our evidence base included 517 studies (published in 482 articles). A little over half of the studies in the evidence base focused on water supply, followed by sanitation and handwashing. Studies focusing on menstrual and other types of hygiene were not prominent in the evidence base. The majority of studied interventions related to behaviour change, followed by infrastructure provision. Policy and financial interventions, marketing-based approaches, and interventions at the service provider level were less prevalent in the evidence base. The majority of studies included in our evidence base measured inclusive rather than transformative GESI outcomes of WASH interventions implemented in LMICs. The majority of inclusive outcomes included safe water and sanitation provision, which has the potential to reduce WASH inequalities that disproportionately impact women. However, there were fewer studies in our evidence base that measured transformative outcomes of WASH interventions linked to power relations. Our results imply that most studies about WASH interventions do not aim to provide evidence of outcomes that have a transformational impact for girls and women, such as eliminating violence against women and girls, education, women's economic

empowerment, and women's participation and leadership in WASH services. Moreover, only a little over half of the studies in the evidence base described outcomes by disaggregating across age, gender, and/or social category. Of the studies that provided disaggregated information, the majority focused on women and girls, and only a small percentage focused on a specific caste or class, the elderly, ethnicity, religion, or people with disabilities. We found no outcome themes reported for gender and sexual minorities. Furthermore, most interventions in our evidence base lacked a specific GESI component in the design. This indicates a low recognition of the importance of these components, even among WASH interventions that aim to measure GESI outcomes. Thus, the proportion of WASH interventions with GESI components implemented in practice is expected to be even lower. A majority of research in our evidence base focused on households and schools, but there is a need for research in other settings, such as healthcare facilities and workplaces. Most research in our evidence base was conducted in certain geographical regions, such as India and Kenya; however, the importance of social and cultural drivers for understanding GESI outcomes requires more clarity on these dynamics in other geographical settings. Few interventions in our evidence base evaluated outcomes related to gender-based violence and other forms of violence against marginalised groups in the WASH sector. Most of the interventions described in studies included in our framework synthesis were sanitation interventions, with a handful relating to menstrual hygiene management and water. Our studies largely focused on interventions related to infrastructure upgrades, such as improved lighting or better design of sanitation facilities to decrease the risk of violence. Nevertheless, there is a need for more research to test interventions that reduce violence related to WASH by addressing social and gender norms (and in addition to infrastructure design). The synthesis of time use outcomes is drawn from the 28 studies that presented data on time savings following water and sanitation interventions and/or alternative uses of time resulting from the time savings. The effects of water supply and sanitation interventions are large: around three to four hours per week and in some circumstances more.

**Conclusions.** This review highlights a number of key implications for practice, policy, and research. More research is needed to understand the transformative potential of WASH interventions. In terms of the design and evaluation of WASH interventions and programmes, wider use of GESI outcomes should be incorporated (particularly those that address gender-transformative impacts). This requires a regular collection of data and monitoring of these outcomes – an exercise which should be mainstreamed by practitioners. The findings suggest that there are substantial time savings from water supply interventions, which largely accrue to women, as well as substantial time savings from sanitation accruing to both women and men. There are also significant benefits of these time savings, most prominently for girls' education. These results provide important evidence about the social and economic effects of water supply and sanitation interventions.

## Introduction

Safely managed water, sanitation, and hygiene (WASH) services are viewed as fundamental for human wellbeing, enabling a range of positive outcomes related to health, education, livelihoods, dignity, safety, and gender equality. Progress in providing WASH services, and thus achieving these outcomes, has not occurred equally, with a range of inequalities in regard to who can access and benefit from WASH services across varying sociocultural contexts, geographical areas, and socioeconomic settings. For instance, in 2020 approximately one in four people lacked access to safely managed drinking water at home, and nearly half the world's population lacked access to safely managed sanitation [1]. Of these, those living in fragile contexts were twice as likely to lack safely managed drinking water services as those in non-fragile contexts, and 80% of people lacking even basic services lived in rural areas, with half of these in least developed countries. The COVID-19 pandemic has emphasised the importance of access to good hand hygiene; however, at the start of the pandemic, three in 10 people could not wash their hands with soap and water at home [1]. Aside from socioeconomic and geographical disparities, what has received less attention is that unsafely managed water and water and sanitation disproportionately impacts a number of social categories, including women, girls, sexual and gender minorities, people with disabilities, people marginalised due to ethnicity, caste, poverty, or other factors, and those living in vulnerable situations, such as displaced people or people who are experiencing homelessness. As the COVID-19 pandemic has been shown to disproportionately affect particular groups of people, it has the potential to exacerbate many existing WASH inequalities [2].

Gender inequalities related to WASH are particularly large, as women and girls have specific needs related to biological factors, and experience strongly gendered and patriarchal social norms surrounding water and sanitation, such as expectations of carrying out water fetching, and caregiving and hygiene roles within the household [3]. In many countries where women and girls are responsible for water fetching, this contributes to a substantial burden of musculoskeletal disease and increases the risks of gender-based violence [4]. Additionally, women and girls are more negatively impacted by a lack of private and safe sanitation facilities than men and boys, particularly for menstrual hygiene management, which creates sanitation-related psychosocial stress and may be associated with urinary tract infections [5, 6]. Maternal and child health are also thought to be seriously affected by inadequate WASH: for example, sepsis, one of the biggest causes of neonatal mortality, can be prevented if hygienic practices are carried out by mothers and birth attendants, including handwashing with soap and water [7]. Additionally, a lack of a household toilet and the practice of open defecation have been linked to sexual violence [8]. These WASH inequalities extend beyond the household, with women and girls and socially marginalised groups often under-represented in decision-making processes at all levels of WASH governance [9, 10]. In particular, women have had limited access to skilled and higher-paid employment in the water sector, such as within water utilities [11]. While the WASH sector has frequently focused on women and has applied a binary understanding of gender, sexual and gender minorities also experience a range of WASH-related inequalities [12-14].

Besides gender, there are a range of other social exclusions related to WASH – on the basis of disability, age, ethnicity, caste, religion, or other social categories. The presence of hereditary social groups (such as castes, which are specific to the context of South Asia) has been shown to facilitate, or to create barriers to, sanitation interventions, especially related to cleaning, access to subsidies, latrine design, and purity issues [15]. People experiencing homelessness often face a denial of their rights to safe water and sanitation [12]. For people with disability, WASH services often do not meet specific needs for hygiene and privacy, or eliminate discrimination and abuse [16]. A multi-country study reported that 23%–80% of people with disabilities were unable to fetch water on their own, and those with more severe impairments had problems accessing the sanitation facilities used by other household members [17]. In many cases, gender intersects with these other social identities, and this may exacerbate disadvantage (or expand advantage) [18]. For instance, displaced women and girls face particular challenges in accessing safe and private facilities for menstrual hygiene management [14].

Awareness of these inequalities has resulted in the implementation of WASH interventions that include the mainstreaming of gender equality and social inclusion (GESI) considerations. While a large focus, in terms of both theoretical and empirical work, has been placed on gender inequalities, other forms of social exclusion related to WASH are also increasingly being addressed [19]. WASH practitioners argue that such interventions will result in services that meet the needs of different groups, as well as challenging unequal power relations in society [20]. For example, adequate sanitation and hygiene facilities in schools are widely considered to facilitate girls' school participation and to contribute positively to girls' sense of dignity and self-esteem [21]. Easily accessible and available water sources are thought to increase economic opportunities and economic empowerment, as people spend less time and energy on unpaid work and have more time for productive or leisure activities. The time-savings benefits of improved water access have long been recognised as reason alone to invest in improved water supply, even without demonstrable benefits on child survival health [22]. For example, Cairncross and Cliff [23] demonstrated substantial opportunity costs of inadequate water supply for women, which affected time available for childcare, food preparation, household hygiene, rest, and income generation. Moreover, household sanitation facilities or water on premises are thought to decrease the risks of violence associated with open defecation or water collection [24, 25]. Addressing gender and power relations within WASH interventions may improve women's self-confidence in intra-household bargaining [26], and participation in society, such as in community-level decision-making [27].

Despite the wide range of GESI outcomes associated with WASH interventions, evidence on whether this has a positive effect has often been anecdotal, based on assumptions, or reported only in the grey literature. For instance, whether extra time generated by nearby water sources can be used in a way a woman values may be dependent on household and community relations and gender norms. Funding agencies, governments, civil society organisations, and academia alike have placed a greater emphasis on the rigorous evaluation of technical and health outcomes of WASH interventions. This includes measuring the provision or uptake of WASH-related technology or behaviours, such as safe water storage, handwashing with soap after using a toilet, toilet maintenance, and similar [28], or evaluating the relationships between

access to inadequate WASH facilities and child growth or incidence of diarrheal diseases and other infectious diseases [29, 30]. In contrast, much research on gender inequalities does not measure these outcomes in the context of specific WASH interventions. While the findings of these types of research provide insights into inequalities, they do not indicate what works to address them.

Limited efforts to evaluate GESI outcomes may be related to the challenges of measuring social change, which is often a complex, non-linear, context-specific, and slow process [31]. It can be difficult to trace clear causal pathways between intervention components and targeted outcomes. For instance, improvements in GESI outcomes may be cross-sectoral, so there may be difficulties in attributing change directly to particular WASH components or mainstreaming efforts. Despite these challenges, it is important to understand what kinds of interventions are most often associated with better or worse GESI outcomes. A lack of attention to monitoring and evaluating changes in GESI outcomes, including a lack of attention to developing validated methodological approaches for evaluating GESI outcomes [32], has translated into gaps in understanding which intervention components contribute to the greatest positive impacts on GESI outcomes, as well as which interventions may lead to or contribute to negative impacts that reinforce inequalities. These gaps in understanding are evident in the global policy discourse. For example, Sustainable Development Goal (SDG) 6 'Clean Water and Sanitation' refers to the sanitation needs of women and girls but has been described as 'gender blind' due to the lack of gender-sensitive targets [33]. A comprehensive mapping of evidence of GESI outcomes resulting from WASH interventions is therefore needed to support WASH intervention design, implementation, and evaluation.

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## Objectives

This review aims to synthesise evidence on GESI outcomes in WASH interventions and to advance understanding of the facilitators of, and barriers to, change in violence-related outcomes.

The review questions are:

1. What inclusive and transformative outcomes have been reported and measured in the literature on WASH interventions?
2. Do WASH interventions lead to changes in outcomes related to different forms of violence?
3. Why and how? What are the barriers and facilitators?
4. How do experiences of safety (or violence) differ across social and gender categories, and intersections between gender and disability, caste, and ethnicity?
5. Is a defined gender or social equality component needed in an intervention to achieve an experience of safety?
6. What are the effects of WASH interventions on time savings and alternative uses of time?

The review questions are adjusted from the ones originally published in the review protocol [34] (for more details see the Methodology section).

To understand violence in relation to access to WASH in development and humanitarian emergency contexts we build on a typology of violence developed by Sommer and colleagues [35] (see **Table 1** for an overview). In addition to gender-based violence, we focus on experiences of violence by any social category. Although the original Sommer *et al.* typology includes four types of violence, we excluded sociocultural violence from the scope of the review as we decided to focus on direct forms of violence only (*sensu* [36]).

Table 1: Types of violence related to WASH relevant for this review (adapted from Sommer and colleagues [35]).

Type of violence	Description
Sexual violence	Rape, assault, molestation, and inappropriate touching
Physical violence	Beating or fighting leading to injury or death
Psychological violence	Harassment, eve-baiting (public harassment of women by men), bullying or other actions that may cause fear, stress, or shame

## Contribution to the literature

Evaluation practice and corresponding literature in the WASH sector have placed more focus on technical and health outcomes, such as technical standards for water sources, or evaluating diarrhoea prevalence, than on evaluating GESI outcomes [37, 38]. Most existing reviews on WASH have no explicit focus on gender, education, or other social outcomes. Some reviews account for gender only as a contextual factor in the WASH intervention design [39] or adoption [40]. Past and ongoing reviews that explicitly focus on social outcomes have a relatively narrow scope (only one WASH component, such as menstrual hygiene management) or one specific group (e.g. girls in schools), and some of them were conducted more than seven years ago [35, 41-47]. An evidence-and-gap map [48, 49] compiled systematic reviews and impact assessments and mapped outcomes such as psycho-social health, education, labour market outcomes, safety and income, consumption or poverty (see <https://gapmaps.3ieimpact.org/evidence-maps/water-sanitation-and-hygiene-wash-evidence-gap-map-2020-update>). The evidence-and-gap map did not include primary studies that used methods other than quantitative approaches, and hence omitted many qualitative studies with outcomes explicitly related to gender-based violence or other forms of violence. In addition, to our knowledge, no synthesis exists of evidence on time savings and time use resulting from WASH interventions.

The lack of synthesis of evidence on GESI, and specifically on gender-based violence and time use, are critical gaps in the literature in the WASH sector. Thus, this review provides a much-needed mapping and synthesis of a wide range of GESI outcomes resulting from WASH interventions, facilitating better conceptualisation of the links between GESI and WASH, as well

as contributing to the development of measurement tools that can be used to more accurately evaluate the GESI outcomes. For instance, evaluation tools for gender outcomes have recently been developed (e.g. [the Empowerment in WASH Index \(EWI\)](#)); or [the WASH Gender Equality Measure \(WASH-GEM\)](#) and the review can directly inform this ongoing work.

## Policy relevance

The SDGs promote equitable access to WASH services for all, emphasising that no one should be left behind. A focus on ensuring universal access and benefits has both increased the demand for, and the accessibility of, GESI evidence among implementers and decision makers, in order to contribute to meeting SDG targets. This includes a recent and growing interest in gender-transformative WASH interventions, such as those that meet targets for both SDG 5 and 6 priorities, which have been shared in a number of briefing notes and frameworks published by WASH sector stakeholders (e.g. [50-52]). This interest is due to the potential of transformative interventions to deliver greater impact [50, 53]. In this regard, the UN Women Expert Group Meeting on Gender Equality and Water, Sanitation and Hygiene made the following key statement: 'Taps and toilets are not enough. To realize transformative WASH outcomes, governments must enable women's voice, choice and agency' [54]. To support this, there is a growing emphasis on developing tools for collecting data on gender outcomes of WASH interventions and disaggregating data by sex, age, ability status, and other factors [55]. Despite this growing interest, there has thus far been only limited evaluation of such outcomes. The focus on infrastructure provision in the WASH sector has constrained the generation and uptake of evidence on a wider range of GESI outcomes. This gap can translate into a lack of budget line items and a lack of prioritisation by stakeholders. For instance, many WASH interventions are evaluated based on technical outcomes, and positive changes in gender or social equality are often assumed to occur but not evaluated. In some cases, negative changes in GESI outcomes may take place but are not evaluated. An example would be where the promotion of water treatment and hygiene creates a greater time burden for women.

Increased demand for evidence on GESI outcomes is being seen in several policy fora. This evidence was requested by members of the Sanitation and Water for all multi-stakeholder partnership that includes country representatives, WASH civil society organisations (e.g. WaterAid, IRC WASH), private sector actors, and research organisations, as well as in a study of knowledge gaps in relation to achieving Agenda 2030 [56]. In addition, the former UK Department for International Development (DFID) established a Strategic Vision for Gender Equality that includes priorities such as unequal power relations, empowerment, and transformational impact, which are addressed in this evidence synthesis. Although the department's replacement, the UK Foreign, Commonwealth and Development Office, has not released a similar vision document, these challenges are likely to remain development priorities. Greater availability and synthesis of evidence of GESI outcomes are needed to ensure its uptake in decision-making and policymaking processes within the sector.

## Innovation and relevance to CEDIL

This project offers several contributions relating to review methodology, policy, and practice. The overall review logic model was built iteratively, informed by theory, and refined by stakeholders. Strong stakeholder engagement helped to shape the review's scope and focus, ensuring the relevance of the review outputs and stronger policy impact. To synthesise evidence on gender-based violence in the WASH sector we used a combination of framework synthesis with a theory of change that helped hypothesise causal relationships among intervention components. Furthermore, we increased the efficiency of screening with the support of machine learning, including a combination of bespoke models and priority screening functions (based on text mining).

## Methodology

### Adjustments and amendments to the protocol

A detailed methodology for the review is described in the protocol [34]. Nevertheless, during the review process we made specific adaptations to the review's scope and methodology based on the size of the evidence base, available resources, and stakeholder input.

Specifically, the methodology was adapted so that it followed a three-step process. Namely, the first part of the review involved applying a systematic mapping methodology (*sensu* [57]) to catalogue and describe all available scientific evidence on GESI outcomes in the context of WASH interventions and across a wide range of variables (such as study location, study population, type of WASH interventions, outcome themes, and implementation context). The mapping process facilitated the discovery of research and highlighted knowledge gaps and clusters (without involving a full synthesis of individual study findings). Second, to choose the most relevant outcome for the second stage of the synthesis, we presented preliminary findings to stakeholders (in a webinar arranged during World Water Week in August 2021). The input we received informed the framework synthesis of violence-related outcomes. Finally, a quantitative synthesis of time savings and time use outcomes was conducted, as a critical evidence synthesis gap was identified for these areas, with important implications for policy and programmes. This three-step process was necessary for the topic area, to increase the policy relevance of the review findings.

Full details of the adjustments and amendments to the review questions, search sources, inclusion criteria, and framework synthesis are detailed in the following sections.

### Selection criteria

Below we describe the eligibility criteria. Almost all eligibility criteria were applied for all review questions equally. However, criteria for outcome eligibility differed across review questions (details are given below).

### Types of studies

All types of studies and all study designs were considered, including qualitative, quantitative, and mixed-method studies. No commentaries, or theoretical or modelling studies were considered eligible. Studies were included regardless of their publication status and their availability in electronic format.

### Types of participants

All types of study participants (from different gender and social categories, from different age groups, and from across rural and urban settings) were included, but restricted to those in LMICs. We used the LMIC definition provided by the World Bank, including low-income, lower middle-income, and upper middle-income economies from their classification for the year

2021 (see <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>).

## Types of interventions

All types of interventions providing water, sanitation, and hygiene software and hardware technologies, implemented in both rural and urban settings, were eligible for the review. We define an intervention as a set of activities organised within a project, programme, or instrument [58], with clearly defined aims and sufficient details about implementation (including a defined target population, intervention location, and implementation duration). Studies without a clear and detailed description of interventions were not eligible. Based on Waddington and colleagues [48], WASH intervention components were categorised as:

- direct hardware provision;
- provision of consumable products (e.g. menstrual pads);
- behavioural change communication (such as health messaging and psychosocial ‘triggering’);
- market-based approaches (e.g. development of supply chains);
- tariffs, loans, and subsidies (e.g. pro-poor tariffs);
- capacity development or training (e.g. training women entrepreneurs to repair water points);
- service provider interventions; or
- policy interventions (e.g. Swachh Bharat Mission).

Interventions focusing on irrigation or water resources management were beyond the scope of the review.

## Types of outcome measures

### Outcomes for review question 1

Any types of GESI outcome themes resulting from WASH intervention(s) were included and categorised into inclusive and/or transformative (as described in the protocol [34]).

Transformative outcome themes included, for example, the level of or change in empowerment, such as self-efficacy, voice, participation, agency, and decision-making related to WASH or more generally (e.g. participation in community-based decision-making on WASH or more generally), gender-based violence, discrimination, mental health, other psychosocial outcomes (e.g. self-esteem), time use, and economic opportunities. Inclusive outcomes related to access and use of WASH facilities among different groups (for a full list please see the results). The outcome themes were recoded regardless of whether they pointed to positive, negative, or unintended changes.

Outcomes relating to infectious disease and poor water quality, such as diarrhoea and stunting, were not part of this review. Nevertheless, health outcomes related to GESI and arising from gender roles and social norms, such as musculoskeletal injuries and reduced nutritional status due to water carrying, infections from poor menstrual hygiene management, and psychosocial stress from poor sanitation facilities, were eligible.

### Outcomes for review questions 2, 3, 4, and 5

We included any types of sexual, physical, and psychological violence (or absence of it) because of WASH intervention(s), as experienced by any social categories. We did not consider indirect types of violence, such as sociocultural violence, including social ostracism, discrimination, political marginalisation, or social norms that have negative impacts. We excluded studies that measured safety in a very minor way as a part of a broader evaluation (e.g. latrine checklist) and did not aim to understand any of the drivers, barriers, or facilitators.

All types of violence-related outcome measures were considered, including:

- reports of (absence of) violence;
- threats of violence (or absence of threats);
- fear of violence (or absence of fears);
- perceptions or feelings of safety or security related to the absence of violence (but not to, for example, work injuries);
- safety audits to identify specific risks of violence against gender or socially marginalised groups (e.g. poor lighting);
- perceptions of violence as acceptable (i.e. gender norms);
- lack of control over one's own body and exchange of sexual favours, forced labour, and trafficking for access to water or sanitation.

### Outcomes for review question 6

All types of time use outcomes as a result of a WASH intervention were eligible for the review, including time spent on WASH and/or time saved for use on other activities (including education, economic activities, leisure, and similar). Reported time savings measures were converted into three common metrics:

- minutes per trip (e.g. time taken to walk to fetch water and return, including time spent queuing);
- hours per household per week (i.e. total weekly hours performing the activity); and
- the standardised mean difference effect size, also known as the *d* statistic, together with its variance, which was used in meta-analysis.

### Duration of follow-up

All durations of follow-up were eligible for this review, including multiple durations of follow-up in any single study.

### Timeframe

Due to the wide-ranging and comprehensive scope of the review, we included publications from January 2010 to ensure feasibility. Publications from prior to 2010 were excluded.

### Types of settings

WASH interventions implemented in both rural and urban settings, including households, schools, health facilities, community spaces, or workplace settings, restricted to LMICs, were considered eligible for this review.

## Eligible languages

We included studies in English and Spanish (as per the skill set of the review team). Due to a lack of resources, studies in French were not included.

## Search

We applied a multi-pronged search strategy that is elaborated in the protocol and summarised below. All the searches, as justified above, were conducted for literature published after 2010.

## Bibliographic databases

We searched for literature in English in 15 bibliographic sources (using the subscriptions of Stockholm University and the University of Sussex). Detailed search records for each search source (including search strings and specific search settings) are given in the annex (Table S3).

Table 2: Search string (shown as formatted for Web of Science)

Sub-string 1: WASH-related terms	Sub-string 2: GESI-related terms
toilet* OR latrine* OR watsan OR sanita* OR sewage OR sewerage OR wastewater* OR "waste water" OR (water NEAR/2 suppl*) OR (water NEAR/2 access) OR "water management" OR (water NEAR/2 drinking) OR (water NEAR/2 scarcity) OR handwash* OR "hand wash*" OR soap\$ OR "WASH intervention*" OR "piped water" OR "tippy tap*" OR (water NEAR/2 point) OR (water NEAR/2 service) OR (water NEAR/2 security) OR (water NEAR/2 insecurity) OR "open defecat*" OR (hygiene NEAR/2 promo*) OR "water filter" OR "water pump*" OR "menstrual poverty" OR "period poverty" OR handpump* OR "hand pump*" OR (water NEAR/2 collection) OR "water committee*" OR "water well*"	AND gender* OR discrimination* OR *equalit* OR *equit* OR inclusive OR "sexual minorit*" OR transgender OR femin* OR masculin* OR menstr* OR menses OR UTI OR "urinary tract infection" OR uro\$genital OR pain OR *empower* OR school* OR educat* OR violen* OR psychosocial OR "psycho-social" OR "psycho social" OR "psychological *stress" OR "mental health" OR dignity OR fear* OR taboo* OR elder* OR disabilit* OR caste OR "social class*" OR daughter* OR girl* OR boy\$ OR child* OR prestig* OR sham* OR stigma OR privacy OR voice* OR well\$being* OR povert* OR "unpaid labor" OR "unpaid labour" OR livelihood* OR income OR fetch* OR esteem* OR "social capital" OR "land tenure" OR leadership OR time\$saving OR "transactional sex" OR musco\$skeletal OR musculoskeletal OR wife OR wives OR husband\$ OR "decision-making" OR "decision making"

Table 2 shows two search sub-strings with terms related to WASH interventions and GESI outcomes (shown as formatted for Web of Science and adapted for other search sources

depending on their search facilities (see Annex, Table S3)). The full search string combines the two sub-strings with the Boolean operator 'AND'. Search terms were compiled with stakeholders' input (as explained in the protocol).

### Specialist websites

We searched the websites of 57 organisations, using English (which was used on 56 of the websites) and Spanish (which was used on 12 of them) language search terms (see the annex, Table S4). We did not perform website searches in French due to resource constraints. The list of the relevant websites was compiled with inputs from stakeholders. These searches were particularly important for capturing grey literature. Each website was hand-searched for relevant publications using simplified search strings or individual search terms (depending on the search functionality of each source).

### Search engines

Searches were not performed in Google Scholar due to resource constraints.

### Additional sources

Bibliographies of 46 relevant reviews identified during searching were checked for relevant literature (see the annex, Table S5). We also asked stakeholders (including researchers) to provide relevant literature, including data from unpublished or ongoing relevant research, but no additional search results were added as a result of this request.

### Testing the comprehensiveness of the search

A list of 32 articles of known relevance to the review (a benchmark list) was screened against the search results to examine whether the search strategy was able to locate relevant records (the list was published in the protocol). In cases where these articles were not found during the scoping exercise, the search terms were examined to identify the reasons why relevant records were missed, and the search terms were modified accordingly until all of the records from the benchmark list were picked up by the string. The final version of the search string picked up all the articles from the list.

### Assembling a library of search results

The results of the searches in bibliographic databases were combined, and duplicates were removed prior to screening. A library of search results was assembled in the review management software EPPI-Reviewer Web [59].

### Data collection

Our evidence base included quantitative, qualitative, and mixed-method research, including impact and process evaluations. Multiple intervention groups were carefully assessed to avoid double-counting and/or the omission of relevant groups. We endeavoured to group any studies that were based on the same dataset under a single study. Similarly, we grouped

multiple publications relating to the same analysis (e.g. working paper versus journal article) under a single study.

## Selection of studies

The screening was conducted at two levels: at the title and abstract level together, and at the full-text level in the EPPI-Reviewer Web software. Retrieved full texts of potentially relevant records were screened, with each record being assessed by one experienced reviewer. Since the search yielded a large number of records (>60,000), only a subset of records (3,642) was double-screened.

## Consistency checking

To ensure consistency among all reviewers, consistency checking was performed on a subset of records at the beginning of each screening stage. The results of the consistency checking were compared between reviewers and all disagreements were discussed in detail. When the level of agreement was low (below c. 80% agreement), further consistency checking was performed on an additional set of records and then discussed. A subset of 600 title and abstract records was independently screened by all reviewers in three consistency checking rounds (200 titles and abstracts per round). The level of agreement between reviewers was between 88% and 95%. One hundred and thirty-two full texts were independently screened by all reviewers in three consistency checking rounds (44 full texts per round). The level of agreement between reviewers was between 78% and 95%.

Following consistency checking (i.e. when the agreement was above 80%), an additional 3,642 titles and abstracts were screened by two reviewers to build a consistent training set for machine learning application (see details below) and the rest of the records (titles and abstracts and full texts) were screened by a single reviewer.

## Machine learning and screening automatisisation

We made the process of screening more efficient through the innovative use of machine learning in EPPI-Reviewer Web. Specifically, a combination of a machine learning-assisted screening function ('priority screening') and machine learning modelling ('bespoke classifiers') was used to support and facilitate manual title and abstract screening and to help devise an empirically informed cut-off point below which no manual screening was to be done. The machine learning functionality in EPPI-Reviewer Web is a technology that is still in development, but it showed good performance in screening [\[60\]](#).

Priority screening uses a machine learning algorithm to 'learn' the scope of the review (i.e. the characteristics of included and excluded studies) and predicts the likely relevance of a given record during the screening process [\[61\]](#). This is done via an iterative process called 'active learning' that increases the accuracy of predictions in interactions with a reviewer and the number of screened items. Items predicted to be more relevant are then placed at the beginning of the screening queue, while the ones predicted to be irrelevant are pushed further down.

To create an empirically informed screening cut-off point after which no manual screening was done, we used bespoke machine learning classifiers. We manually screened 14,040 records (or

22.5% of all identified deduplicated records). In this batch of manually screened studies, one-quarter of records (3,642) were screened by at least two reviewers. From the manually screened items we created two subsets of data at random – a training set (80% or 11,234 records) and a test set (20% or 2,806 records). We assume that the subset of 11,234 records is large enough to be representative of a wide range of relevant studies so that hasty generalisation bias can be avoided [62].

As we progressed with screening (using priority screening functionality) we ran several models to create classifiers until our models reached satisfactory performance and class balance. Performance was measured by several parameters, including model accuracy and recall. Accuracy was defined as the proportion of correct predictions, whereas recall was defined as the number of relevant studies identified by the model, divided by the total number of relevant studies [63]. The output of the model was a list of records classified in 10 classes corresponding to probabilities of relevance (with items in class 10 predicted to be highly relevant, and those in class 1 predicted to be irrelevant).

We selected two models with the highest recall, and we applied them to a test subset of records. We checked for the numbers of incorrectly classified ‘includes’ across classes in the models. We selected one of the models based on the performance with the lowest number of false negatives (in the first three classes only 0.6% of ‘includes’ were incorrectly classified). We then applied the selected model to all non-screened items. We manually screened items in categories 4–10, while items in categories 1–3 were excluded automatically (see the annex, Figure S2).

## (Meta)data extraction

We extracted meta-data from all studies following the theory of change components, including bibliographic information, study location, research type or analytic approach, study design, details about the intervention and implementation context, information about the population, and outcome themes. Definitions of interventions and study designs used for coding are available in the annex (Tables S1 and S2).

Before starting meta-data coding, and to ensure repeatability of this process, a consistency checking exercise was performed on a subset of 132 records independently by all reviewers and across three rounds of consistency checks. All disagreements were discussed among reviewers, and the coding scheme was clarified where needed. The data extraction was then performed by a single reviewer. Discrepancies in meta-data extraction between the reviewers were resolved through discussion.

## Critical appraisal

Eligible studies for the framework synthesis (research questions 2–5) were subject to critical appraisal. We used a mixed-methods critical appraisal tool (MMAT) that accommodated all study designs included in the framework synthesis [64].

Qualitative and quantitative domains had five criteria to rate, whereas there were 15 criteria for mixed-methods studies (see the MMAT user’s guide for the details of each criterion and

definitions). We treated each MMAT criteria as having equal weight, and this information was combined into an overall assessment. As a result of the critical appraisal process, we categorised relevant studies as having a high, medium, or low quality, or if they were unclear. Studies were categorised as having 'low validity' if only one question (out of five) was answered with a yes. 'Medium validity' was assigned to the studies where two and/or three questions were answered with a yes. 'High validity' was reserved for studies with a yes answer to all (five) or four questions. The 'unclear' category was applied if all questions were answered as 'Can't tell'. Alternatively, 'can't tell' answers were treated as no answer. Based on the premise that the overall quality of a combination cannot exceed the quality of its weakest components, the overall quality score for mixed-methods studies was the lowest score of the study components (for more information, see the MMAT scoring instructions). Each assessment was accompanied by a descriptive justification. Studies with low quality were excluded from the review. The cut-off points for each of the categories were decided so as to be as inclusive as possible. Studies were not excluded based on reporting of the outcome data, to avoid selective outcome reporting bias.

Before starting this stage, to test the appraisal tools and ensure the repeatability of the appraisal process, consistency checking was performed on a subset of five records (including a range of different study designs) that were independently assessed by all reviewers. All disagreements were discussed among the team, and assessment criteria were clarified where needed. All the studies were appraised by at least two reviewers, with one reviewer conducting the appraisal and this then being checked by the second reviewer. Discrepancies were resolved through discussion.

Eligible studies for the meta-analysis (review question 6) were also subject to critical appraisal. The assessment was based on two criteria:

- 1) Did the study use an appropriate method to address confounding? i.e. alternative explanations (other than WASH intervention(s)) for the changes in time saved or time used):
  - a. either through measurement of a short period before and after the WASH intervention was implemented in before-versus-after studies; or
  - b. a strong control or comparison group design (a randomised controlled trial (RCT) or non-randomised study collecting data before and after the intervention with a comparison group); and
- 2) Was the data collection method used to measure time use reliable?
  - a. either through use of observation; or
  - b. if a reported measure was used, some method was used to improve reliability, such as a time diary.

## Data synthesis

### Framework synthesis of violence-related outcomes

We applied framework synthesis [65-68] to synthesise mixed-methods, quantitative, and qualitative studies on violence-related outcomes of WASH interventions, to identify barriers to

and facilitators of (or lack of) violence, and to build a conceptual framework and a mid-range theory of violence-related outcomes in the context of WASH interventions. In the process of the synthesis, we built on and expanded the initial theory of change (Annex, Figure S5) with a more detailed understanding of the links between WASH interventions, their components, and violence-related outcomes, including intermediate outcomes. Analysis of the effect sizes and qualitative comparative analysis were not conducted due to changes in the scope of the review (see '*Adjustments and amendments to the protocol*' section).

The framework synthesis consisted of the following six analytical stages: 1) familiarisation with the data; 2) framework creation or selection; 3) indexing of data according to the framework; 4) charting or rearranging the data according to the framework and potentially framework modification; 5) mapping; and 6) interpretation.

The team familiarised themselves with the data during systematic mapping, and specifically the meta-data coding process (during which studies were described according to their population, intervention, outcomes, and study settings). In consultation with stakeholders, focusing on the synthesis of violence-related outcomes, the team built a preliminary conceptual framework based on the violence and WASH literature. The framework sketched the potential links between WASH interventions, intermediate outcomes, and final violence-related outcomes (see the annex, Figure S5).

In the next step, at the indexing stage, the review team re-screened the mapping database to identify relevant studies for the framework synthesis of violence-related outcomes (please see the sections '*Selection criteria*' and '*Outcomes for review questions 2, 3, 4, and 5*' for details of the scope of the synthesis). Eligible studies were then critically appraised. At the charting stage, studies judged to be of high validity were inductively coded. Coding was based on a scheme developed during the review process that included several domains: outcome description; change in outcomes across time; gender and social categories; the direction, intensity, and nature of change in outcomes; and details about barriers to, and facilitators of, change (Annex, Table S9).

Using the scheme as a guide, we performed line-by-line coding of the data located in the results sections (including text, tables, or graphs) of the eligible studies. Line-by-line coding was done in EPPI-Reviewer Web. The coded data were extracted into a spreadsheet, where we inductively derived descriptive themes from the data and for each domain. New themes were used to expand the initial framework with barriers (e.g. social acceptance of violent behaviours), facilitators (e.g. social cohesion and group protection), and intermediate outcomes (e.g. access to (safe) sanitation facilities) concerning violence in WASH. For each eligible study, we also extracted information about the study location and setting, the type of intervention and GESI component, the study design, the groups studied, and the types of outcome measurement methods used.

All data coding was conducted by at least two reviewers: one reviewer conducted the inductive coding, and this was then checked by the second reviewer. Discrepancies in inductive coding between the reviewers were resolved through discussion.

## Quantitative synthesis of time use outcomes

The synthesis of time use outcomes used a combination of weighted averages, such as inverse-variance weighted meta-analysis, meta-regression analysis, and publication bias assessment of  $d$  statistics, together with narrative synthesis of time measured in natural units (minutes per trip or hours per household per week) using a theory of change approach. The standardised mean difference ( $d$ ) measures the size of the intervention effect in each study in units of standard deviation observed in that study and is thus independent of units of measurement. The  $d$  statistic is the ratio of the mean difference, where  $y_t$  is the outcome in the treatment group and  $y_c$  the outcome in the comparison group, to the standard deviation of the outcome,  $S(y)$ :

$$d = \frac{y_t - y_c}{S(y)} \quad (1)$$

For the denominator,  $S(y)$ , the pooled standard deviation  $S_p$  was calculated as follows:

$$S_p = \sqrt{\frac{(n_t - 1)s_t^2 + (n_c - 1)s_c^2}{n_t + n_c - 2}} \quad (2)$$

The 95% confidence intervals used the standard error of  $d$ ,  $se(d)$ , given by:

$$se(d) = \sqrt{\frac{n_c + n_t}{n_c n_t} + \frac{d^2}{2(n_c + n_t)}} \quad (3)$$

In cases where outcomes were reported in frequencies, such as households whose travel times were less than or greater than 30 minutes, the Cox-transformed log odds ratio (OR) was estimated as follows:

$$d = \ln(OR) \frac{\sqrt{3}}{\pi} \quad (4)$$

The standard error of Cox-transformed  $d$  is given as:

$$se(d) = \frac{\sqrt{3}}{\pi} \sqrt{\frac{1}{n_t p_t} + \frac{1}{n_t(1-p_t)} + \frac{1}{n_c p_c} + \frac{1}{n_c(1-p_c)}} \quad (5)$$

For studies reporting effect sizes from regression estimates on outcomes, then:

$$d = \frac{b}{S(y)} \quad (6)$$

where  $b$  is the (mean difference) coefficient estimated in the regression. Where regression studies did not report  $S(y)$ , the standard error  $se(b)$  of the test statistic for effect size estimate

b was usually available or could be calculated. In such cases, the pooled standard deviation was calculated using (Lipsey and Wilson, 2021):<sup>1</sup>

$$S_p = se(b) \sqrt{\frac{n_t n_c}{n_t + n_c}} \quad (7)$$

We estimated forest plots to show the central tendency and variation in d across study contexts. Meta-analysis and meta-regression analysis of d statistics were performed using Stata. Publication bias analysis was also carried out by plotting funnel graphs and in meta-regression of d estimated on its standard error, following standard approaches (Higgins *et al.*, 2021).<sup>2</sup> Where studies contained multiple estimates of effect, we first calculated a synthetic mean and standard error of d at the study level, which was then used in the meta-regressions and publication bias assessment to avoid incorporating dependent effects – and therefore violating a key assumption of the analysis.

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<sup>1</sup> Lipsey, M.W. and Wilson, D.B. (2001). *Practical meta-analysis*. SAGE Publishing, London.

<sup>2</sup> Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. and Welch, V. (2021). *Cochrane Handbook for Systematic Reviews of Interventions*. Version 6.2. Available at <https://training.cochrane.org/handbook/archive/v6.2> (accessed 1 November 2022)

## Part 1

### Results for review question 1

This section summarises the results from the evidence mapping performed for research question 1: *What inclusive and transformative outcomes have been reported and measured in the literature on WASH interventions?*

#### Description of the screening process

Our searches yielded 76,622 results in total (76,090 from bibliographic databases and 532 from specialist websites and citations from relevant reviews). Based on the applied machine learning model (81.2% recall), 39,091 records were marked as ineligible by automation. After deduplication, we manually screened 23,051 titles and abstracts from bibliographic databases, out of which 2,715 titles and abstracts were identified for retrieval. The retrieval rate was high (87%). After the full text screening, our evidence base included 485 publications from bibliographic databases. Searches of organisational websites and bibliographies of reviews yielded 532 potentially relevant records. The retrieval rate was somewhat lower for grey literature (83%). After the full text screening process, only nine publications from grey literature sources and five publications from review bibliographies were included in the evidence base.

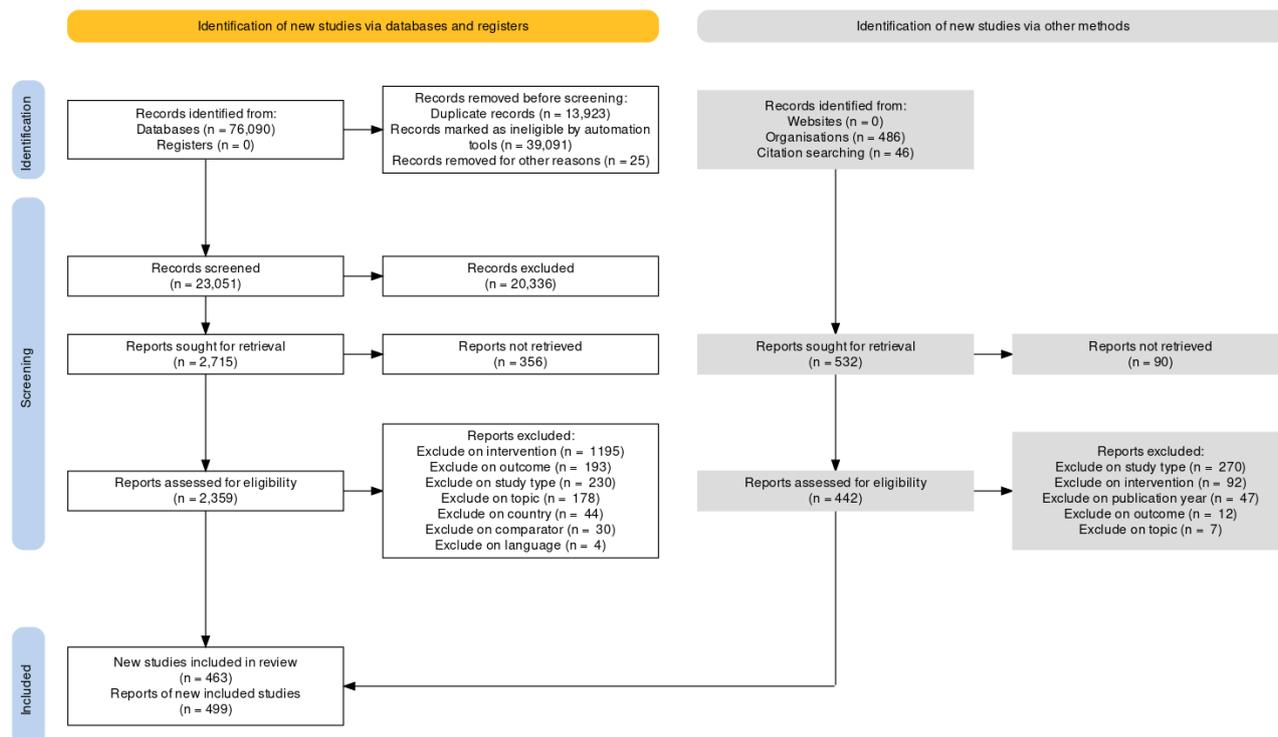


Figure 1 Prisma diagram [69, 70].

In sum, the evidence base for this systematic map included 499 publications across 463 studies (66 publications originated from 30 studies). Publications were deemed to be part of a study if they were produced by the same (group of) authors and examined the impacts of the same intervention(s) at the same study site(s). Studies also included intervention pilots that might

have occurred at the different study sites. Figure 1 shows the flow of information through the different phases of our systematic mapping stage, including the number of records identified, included, and excluded, and the reasons for exclusions. See the annex (Table S7) for a browsable database of this systematic mapping exercise and a list of excluded full texts, with reasons for exclusion (Table S6).

## Literature trends

The number of eligible publications has grown relatively steadily over the last 10 years, with peaks in 2017 (72, 14.4%), 2019 (64, 12.8%), and 2020 (55, 11%). There was only one publication from 2021 (as most searches were conducted in September 2020). Publications in academic journals were prevalent in the evidence base (395, 79.2%), followed by dissertations (61, 12.2%), reports (39, 7.8%), and articles in conference proceedings (4, 0.8%) (Figure 2).

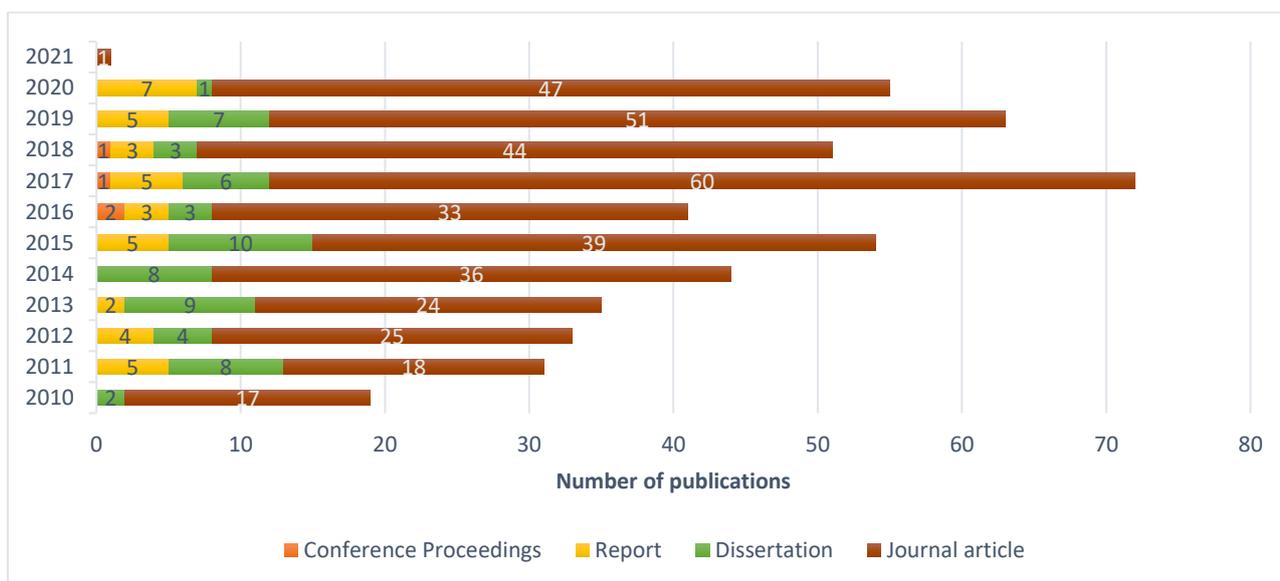


Figure 2 Distribution of publications across publication year and type

## Research type and study designs

The rest of Part 1 findings describes the evidence base at a study level. Quantitative research was most prevalent in the evidence base (240 studies), followed by qualitative (123) and mixed-methods studies (103) (Figure 3a). Most of the studies were studies evaluating impacts or outcomes (373), followed by other types of studies (134) (Figure 3b), including process evaluations (74), intervention acceptance studies (42), feasibility studies (8), pilots (8), and others (8), such as intervention sustainability analyses. Our evidence base included 95 randomised experiments (including RCTs), 61 experiments without randomisation (including quasi-experiments), and 51 one-group pre-/post-test designs. Other quantitative observational designs (38%, 127 studies) included survey studies (71), case-control studies (23), one-group

post-tests (16), cohort studies (11), and others (10) (Figure 3c). Most qualitative designs included studies without a specific description of their qualitative methodological approach (qualitative description category, 142 studies). Case studies accounted for 19% (42) of all qualitative designs, followed by ethnography (19), phenomenology (18), and grounded theory (2) (Figure 3d).

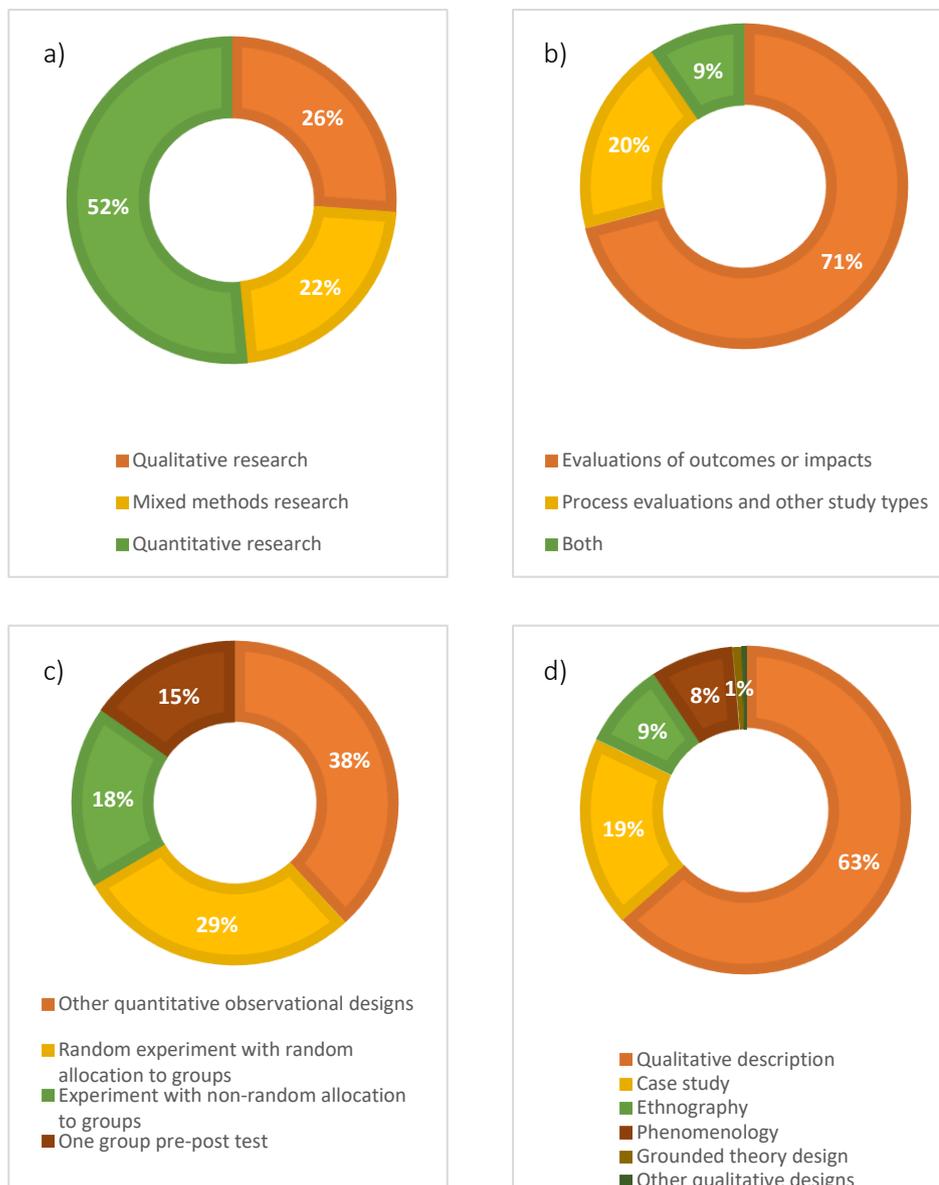


Figure 3 Distribution of studies according to research type (a), study type (b), and quantitative (c) and qualitative (d) designs.

## Geographical and socioeconomic context

Out of 135 LMICs (as per [71]), 62 were represented in the evidence base (Figure 4). Twenty studies (4.3%) were conducted in more than one country. Sub-Saharan Africa and South Asia were the most represented regions in the evidence base (featuring in 238 and 145 studies, respectively), while India (represented in 81 studies), Kenya (62), and Bangladesh (49) were the most frequent research locations (counting single- and multi-site studies). Out of 46 least developed countries (as per [72]), 23 were included in the evidence base across 211 studies (see the annex, Table S7).

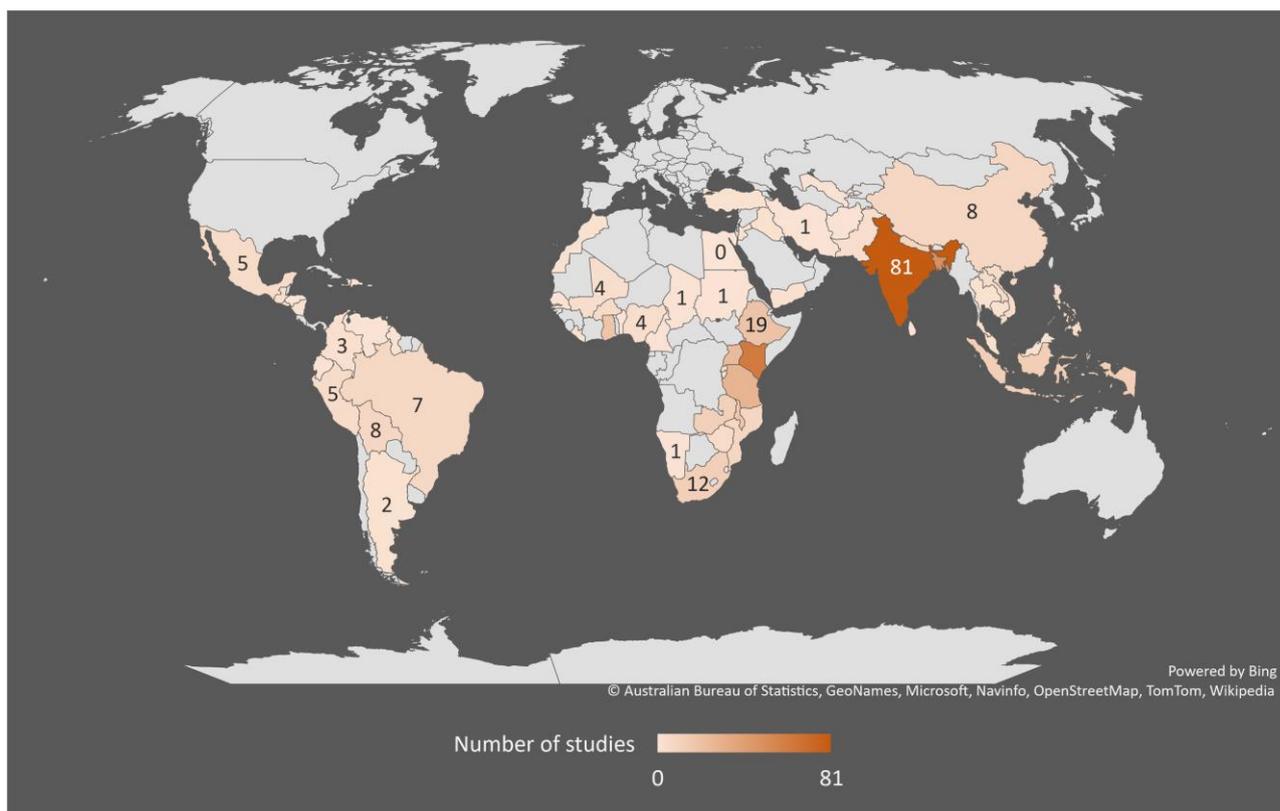


Figure 4 Geographical distribution of studies (darker shades of orange represent higher numbers of studies per country)

## WASH interventions

A little over half of the studies in the evidence base focused on water supply (256 studies or 55.3%), followed by sanitation (43.4%) and handwashing (32.6%). Studies focusing on menstrual hygiene management (5.6%), as well as other types of hygiene (such as personal or general hygiene) (1.5%), were not prominent in the evidence base (Figure 5). Over half of all water supply studies were about water quantity (51.5%), followed by water quality (38.3%) or a mix of the two categories (7.4%) (3.1% did not specify the category).

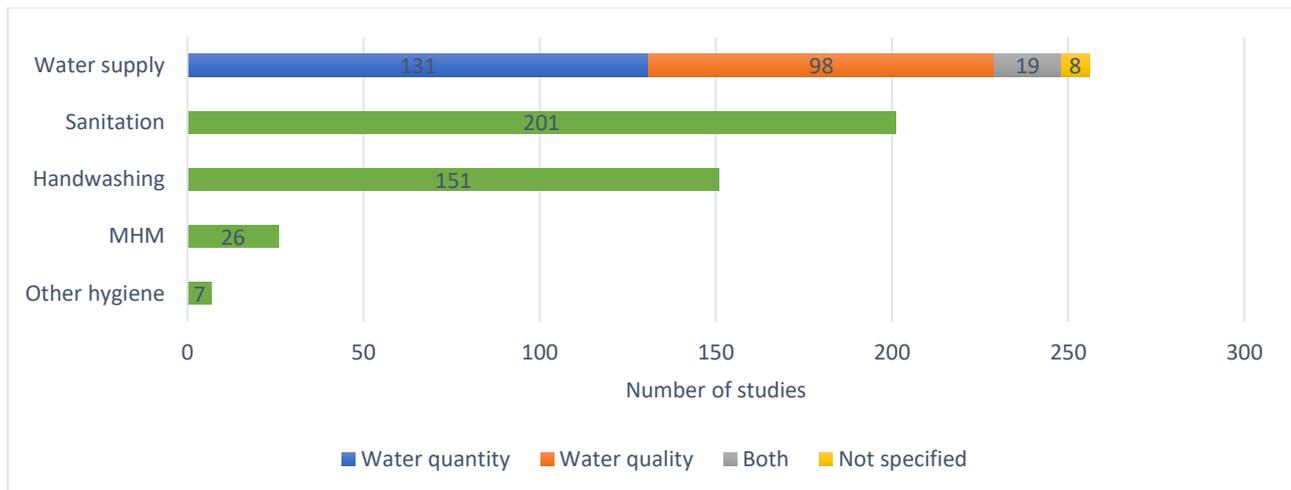


Figure 5 Distribution of studies coded by WASH sector categories: water, sanitation, hand hygiene, or menstrual hygiene management (numbers include multi-sector studies) (water supply is split into water quantity, quality, and a combination of the two. MHM stands for menstrual hygiene management)

The evidence base included several types of interventions (Figure 6), and a little over half of all studies examined the effects of behaviour change interventions (50.5%), followed by interventions that provided WASH infrastructure (40%), training and capacity building (24.8%), and specific consumable products (such as single-use toilet bags, menstrual pads, and similar) (19.4%). Policy interventions (8.6%), interventions at the service provider level (8.9%), marketing-based approaches (6.7%), and financial interventions (such as tariffs, loans, and subsidies) (2.2%) were less prevalent in the evidence base. We found only one study describing the maintenance of existing WASH infrastructures. The majority of behaviour change interventions were interventions focusing on awareness building or messaging only (169 or 72.2%), while the rest involved triggering approaches (45 or 19.2%) or a mix of the two approaches (20 or 8.5%).

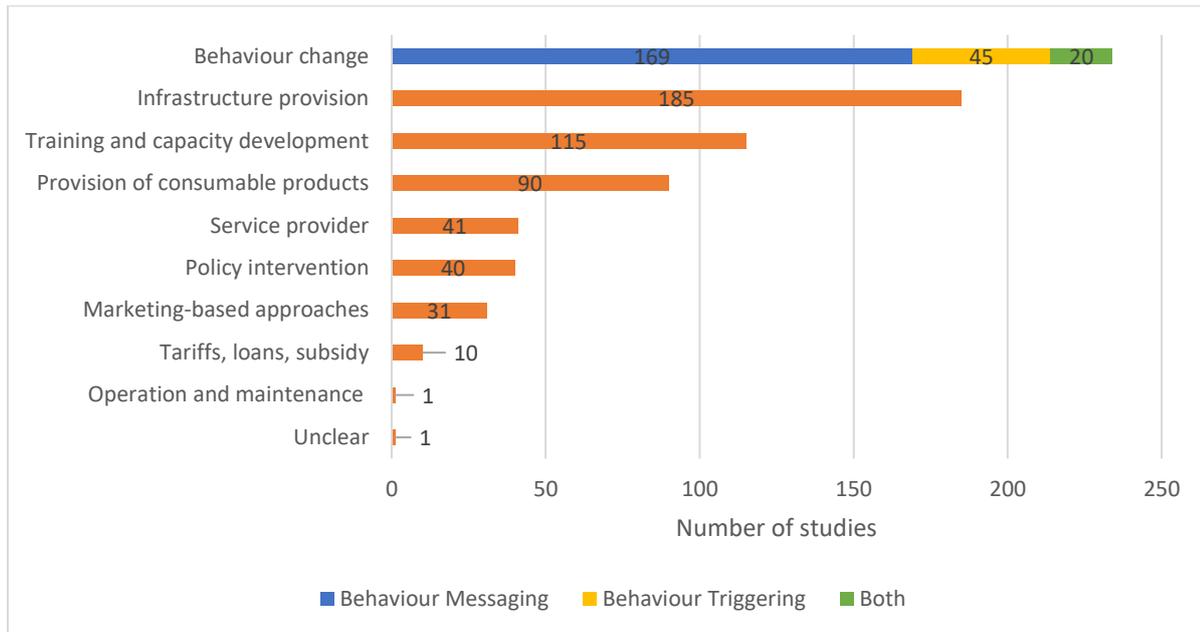


Figure 6 Distribution of studies per intervention type and GESI component (numbers include studies with multi-component interventions)

Eligible studies about infrastructure provision interventions were prevalent in the water sector, while studies reporting on GESI outcomes of behaviour change interventions prevailed in the sanitation, handwashing, and menstrual hygiene management sectors (Figure 7).

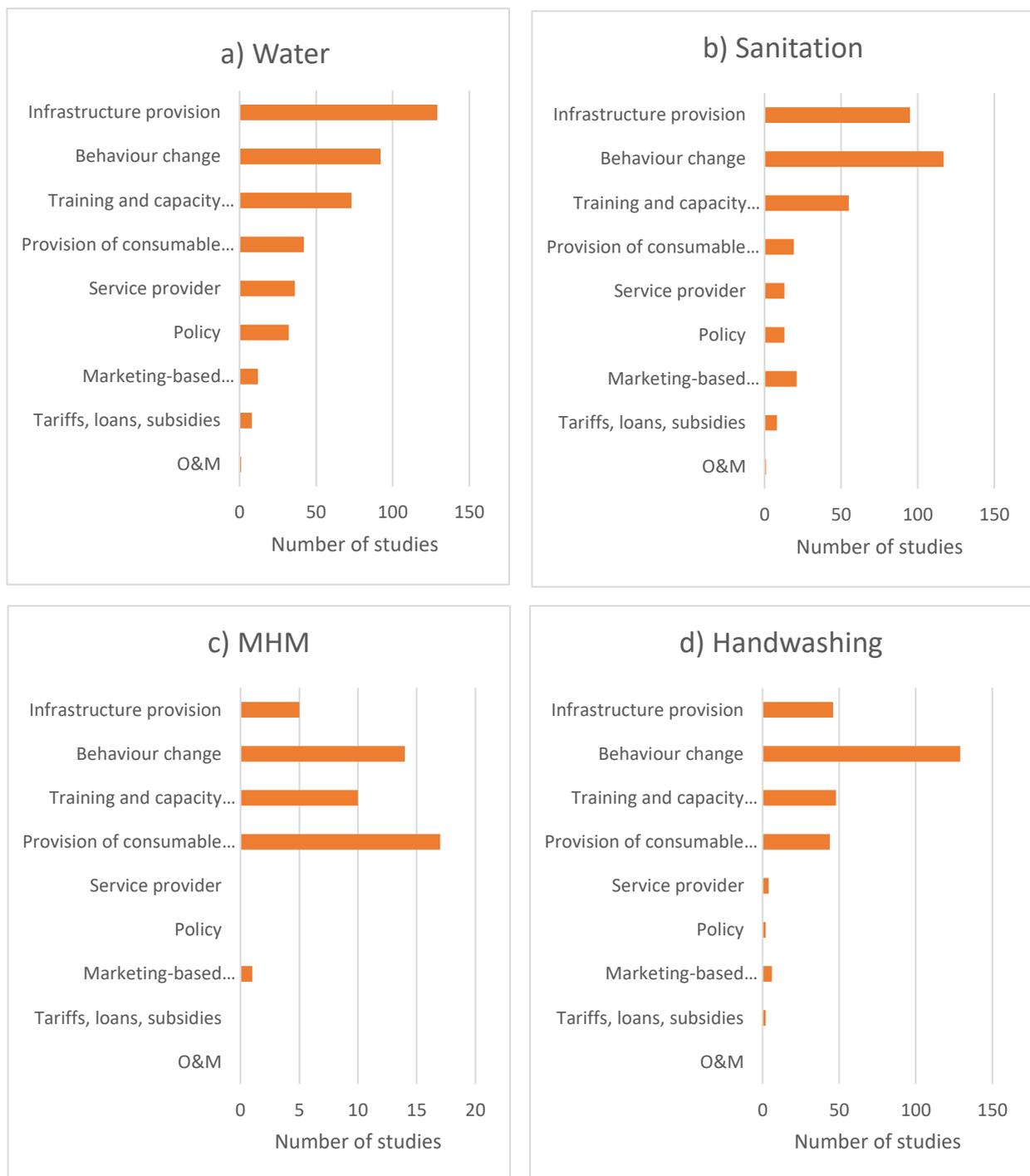


Figure 7 Distribution of intervention types across WASH sectors (O&M stands for operation and maintenance).

## GESI components of WASH interventions

Importantly, only 104 studies or 22.5% (out of 463) in the evidence base had interventions with GESI components, i.e. interventions specifically designed to target GESI issues (Figure 8).

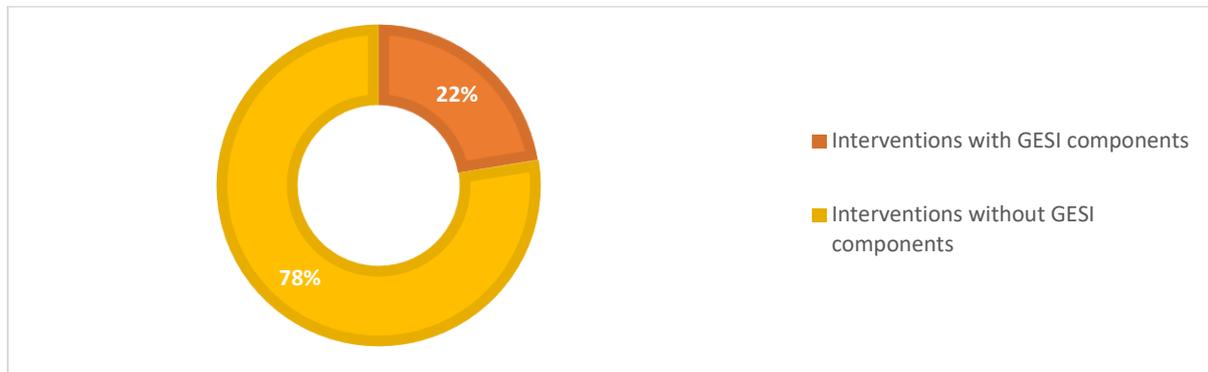


Figure 8 Proportion of studies focusing on interventions with GESI components

The majority of the GESI intervention components involved capacity building and training (41.3%), participation and leadership opportunities (25%), product provision (21.2%), infrastructure (19.2%), financial support (13.5%), and other (2.9%). Capacity building and training included individual and group mentoring (e.g. to improve business), increasing awareness about WASH services, and additional training activities targeting women and girls. Participation and leadership opportunities included activities to improve financial independence, to ensure that vulnerable individuals are included in decision-making and participate in, for example, water management committees. GESI intervention components also included the provision of water filters, menstrual cups and pads, hygiene kits, and similar. In addition, they provided infrastructure such as toilets, water stations, water pipes, boreholes, latrines, and similar. Financial support encompassed loans and tariffs, subsidies, or microloans. Three studies (2.9%) described the provision of basic services.

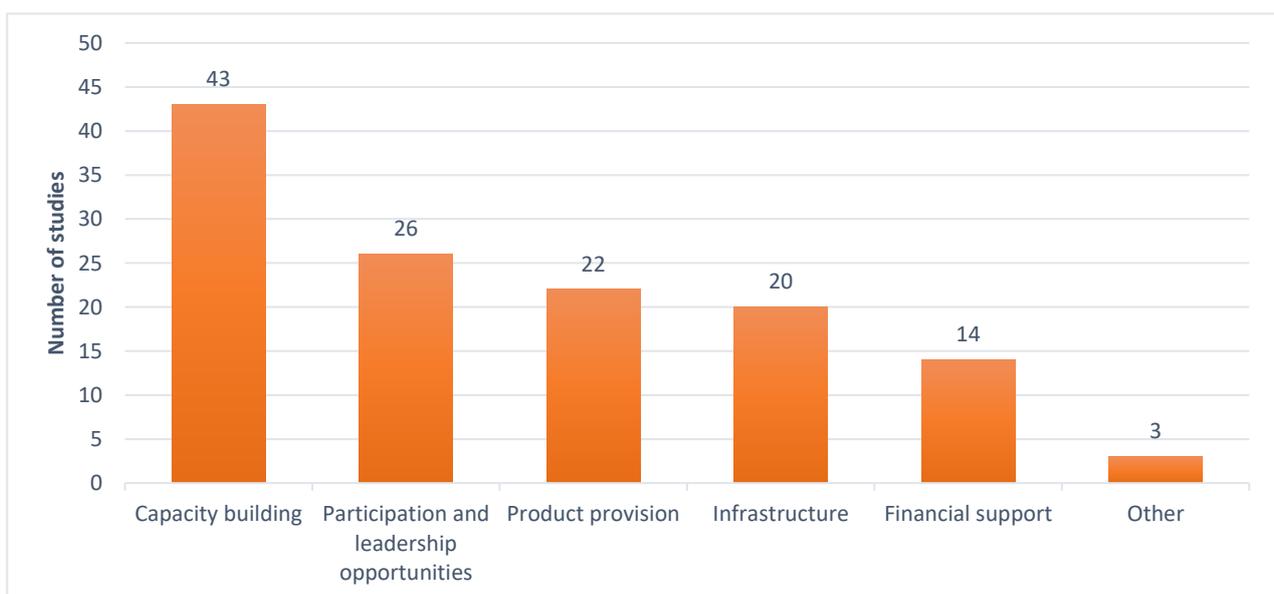


Figure 9 Distribution of studies across types of GESI components

GESI components mostly targeted women (51.9% out of 104 studies) and girls (24%). People with disability status and chronic illness (9.6%), marginalised social groups (including slum dwellers) (6.7%), children (3.8%), the elderly (2.9%), ethnic groups (2.9%), men (1.9%), boys (1%), and other social categories were mostly missing from interventions with GESI components (Figure 10).

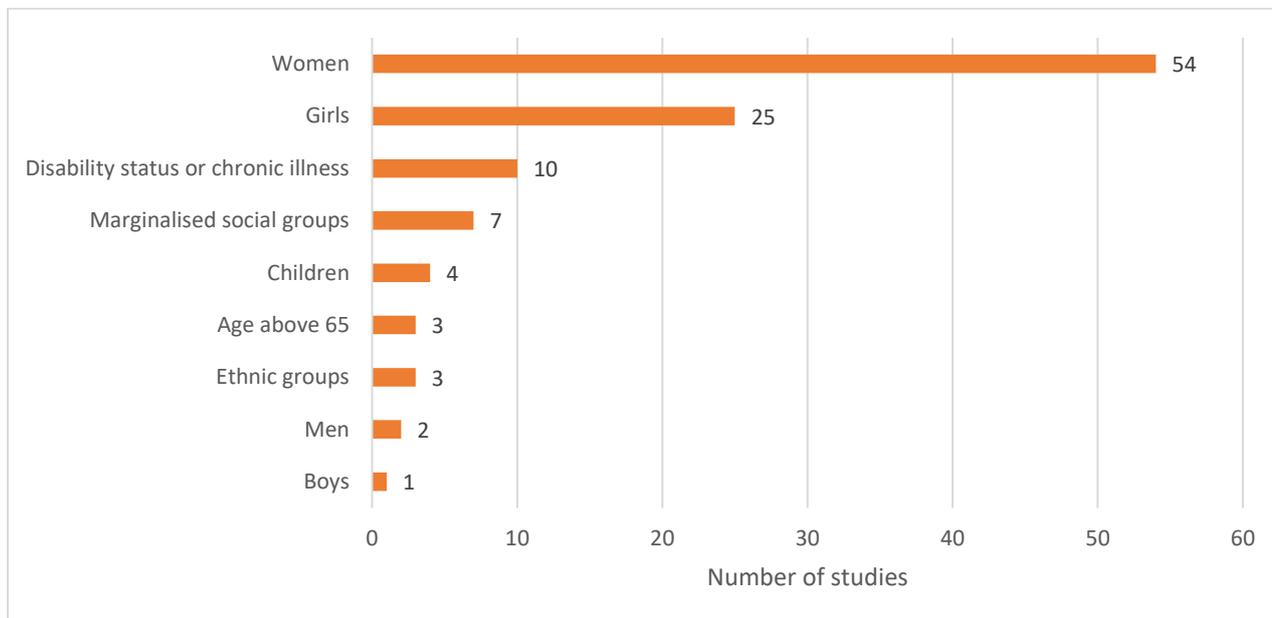


Figure 10 Distribution of studies with GESI outcomes across subject groups targeted by interventions with GESI components

## Outcome themes

Most of the GESI outcome themes reported in the evidence base were inclusive (435 studies, 94%). 194 studies (41.9%) in total reported on transformative outcome themes (Figure 11).

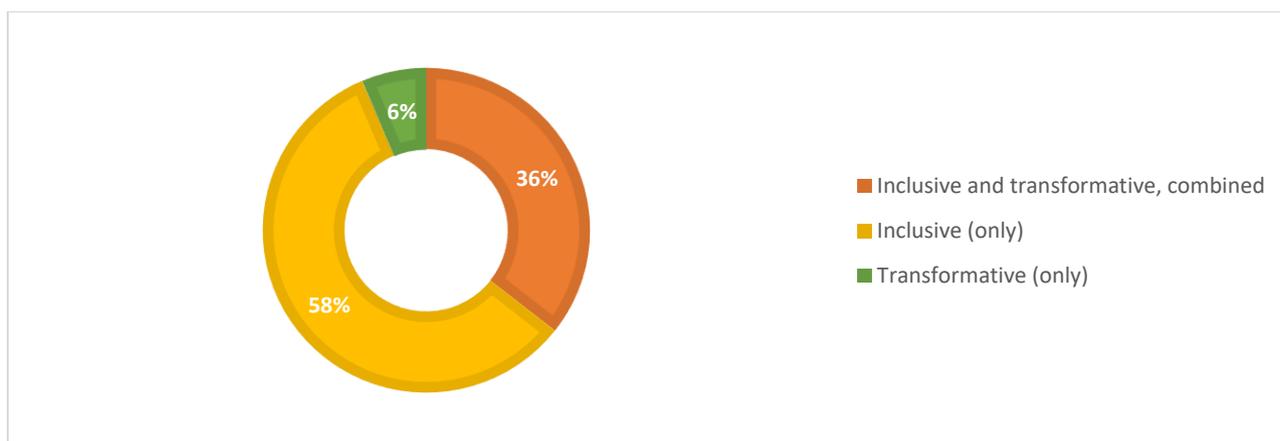


Figure 11 Distribution of studies across transformative and inclusive outcomes

Studies with inclusive outcomes focused on improving access to and use of WASH for all users. Specifically, the outcomes included equitable access to and use of safe water supply (in 41.3% of 463 studies), sanitation (31.1%), and handwashing facilities (27.2%), knowledge of WASH (32.2%), service quality (29.4%), attitudes towards safe WASH (23.5%), affordability of WASH

services (19.9%), physical health (6.5%), safe menstrual hygiene management (6%), and others (Figure 12, blue bars).

A smaller percentage of studies reported transformative outcomes that attempted to challenge existing gender norms, roles, or other power relations, including change in time use (15.8%), participation in WASH-related decision-making activities (10.2%), education (8.9%) and economic and livelihood opportunities (8.6%), empowerment and agency (8.2%), non-discrimination and equality (6.9%), gender attitudes and norms (6.3%), self-confidence and -efficiency (6.3%), mental health and psychosocial outcomes (4.8%), violence-related outcomes (4.8%), and others (Figure 12, blue bars).

The majority of transformative outcome themes were reported in connection to the menstrual hygiene management and water supply sectors. Moreover, these outcomes were specifically reported in connection with interventions related to service providers and policy, followed by infrastructure provision interventions and marketing-based approaches (see the annex, Figures S3 and S4).

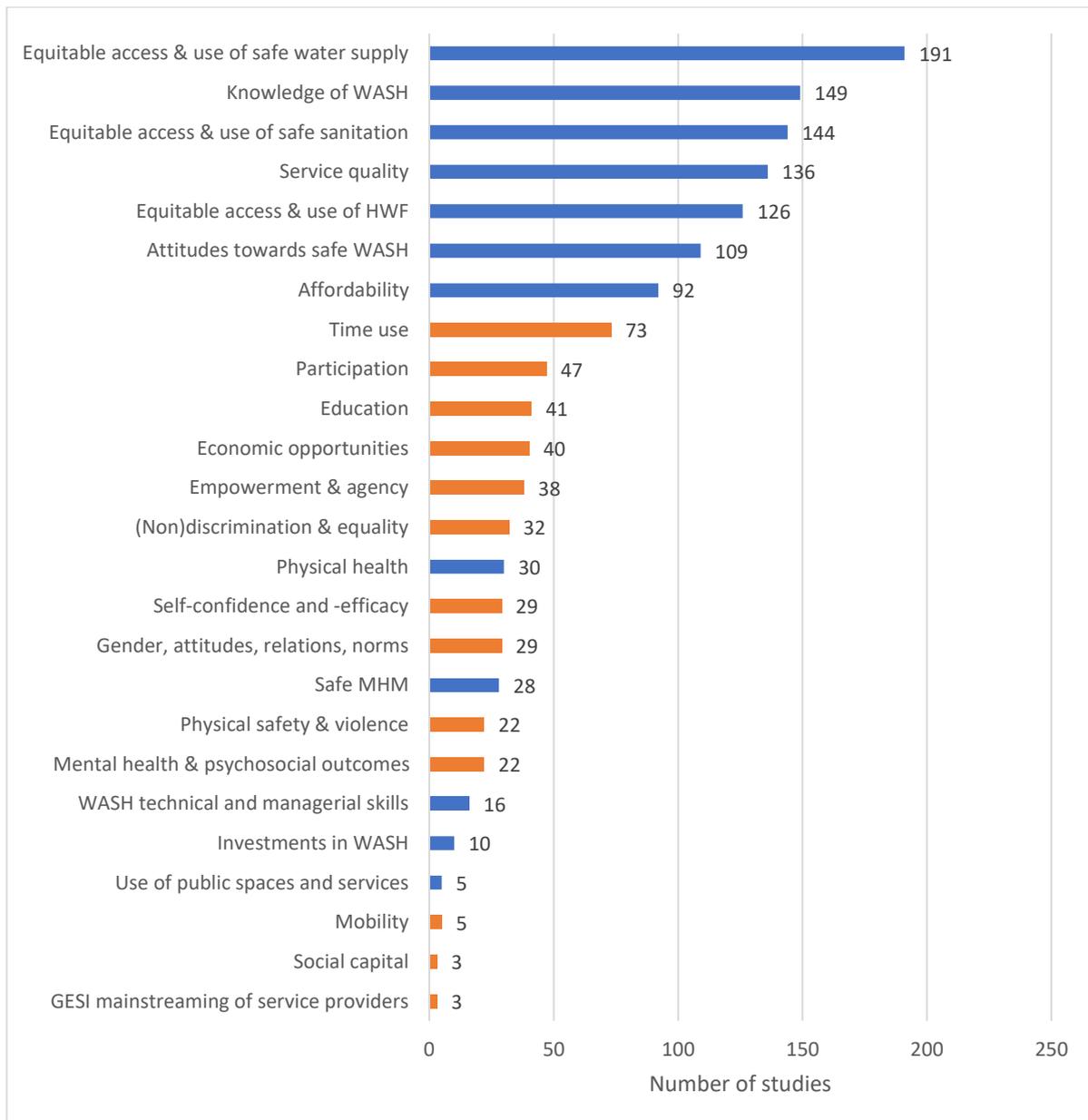


Figure 12 Distribution of studies per outcome themes (blue bars represent inclusive outcome themes and orange bars transformative themes; HWF stands for handwashing facilities)

Out of 463 studies in the evidence base, only a little over half (57.5% or 266 studies) described outcomes by disaggregating across age, gender, and/or social category. About a third of studies in the evidence base (29.8% out of 463) showed outcome data disaggregated across two or more gender and social categories (Figure 13).

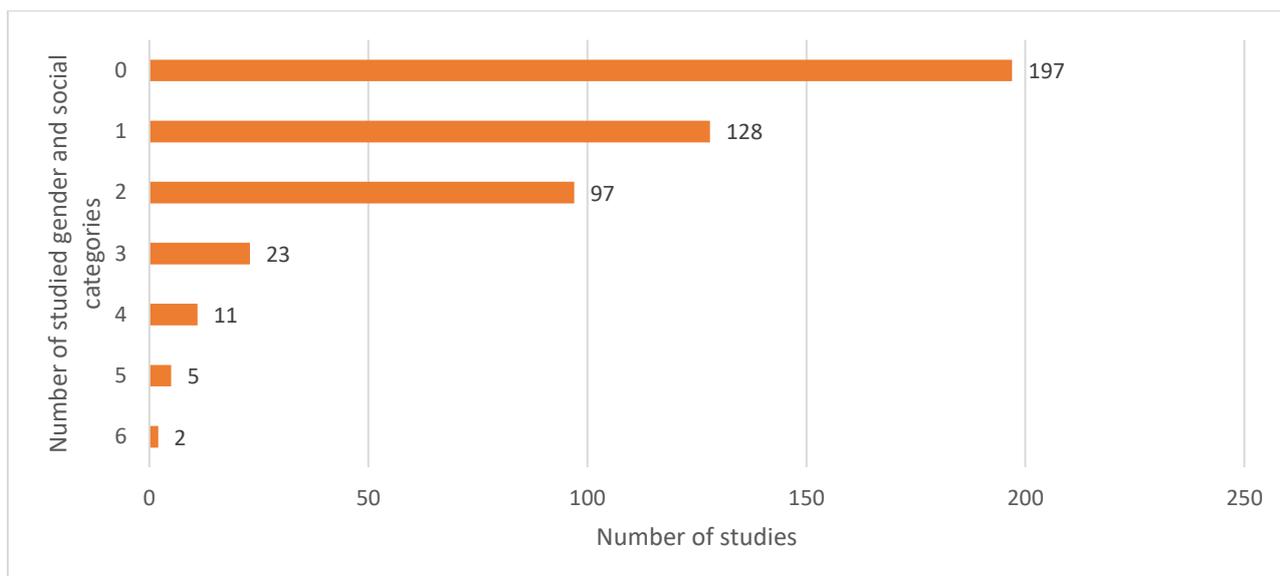


Figure 13 Distribution of studies across gender and/or social categories (category '0' implies no disaggregation across gender and social categories)

Reported outcome themes in the group of studies that provided disaggregated information related to women (37.4%), followed by men (18.8%), girls (11–18 years old, 15.3%), children (five to 10 years old, 13.8%) and boys (11–18 years old, 9.3%). Only a small percentage of studies reported outcome information in relation to social status, ethnicity, or religion (3.7%), disability status (2.2%), and adults above 65 years old (1.5%). No studies reported outcomes for gender and sexual minorities (Figure 14).

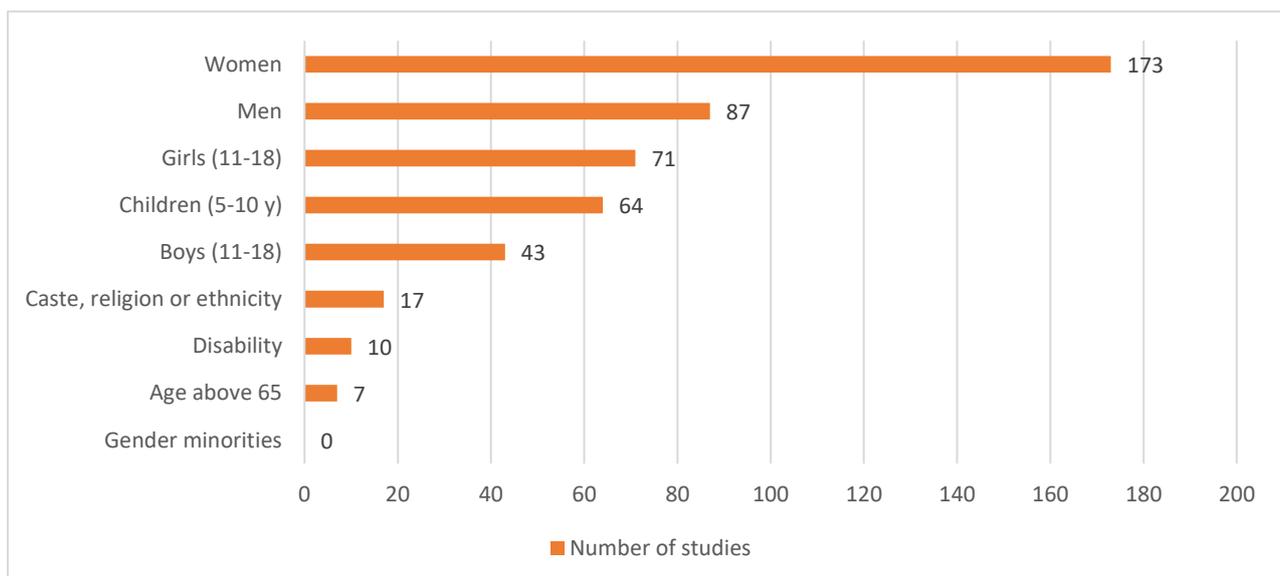


Figure 14 Reporting of outcome themes across gender and social categories

## Implementation setting and scale

Most studies (68.9%) described interventions implemented in rural settings, followed by urban settings (17.5%), slums and informal settlements (9.3%), or others (<3% each) (Figure 15). Some studies (8.6%) did not clearly indicate the intervention setting.

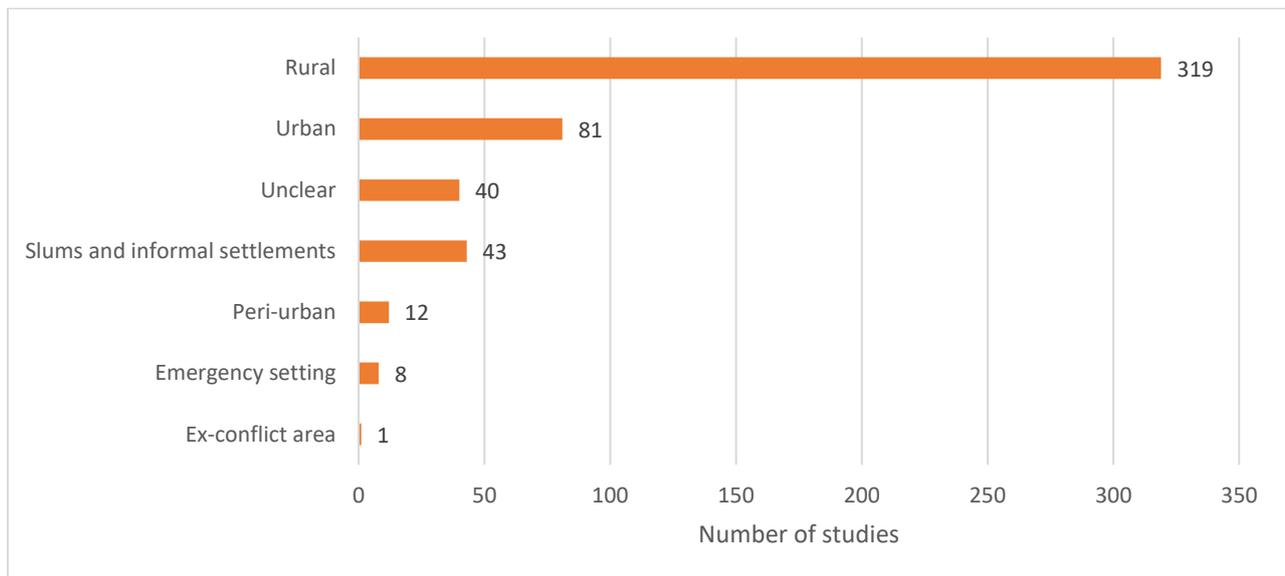


Figure 15 Distribution of studies across different implementation settings

Interventions were mostly targeted households (56.8% out of 463 studies), followed by community-level (25.3%), schools (19.4%), and individual-level interventions (10.8%) (Figure 16). Less than 7.5% of studies in the evidence base included interventions implemented at the service provider level, in health care facilities, governmental offices, local markets and similar.

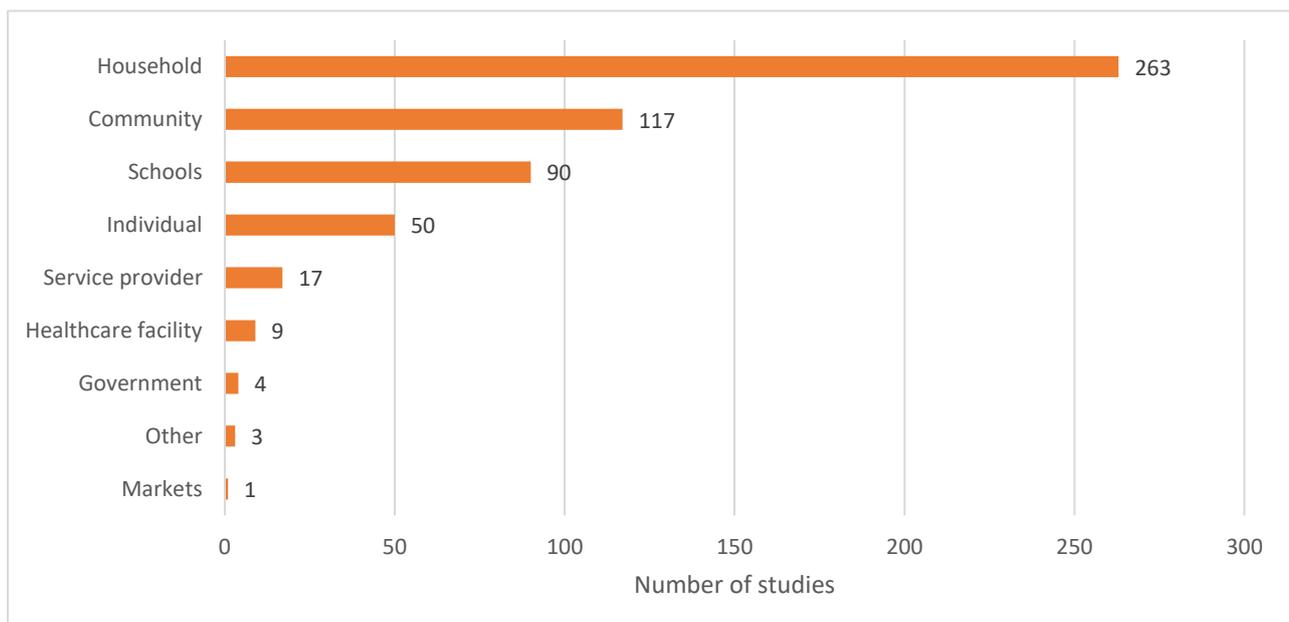


Figure 16 Distribution of studies across different intervention targets.

## Implications and conclusions for research question 1

This section summarises the findings, provides an overview of the limitations, and describes the implications for research and practice, as well as conclusions related to the evidence mapping performed, for research question 1.

### Limitations

We conducted extensive academic literature searches using English search terms. From this search, full texts in English, Spanish, and French were screened for eligibility. We also searched specialist websites for grey literature in English and Spanish. We did not perform searches in the French language on specialist websites, and could not conduct searches in Google Scholar due to resource constraints. Searches in specialist websites in English and Spanish covered a wide range of grey literature sources (see the annex, Table S4). Nevertheless, they yielded only nine publications in total (across 10 studies), which is 1.8% out of 499 publications in the evidence base (or 1.9% out of 463 studies), all from English language specialist website searches. This implies that French language grey literature searches were unlikely to yield a substantial number of relevant studies. We limited our search to a 10-year period (between 2010 and 2020), and only included studies conducted only in LMICs. For a more extensive evidence base, future work could capture research published before 2010 and after 2020, without geographic restrictions. Furthermore, our scope was limited to research that evaluated GESI outcomes of WASH interventions. There is a large body of research that could be informative for a general understanding of GESI outcomes in the WASH context, but it does not evaluate outcomes of specific or well-described WASH interventions. This body of evidence could be examined in future work.

### Summary of results

Overall, the majority of interventions included in the review evaluated inclusive outcomes, such as access and use of safe WASH facilities, knowledge of WASH, and service quality outcomes. Only around 42% of the evidence base included transformative outcome themes. The top four most reported transformative outcome themes were time use, participation, education, and economic opportunities. Other relevant transformative outcomes, such as gender attitudes and norms, self-confidence and self-efficacy, and psychosocial and mental health, were only sporadically addressed in the literature within the scope of this systematic map. In particular, few studies were studies looking at transformative outcomes related to gender-based violence and other forms of violence, despite their importance for addressing gender equality.

Apart from gender equality, this systematic map focused on social inclusion. Nevertheless, disaggregated outcome-related information across gender, as well as other social categories, was rarely provided. Where disaggregated outcome-related information was provided, most of the evidence was related to women. Very little data on GESI outcomes were reported for other social categories, including disability status or ethnicity.

Most studied interventions did not have explicit GESI components in their design. If they did include a GESI component in the intervention, that component focused mostly on adult women and girls, with other age, gender, health, or social categories not as frequently targeted.

Few studies in this evidence base were carried out in healthcare facilities or at the service provider level, with most focused on the household level. Not many studies described the GESI outcomes of WASH interventions in informal settlements or post-disaster settings, and this remains a research gap.

## Implications for practice

This evidence mapping highlights a number of key implications for practice. In terms of the evaluation of WASH interventions and programmes in the broader WASH sector, wider use of GESI outcomes should be incorporated. This is particularly the case in regard to including transformative outcomes in evaluations: such outcomes offer high potential for addressing underlying drivers of inequalities, such as harmful gender norms. While addressing gender inequalities is often described as a key aim of WASH programmes, regular collection of data and monitoring should be mainstreamed by practitioners to achieve this aim.

In addition to evaluation, there is a need for wider use of GESI components in WASH intervention design. This is in line with findings from the broader development sector showing that incorporating gender equality and women's empowerment components in sector intervention design is associated with improvements in those development and health outcomes [73].

## Implications for research

This systematic evidence synthesis highlights a number of key implications for research. In terms of study design, it is recommended that WASH intervention studies measure a wider range of GESI outcomes. There has been a focus in the sector on measuring health outcomes, particularly those related to diarrheal disease. While this is important, many recent well-designed intervention studies have not identified expected health outcomes, such as reductions in diarrheal disease or stunting. This review highlights the importance of research on other benefits of WASH interventions, beyond diarrheal disease.

There is a need for WASH intervention research that targets some of the thematic gaps identified in this review. More research evaluating GESI is needed in settings beyond households and schools, such as healthcare settings or workplaces. More research that measures outcomes for groups other than women is also needed, such as GESI outcomes among men, girls, boys, and social categories beyond gender, such as disability status and ethnicity. There are geographical gaps, as the majority of studies in the evidence base were located in sub-Saharan Africa, and around 41% of all included studies were conducted in India, Kenya, and Bangladesh.

A research gap that may underpin the limited findings in this review is the lack of validated tools for measuring GESI outcomes in the WASH sector [74]. As no one tool is likely to be

applicable across all contexts, there is a need for research to develop a wider range of validated tools for measuring GESI outcomes, to improve evaluation practice. To this end, researchers can draw on experiences in other sectors, such as reproductive health and agriculture, where such tools have been used more extensively [\[31\]](#).

## Part 2

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### Results for review questions 2–5

This section summarises the results from the evidence synthesis performed for review questions 2–5:

- 2) Do WASH interventions lead to changes in outcomes related to different forms of violence?
- 3) Why and how? What are the barriers and facilitators?
- 4) How do experiences of safety (or violence) differ across social and gender categories, and intersections between gender and disability, caste, and ethnicity?
- 5) Is a defined gender or social equality component needed in an intervention to achieve an experience of safety?

### Description of the screening process

Out of 463 studies included in the map, we identified 22 as potentially relevant for the framework synthesis as they reported on relevant violence-related outcomes (see the sections ‘Selection criteria’ and ‘Outcomes for review questions 2, 3, 4, and 5’ for an overview of eligibility criteria). These studies were screened for eligibility, and we excluded five full texts due to their lack of details about violence-related drivers, barriers, or facilitators (4), or due to their having only a structural violence focus (1) (see the annex, Table S8). We included 17 studies in the critical appraisal process.

### Quality of studies in the evidence base

During the critical appraisal process, we excluded six studies, out of which five were judged as being of low quality and one as unclear. The excluded studies lacked methodological rigour and crucial details about the methods, data collection, and/or analysis. Our evidence base included 11 studies in total, with four studies judged as being of medium quality and seven studies judged as being of high quality. Studies judged to be of medium quality had issues with sampling procedures (1) or analysis methods (2), or changed methods during the study (1) (see the annex, Table S8)

### Overview of included studies and study context

The evidence in this review originates from two contexts: East Africa (six studies) and South Asia (5). The majority of studies were located in India (4) [75-78], followed by Kenya (2) [79, 80] and four least developed countries: Uganda (2) [81, 82], Bangladesh (1) [83], Malawi (1) [84], and Mozambique (1) [85]. Most studies were located in rural settings (6) [75, 76, 78, 83-85], followed by informal settlements (3) [77, 79, 80] and urban environments (2) [81, 82]. Eight studies focused on sanitation and two engaged with menstrual hygiene management ([80, 81]). There was only one study in our evidence base related to infrastructure for water supply [83]. The

studied interventions targeted households (6) [76-79, 84, 85], schools (3) [80-82] and communities (2) [75, 83]. Most of the studied interventions involved the provision or improvement of infrastructure (including latrines or similar sanitation facilities) ([78-80, 82, 85]). Other intervention components included behavioural triggering [76, 77, 84], shifting gender norms around menstruation [81], and financial subsidies ([75, 76]). Six studies reported on interventions with GESI components, such as training and capacity building ([80, 81, 84]), financial subsidies targeted at poor populations or women ([76, 78]), the provision of menstrual products ([80, 81]), participation in community mobilisation events ([76]), and software and hardware approaches to improve WASH access for children ([79], [84]) and the disabled [84]. Five studies focused on infrastructure provision or sanitation behaviour change without a GESI component, but measured outcomes related to violence. Out of 11 studies, three recorded occurrence of physical violence, two reported sexual violence, and 10 reported psychological violence (Table 3).

Table 3 Summary of studies included in framework synthesis (on following pages)

CEDIL syntheses working paper 7: Gender and social outcomes of WASH interventions: synthesis of research evidence

ID	Short title	WASH component	Location and study setting	Type of intervention (relevant for the outcome)	Intervention with GESI component	Groups studied	Type of violence studied	Type of outcome measured	Outcome measurement methods	Critical appraisal score	Study design (relevant for the outcome)
1	Arnold <i>et al.</i> (2010)[75]	Sanitation	12 rural villages near the city of Tiruchirappalli in Tamil Nadu, India	Sanitation and hygiene behaviour change campaigns (India's Total Sanitation Campaign), including behavioural triggering, capacity building, and assistance with capital costs	No	Men and women	Psychological violence	The perceived safety of households with private latrines vs. households without private latrines	Surveys	High	Quantitative/ matched cohort study
2	Cronin (2012)[79]	Sanitation	Soweto East informal settlement Kibera, Kenya	Construction of toilets, and showers, within eight building blocks in the settlement	Yes, adapted Infrastructure, targeted at children, the disabled, and others in an informal settlement	Men and women	Physical violence and psychological violence	Reports of physical violence at the facilities and experiencing fear, particularly for women and children	Participant observation, rapid ethnography, semi-structured interviews, and focus group discussions	High	Qualitative/ case study
3	Dreibelbis <i>et al.</i> (2018)[76]	Sanitation	Rural districts in Bihar, India	Standard intervention: community mobilisation activities, provision of government subsidies and incentives, and supply-side improvements. Modified intervention: engagement of government actors, and household loans for latrine construction	Yes, participation in community mobilisation events targeted at women's self-help groups, and loans for latrine construction targeted at women	Women between the ages of 14 and 65	Psychological violence	Perceptions of safety and reports of harassment by builders of the facilities	A cross-sectional survey, ethnographic investigation, and quantitative surveys	Medium	Qualitative/ ethnographic study
4	Girod <i>et al.</i> (2017)[80]	Sanitation, menstrual hygiene management	Schools in Mukuru and Mathare informal settlements, Kenya	Construction of modular toilets called 'Fresh Life Toilets' in <b>schools</b> and other public spaces, and sanitary towels programme	Yes, including capacity building and training, and product provision; targeted at girls	Girls and boys	Psychological violence	Reports of boys harassing girls when using Fresh Life Toilets; experiencing fear and stigma when using Fresh Life Toilets during menstruation	Focus group discussions with girls, key informant interviews with head teachers, school facility observations, and anonymous question sessions with girls	High	Qualitative/ 'views' study
5	Kayoka <i>et al.</i> (2019)[84]	Sanitation	Households in Rumph District, Malawi	Inclusive community-led total sanitation programme that specifically responded to household-level needs of people with disabilities	Yes, capacity building related to disabilities, including hardware and software approaches to improve WASH access for people with disability status	People with disabilities, community-led total sanitation implementers	Psychological violence	Perceptions of safety; stigma towards people with disabilities	Safety and accessibility audits, interviews with implementers	High	Qualitative/descriptive study

CEDIL syntheses working paper 7: Gender and social outcomes of WASH interventions: synthesis of research evidence

6	Nalugya <i>et al.</i> (2020)[81]	Mens trual hygiene mana gement, supported by adequate WASH	Two secondary schools, Entebbe, Uganda	WASH facilities (including sanitary waste bins, availability of water, soap, and toilet paper) and gender norms related to menstruation at secondary <b>schools</b>	Yes, including capacity building and training, and product provision; targeted at girls	Girls and boys	Psychological violence	Reports of fear, stigma, and other psychosocial outcomes	Interviews with menstruating girls, parents, and teachers, focus groups with boys and girls	High	Qualitative/ descriptive study
7	Prabhakaran <i>et al.</i> (2016)[77]	Sanitation	Kalyani municipality, two informal settlements, West Bengal, India	Community-led total sanitation programme	No	Women and adolescent girls	Psychological violence	Fear and harassment, perceptions of safety	Focus group discussions with women, interviews with female participants and institutional actors	Medium	Qualitative/ case study
8	Routray <i>et al.</i> (2015)[78]	Sanitation	Rural villages in Puri district, Odisha, India	Self-financed or subsidised latrines with and without further improvements	Yes, financial subsidies; targeted at the poor population	Men and women, different caste, age, and marital status	Psychological violence	Fear of harassment or attack, perceptions of safety	Focus group discussions with implementers, women's groups, and other male and female participants; observations and conversations with latrine owners	High	Qualitative/ descriptive study
9	Shiras <i>et al.</i> (2018)[85]	Sanitation, hygiene	Maputo, informal settlement, Mozambique	Shared latrines shared by up to 20 individuals, and community sanitation blocks	No	Men and women	Psychological violence, physical violence, sexual violence	Perceptions of safety, reports of harassment, direct and indirect reports of physical and sexual assaults	Interviews, focus groups, and structured observations	High	Qualitative/ grounded theory
10	You <i>et al.</i> (2020)[82]	Sanitation	Girls' school in Kisoro, Uganda	The lighting of an existing shared school toilet block	No	Girls aged between 11 and 19	Psychological, physical, and sexual violence	Perceptions of safety, reports of violence	Surveys and focus groups with students, informal reports from the teacher	Medium	Mixed-methods study
11	Karim <i>et al.</i> (2012)[83]	Water	Paba subdistrict, an agrarian village in north-west Bangladesh	Construction of deep tube wells, shallow tube wells, and handpumps	No	Women	Physical violence, psychological violence	Reports of physical and psychological violence towards women	Interviews and household surveys	Medium	Mixed-methods study

## WASH interventions and changes in violence-related outcomes

Several interventions involved the installation of physical sanitation facilities (e.g. lighting, attendants, or shared sanitation blocks). You *et al.* (2020) [82] conducted a survey after the installation of toilet block lighting (Pee Power toilets) and found improvements in feelings of safety among girls. After installation, 85% of students said that the lights powered by Pee Power made them feel safer when using the toilets at night. One student reported (p. 8): *'Pee Power toilets are safer than the other school toilets because of the lights. With them around the toilet block it is bright enough to see if any strangers are present'*. However, 55% of respondents still felt that it was not safe to go to the toilet alone at night. One reason was that the 50 metre path to the toilet block was not lit. Cronin (2012) [79] conducted interviews with residents of an informal settlement after the construction of toilet blocks in their area and found that some residents reported feeling safe while using the facilities, partly due to the presence of toilet management attendants and lighting (p. 292): *'But you see these ones, it's being manned with something. So at least you will find someone there and your security is sort of guaranteed'*, while some others, particularly women and children, feared using the facility at night-time: *'Women and children are scared. Women are scared because they can't go out after 8 o'clock at night but men we can go'*. Some women reported using flying toilets to avoid using the facilities late at night. In the case of implementation of an intervention with either shared latrines or community sanitation blocks in urban informal settlements in Maputo, Shiras *et al.* (2018) [85] found that less than half (41%) of shared latrine users reported safety and security stressors, compared to approximately 80% of both community sanitation block and traditional latrine users. The sense of security among improved latrine users increased because of the presence of doors, locks on the inside and outside of the doors, and the proximity of the new latrine. Despite this improvement, the authors conclude that the installation of private shared sanitation in Maputo, Mozambique, only had a limited impact on (female) users' perceptions of safety, particularly at night. However, the majority of male respondents reported that they felt secure using the latrine, even at night.

Several studies involved household-level latrine ownership interventions. Arnold *et al.* (2010) [75] measured the change in private toilet ownership after sanitation and hygiene behaviour change campaigns in India and found that private toilet owners were more likely to report that girls and women felt safe while defecating at day and at night-time, compared to households that did not own a sanitation facility (81% vs. 53%). Dreibelbis *et al.* (2018) [76] reported that mothers reported no longer feeling worried about their young daughters' safety after having built a latrine at home. Women and girls also reported feeling relief when using a latrine with doors because this prevented them being seen and looked at by men. Similarly, Routray and colleagues (2015) [78] conducted focus groups with men and women of different ages and from different castes to collect a range of perspectives about the uptake of latrine use related to self-financed and government-subsidised facilities in rural Odisha, India. Their study found that well-designed latrines generated feelings of safety (p.13): *'With a latrine, there was also no need for someone to safeguard or accompany the female member when going for defecation'*. Prabhakaran *et al.* (2016) [77] conducted a series of focus groups and interviews in two slums

in Kalyani, near Kolkata, India, to understand the impact of improved sanitation and the community-led total sanitation process on women's health and wellbeing. They found that women (across all age groups) reported a feeling of security, safety, and convenience as a result of having a toilet at home (p. 31): *'Women from both Vidyasagar Colony and Harijan Para stated that one of the biggest gains of building a toilet in their homes was the psychological relief and peace of mind that it offered them [...] going out at night presented great danger which filled the women with all kinds of fears. One would be the fear of snakes in the field. The second would be the fear of being attacked by goons or alcoholics who roamed around freely in the night. During the day, there was the fear of passers-by prying on them while they defecated [...] "We were stressed all the time and so much that we would not be able to defecate freely. There were times when we would have to stand up halfway at the sight of any passers-by either due to fear or embarrassment and sit down again after they passed by."*

Three studies were conducted in schools, including menstrual hygiene management and WASH intervention components. Girod *et al.* (2017) [80] conducted focus group discussions with girls from public and private schools and found that girls in both schools faced harassment from their male peers when using the Fresh Life Toilets, which prevented them using the facilities. Girls in public schools, however, had better access to menstrual pads because they benefited from the Sanitary Towels Programme and WASH government initiative, something that girls in private schools did not have access to. Nalugya *et al.* (2020) [81] found that in addition to providing adequate WASH facilities and menstrual products at schools, including boys in awareness building around menstruation resulted in a positive change in social norms. The intervention changed boys' perceptions towards menstruation and made them more comfortable around menstruating girls, such as loaning a girl a sweater rather than mocking her for her stained clothing. Girls also reported feeling less shame, embarrassment, fear, and anxiety. Girod *et al.* (2017) [80] found that a sanitary towel programme that provided pads for girls in public schools but no awareness-raising activities for boys only resulted in boys constantly harassing girls and teasing them during their period. As described above, You *et al.* (2020) [82] reported on the installation of toilet block lighting (Pee Power) in schools and found some improvements in feelings of safety among girls.

In the context of water supply, the only included study focused on water supply infrastructure interventions. Karim *et al.* (2014) [83] found that a water intervention in Bangladesh had unintended effects and resulted in an increase in physical violence in the community. Women in the study reported that longer waiting times at the water point took time away from their day and did not allow them to complete their household chores in time. This increased the risk of their being punished by their husbands. Also, many handpumps dried out during the dry season, which meant that women had to walk to distant wells (p. 210): *"I went to fetch water from the deep tube well. It took a long time because there was a long line ... but when I came back, I saw that the man (husband) was home. He asked me to serve lunch. ... I replied that it took a long time to collect water (as our nearest three handpumps had dried out). But he said that it was my problem if other women can cook on time for their husbands! So when I told him to go to see the deep (DTW) ... he got angry and started beating me. ... I did not argue anymore; rather, I went to cook."*

## How are violence-related outcomes reported and measured?

All studies examined gender-based violence, which for the most part comprised outcomes such as harassment or fear. These were mostly measured based on feelings of safety. Only two studies in our evidence base recorded violence towards other social categories, including people with disability status (Kayoka *et al.*, 2019 [86]) and people of a different caste (Routray *et al.*, 2015 [78]). Cronin (2012) [79] did not report outcomes for people with disabilities, although the study included the provision of toilets with special features (such as lower handrails and adjusted seat heights).

Most outcomes related to reports of safety, with fewer studies reporting outcomes relating to physical or sexual violence. Shiras *et al.* (2018) [85] reported instances of physical and sexual violence. One community sanitation block participant reported an instance of attempted sexual assault while she was using the latrine, and others reported hearing of similar attacks, which made it unsafe to use the toilet, especially at night. Another respondent reported (p. 5): *"I fear because of way that the bathroom is, you think about going out for the bathroom, while there may be a hidden person who can beat or kill you, rape, so many things that happen around here."* After the installation of the Pee Power lighting intervention in a girls' school, the teacher reported no cases of assault at the school; however, this cannot be relied upon alone as there was no systematic data collection and students may not have been comfortable reporting this to teachers. Cronin (2012) [79] reported instances of physical violence, particularly robbery, which were described by an employee of the recently built sanitation blocks.

Only one study measured outcomes related to people with disabilities. Kayoka *et al.* (2019) [84] applied a safety and accessibility audit to show that following the inclusive community-led total sanitation intervention, people with disabilities still faced safety and privacy concerns related to sanitation access at home. This included a gendered dimension as respondents reported that men or boys could easily see women/girls inside the toilet superstructure. Some implementers used stigmatising language to describe people with disabilities, rather than the correct wording, indicating the prevalence of social stigma.

## How do violence-related outcomes change across different groups?

Few studies examined how the outcomes varied for different groups, including in relation to gender, age, and religion. Frequent areas of focus were women and girls of different ages and at different life stages. Prabhakaran *et al.* (2016) [77] reported on the presence of latrines and how women across all age groups communicated that this gave them a feeling of security, safety, and convenience. Menstruating women benefited by having privacy and cleanliness (p. 6): *'Women stated that with the presence of toilets in their homes, their experiences during menstruation had become more pleasant as they had a private and clean space to maintain their hygiene'*. Dreibelbis *et al.* (2018) [76] used a life stage approach, in which girls and women were classified based on social and physical milestones rather than age. Some of the life stages were adolescent, newly married, pregnant, established adults (single and married), and aged adults

(single and married). However, due to sample size restrictions, the authors were not able to undertake a stratified analysis of the impact of the intervention based on the different groups.

Routray *et al.* (2015) [78] found that latrines provided visual privacy for women, and specifically for adolescent girls, women during menstruation, and new daughters-in-law, who culturally should not be seen near other men in the village while going to defecate. Toilets were built before a wedding specifically for the new daughter-in-law: (p. 10): *'Male heads usually are in charge of safeguarding the privacy and safety of their daughters-in-law, so they are often the instigators who feel the need to build a latrine for the women in the household, particularly for the protection of their newlywed daughter-in-law, rather than women themselves demanding it. Some toilets were found to be built just before a wedding, specifically intended for use just by the new daughter-in-law.'*

In terms of religious differences, Girod *et al.* (2017) [80] found that Fresh Life Toilets installed in the schools did not accommodate Muslim girls' need to practice ablution. The Fresh Life Toilets were too small, and water was not available in the facility. This meant that Muslim girls had to use the old toilets, which made them more vulnerable to harassment by male peers, as these rarely had locks for the doors.

## How sustainable are violence-related outcomes?

There were very limited reports on the sustainability of intervention effects (three out of 11 studies). You *et al.* (2020) [82] conducted an end-line survey one week and one year after implementation to assess if outcomes were sustainable after the initial 'novelty' period of the intervention wore off. In the first survey respondents reported that Pee Power toilets made them feel safer when using the toilets at night (85%). The second survey conducted one year after the commissioning of Pee Power toilets showed very similar results related to the feeling of safety. The headteacher reported that there were no incidents of intrusion or assault against the pupils during the time that Pee Power was running at the school; however, this could be due to under-reporting or other reasons.

In an intervention to make community-led total sanitation more inclusive of the needs of people with disabilities, Kayoka *et al.* (2019) [84] assessed implementer recall of the community-led total sanitation-plus method 18 months after the intervention. They found that implementers had forgotten some principles of the approach, such as the need to involve people with disabilities in the implementation process. Dreibelbis *et al.* (2018) [76] implemented an end-line survey to evaluate the impact of the intervention two years after the implementation period and women reported that their sanitation facility made them feel less stressed because the facilities had adequate privacy for bathing and changing and they did not have to walk a long distance to relieve themselves. Some women stated that they did not have to restrict their food intake to avoid the need to defecate or urinate during the daytime.

## Barriers to change in violence-related outcomes

Nine studies comprehensively described barriers to change for violence-related outcomes. We identified three main themes: 1) the influence of the wider environment, 2) existing levels of gender-based violence, and 3) existing sociocultural norms.

While WASH interventions are generally focused on a particular facility, the wider built environment was found to be important. Shiras *et al.* (2018) [85] found that compound fencing, compound lighting, and door locks were major determinants of perceptions of safety. This is even though fencing and other aspects of the surrounding environment go beyond the scope of most sanitation interventions. Whether a toilet was situated facing a main road also affected feelings of safety in this study. Users of Pee Power school toilets did not feel safe walking to the toilets on an unlit path, despite the presence of toilet block lighting. Furthermore, a nearby wire fence had been damaged by intruders in the past. Routray *et al.* (2015) [78] reported how faults in latrine design and construction affected privacy (p. 9): *'[...]where the latrine was unfinished and lacked a door or sufficient height walls (a frequent occurrence we observed), that visual privacy was not ensured'*. Cronin 2012 [79] found that in the newly built sanitation blocks some people feared using them at night-time due to their proximity to the main road, and the lack of proper lighting. Cronin (2012) [79] also found that poverty and unemployment were identified by residents as barriers to change in violence-related outcomes, contributing to an increase in robberies and crimes outside the sanitation blocks.

The existing levels of gender-based violence in many of the study sites were a barrier to change in violence-related outcomes. In the case of Pee Power school toilets (You *et al.* 2020) [82], community toilets were also discussed and 65% of the respondents were aware that women had been attacked by men in their villages while using a toilet facility. Shiras *et al.* (2018) [85] found that women respondents reported high levels of neighbourhood violence, and felt unsafe, particularly at night. Harassment of women and girls reported by Dreibelbis *et al.* (2018) [76] went beyond the sanitation facility. Women stated that girls could not leave the house on their own, and for many this meant that they could not continue with their education. While women did not report being harassed while practising open defecation, they reported always being afraid of this happening and therefore they took the necessary precautions. In Girod *et al.* (2017) [80], girls' level of safety in their school environment was reported to be reduced due to their fear of being assaulted, harassed, or raped by boys or other members of their community.

Existing sociocultural norms were a barrier to change in violence-related outcomes in many of the studies. Kayoka *et al.* (2019) [84] described cultural norms around disability in Malawi and found that correct wording needed to be emphasised to identify people with disabilities and mitigate the social stigma associated with disabilities. Together with the safety and privacy concerns reported, they suggested positive changes may need more time to materialise as the evaluation was conducted 18 months after implementation. Naluyga *et al.* (2020) [81] reported existing social beliefs and stigma related to menstruation perpetuated fear, and that this prevented girls seeking support. Girod *et al.* (2017) [80] found that girls were not comfortable playing around their male peers because they would try to touch them inappropriately; as a

response to this, teachers would tell girls to stay away from boys, especially during their periods, instead of holding them accountable for their actions. In the same study, it was highlighted that equity in access to Fresh Life Toilets varied for Christian and Muslim girls in the same WASH setting, as Fresh Life Toilets were not designed to accommodate Muslim girls' need to practice ablution.

Dreibelbis *et al.* (2018) [76] found that elder community members in the case study blamed victims for being harassed, stating that this would not happen if women behaved properly. Karim and colleagues (2012) [83] reported that marital violence was seen as a normal 'socially justified' practice in the community, and that wife beating was a demonstration of men's power over women. The fact that women had to leave their household duties to obtain water gave men one more reason to impose physical and psychological violence on their wives.

## Facilitators of change in violence-related outcomes

A range of facilitators were found to help reduce reports of violence-related outcomes. We identified four main themes, including a combination of different sociocultural and environmental factors, as follows: 1) accessibility of safe sanitation facilities and facility ownership, 2) design features of sanitation facilities, 3) punishment of unwanted behaviours, and 4) the level of social cohesion and mutual support.

Dreibelbis *et al.* (2018) [76] and Arnold *et al.* (2010) [75] reported that private ownership of latrines made girls and women feel safer. Similarly, Prabhakaran *et al.* (2016) [77] found that accessible and safe sanitation infrastructure, through ownership of toilets at home, facilitated feelings of safety.

The appropriate type, design, and construction of sanitation facilities was reported to be an important contributor to feelings of safety. The existence of doors, locks, fencing, and lighting at a sanitation facility was mentioned as a facilitator of safety in the majority of studies. Cronin (2012) [79] reported that the presence of staff at all times made residents feel safer while using newly built sanitation blocks. However, staff members reported feeling unsafe when working alone or at night-time. In the case of Pee Power [82], the innovative urine-powered design made students interested in using the toilets. The interest in, and acceptability of, the technology may lead to more long-term use, and thus greater safety, compared to toilets without lighting. Kayoka *et al.* (2019)[84], who examined inclusive community-led total sanitation for people with disabilities, reported that using active demonstrations was helpful in order to increase learning about the barriers faced by people with disabilities. Girod *et al.* (2017) [80] found that girls felt more comfortable using Fresh Life Toilets because they had disposal bins in which they could dispose of their menstrual pads without having to carry them home. An intervention that includes multiple components, such as infrastructure, product provision, training, and efforts to change negative gender norms, can facilitate feelings of safety (such as a menstrual hygiene management intervention reported by Nalugya *et al.* (2020) [81]) and offers the potential to address multiple risk factors for violence.

Sociocultural facilitators were also found to be important among the included studies in the framework synthesis Routray *et al.* (2015) [78] reported how existing sociocultural norms in regard to maintaining household status and dignity motivated the building of safer sanitation facilities for a newlywed daughter-in-law. In addition, this study reported that the geographical area of the intervention was relatively safe due to strong social cohesion and fear of being reprimanded (p. 15: '*Social cohesion and fear of reprimand in the study villages appeared strong enough to prevent individual men from molesting women on their way to the open defecation sites*').

## How do WASH interventions impact violence-related outcomes?

Based on themes identified in the included literature, here we provide a summary of some of the mechanisms through which interventions can lead to positive or negative violence-related outcomes in sanitation (Figure 17a) and water supply contexts (Figure 17b). Namely, access to a safe WASH facility that meets the needs of various gender and social categories, coupled with a change in harmful social and gender norms, attitudes, and behaviours related to violence, are intermediate outcomes that can contribute to safety. Importantly, the construction of a WASH facility alone cannot address all WASH-related violence, and it is important to engage with unequal power relations. In addition, several barriers and facilitators described above may be present along the pathway towards safety and freedom from violence related to the use of WASH.

Gender-blind WASH intervention design and implementation is a clear impediment to positive safety outcomes in both sanitation and water supply contexts. In addition, in a sanitation context, we found that an unfavourable built environment – for example, poor lighting on the way to the toilet, as separate from the lighting around the toilet itself – and poor socioeconomic conditions, coupled with existing levels of violence in a community, harmful social beliefs and stigma, and non-punishment of violent behaviours, are barriers to safety. Similarly, our limited evidence from a single example in a water supply context in Bangladesh shows how household power relations and patriarchy, as well as social acceptance of violent behaviours, facilitate gender-based violence.

In the case of sanitation, household ownership of a sanitation facility, an appropriate design that provides visual privacy during facility use, as well as strong social norms that allow for efficient punishment of abusers and solidarity within a community that can offer protection to vulnerable or marginalised groups, are key facilitators of safety. In the case of water supply, the physical availability of water can facilitate safety by mitigating intra-household conflicts related to large time requirements for water collection (taking away time from other work). These facilitators work under the assumption that there is the existing legal framework and political will to support human rights, that there is buy-in from local WASH champions, and that intervention implementers are aware of the local context and risks of backlash and a weakening of GESI mainstreaming, and seek to address them.

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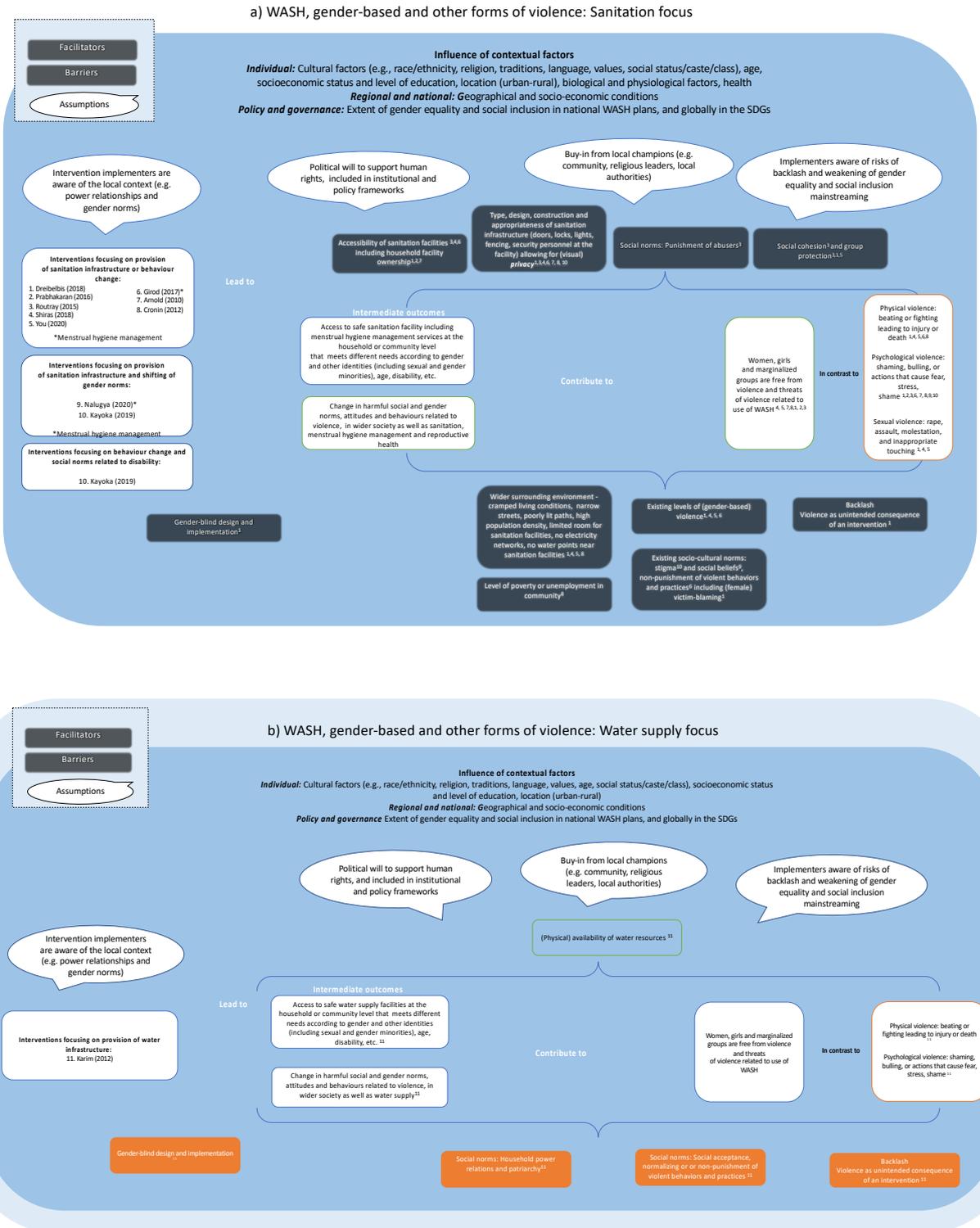


Figure 17 Connections between different types of interventions, facilitators, barriers, and wider implementation context for sanitation (a) and water (b) contexts

## Conclusions

Violence against women, girls, and other vulnerable groups is a major human rights violation, as well as a global public health challenge. Our framework synthesis indicates that there are many gaps in the understanding of this issue in a WASH context. In studies on interventions that installed improved sanitation or lighting, some women respondents still reported feeling unsafe using the facilities. Many factors in the built environment contributed to a feeling of being unsafe, or to reports of violence. The existence of harmful gender attitudes can also contribute to violence, but these are rarely addressed in WASH interventions. This indicates that WASH infrastructure solutions alone are not adequate to address violence. WASH implementers must work together with urban planners and gender practitioners to address the complex drivers of violence.

## Limitations

Due to limited time and availability of resources, we conducted a synthesis of only one outcome, choosing to focus on violence due to high stakeholder interest. Findings from the mapping exercise (described in Part 1 of this report) could be easily used (and extended) in order to proceed with the synthesis of other relevant knowledge clusters.

The studies included in the synthesis were relatively narrow and multiple knowledge gaps can be identified. There was a limited measurement of backlash and unintended effects of interventions. There were no longitudinal observations of outcomes, and there were only a few examples of measures of the sustainability of change after the intervention ended, and then only after approximately one to two years. As gender-based violence is related to power relations, interventions may require a longer period before observable changes materialise. Evaluation studies with follow-ups after a longer period are needed to address this. In addition, most studies reported on feelings of safety, but there was limited use of other measures of gender-based violence. As this is under-researched in the WASH sector, it is important to examine best practices in other fields to expand the use of measures of violence. Finally, most interventions in this review focused on sanitation and/or menstrual hygiene management, and there was very limited information on water supply interventions.

Most interventions focused on infrastructure access, indicating gaps related to interventions that aim to change harmful gender norms. This is critically important in the case of gender-based violence. Of the interventions included in the framework synthesis, nine involved infrastructure interventions and only two studies included intervention components addressing social norms related to gender equality and/or social inclusion. Specifically, Kayoka *et al.* (2019) [84] conducted a study on a community-led total sanitation intervention with attention to changing social norms related to disabilities. Nalugya *et al.* (2020)[81] conducted a study on an intervention that combined infrastructure (ensuring the presence of WASH facilities in schools) with training and awareness building around safe menstrual hygiene among girls, boys, teachers, and parents.

## Implications for practice

More WASH interventions should include considerations of violence in both intervention design and evaluation. The collection of data in connection with interventions should ensure benefits for participants and should follow best practices in regard to collecting information on gender-based violence.

The findings show that it is important to focus not only on latrine design but also on the surrounding built environment. However, sanitation infrastructure and the built environment alone are not adequate for addressing other barriers to change in violence-related outcomes. Multi-component interventions, and particularly those including GESI components, such as building awareness of menstrual hygiene needs among girls, or of harmful gender norms, may help in improving GESI outcomes. In implementing such interventions, greater training of WASH practitioners on risks related to gender-based violence and other forms of violence would improve the awareness and recognition of these challenges, and would provide entry points for better uptake of such considerations. This training should apply a transformative framing that seeks to increase understanding of the role of both infrastructure solutions as well as underlying social and gender norms and relations that drive violence.

## Implications for research

There is an urgent need to collect better evidence to evaluate the impacts of WASH interventions on all forms of violence. Most WASH interventions do not assess outcomes related to violence, so this is an entry point for improving data collection, as well as for improving the design of the intervention itself. There are several possible reasons for this dearth of information. These may include ethical concerns related to conducting research on violence (and particularly sexual violence), shame, risks to the person reporting violence, or a lack of training of researchers on how to measure gender-based violence accurately and ethically. It is important to address these reasons, as gender-based violence related to WASH is ongoing. Data can be collected in various ways so as to improve the safety of data collection: for example, by training interviewers/enumerators to ask sensitive questions, by providing local resources, and, most importantly, by collaborating with gender practitioners with expertise in data collection on violence outcomes.

## Part 3

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### Results for review question 6

This section summarises the results from the evidence synthesis performed for review question 6: *What are the effects of WASH interventions on time savings and alternative uses of time?*

#### Description of the screening process

Out of 463 studies included in the map, we identified 85 quantitative, qualitative and mixed-methods studies as potentially relevant, of which 28 presented quantitative data on time savings following water and sanitation interventions, and/or alternative uses of time resulting from the time savings, with one paper reporting on two interventions [87]. The rest of the papers reported qualitative information relating to use of time, such as the reasons for not adhering to a WASH intervention, and were therefore excluded from the analysis.

#### Quality of studies in the evidence base

Most studies were rated as having a 'low risk of bias' due to confounding, partly because time use is subject to a low risk of confounding, so even uncontrolled before-versus-after studies can produce unbiased effects in theory, provided time use is measured shortly after implementation of the WASH improvement. One study with five-year follow-up noted that 'other factors external to the water project, such as the development of a new road infrastructure in some of the sampled communities could have impacted the level of participation by people in activities that required travel by road to such places as markets within and outside the area' ([88]: p. 236). However, reporting bias was potentially more problematic: especially where studies used recall of baseline measures. All studies used self-report surveys to measure the outcome. Almanzar *et al.* (2017) [89] used time diaries to collect data on time use. Overall, the critical appraisal assessment found that 12 studies were rated as giving rise to 'some concerns' in regard to attributing the change in time use to the WASH intervention, and the remaining studies were rated as at 'high risk of bias'.

#### Overview of included studies and study context

Descriptive information about studies reporting time savings and time use information is provided in Table 4 for drinking water (water supply and water treatment) interventions and in Table 5 for sanitation interventions. No studies measured changes resulting from hygiene interventions. Various water supply interventions were evaluated, including piped water provision to the household or yard [90], or loans [91] and subsidies [92] for piped water, provision of new community standpipes (e.g. [93]), and interventions focusing on privatisation [94] or on improving the payment process, like mobile billing [95]. Water treatment interventions included filtration [96], treated water sold at kiosks [94], rainwater harvesting [97], and chlorination [98, 99]. Sanitation interventions included latrine provision (e.g. [100]) and promotion through community-led total sanitation (e.g. [101]).

Table 4: Drinking water interventions

<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Aleixo (2019) <a href="#">[102]</a>	Brazil	BA	Zero time spent collecting water vs 1+ minutes	Rural	All	Improved	190	-	-	-1.06	Some concerns
Aleixo (2019) <a href="#">[102]</a>	Brazil	BA	Zero time spent collecting water vs 1+ minutes	Rural	All	Improved	190	-	-	-0.97	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent carrying water hours per week	Rural	All	Improved	3,803	-	-4.64	-0.72	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent carrying water hours per week	Rural	Men	Improved	7,784	-	-2.21	-0.78	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent carrying water hours per week	Rural	Women	Improved	7,784	-	-2.43	-0.86	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent doing laundry hours per week	Rural	All	Improved	2,935	-	-4.00	-0.39	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent doing laundry hours per week	Rural	Men	Improved	4,569	-	-2.08	-0.41	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent doing laundry hours per week	Rural	Women	Improved	4,569	-	-2.84	-0.56	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent in education mins per day	Rural	Children aged 5-18	Improved	4,929	-	0.04	0.34	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent in education mins per day	Rural	Boys aged 5-18	Improved	4,929	-	0.03	0.28	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent in education mins per day	Rural	Girls aged 5-18	Improved	4,929	-	0.05	0.41	Some concerns
Almanzar (2017) <a href="#">[89]</a>	El Salvador	DID	Time spent in social activities mins per day	Rural	Men	Improved	3,991	-	0.01	0.11	Some concerns

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<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Almanzar (2017) [89]	El Salvador	DID	Time spent on social activities mins per day	Rural	Women	Improved	3,991	-	-0.06	-0.54	Some concerns
Almanzar (2017) [89]	El Salvador	DID	Time for self mins per day	Rural	All	Improved	8,557	-	0.01	0.07	Some concerns
Almanzar (2017) [89]	El Salvador	DID	Time for self mins per day	Rural	Men	Improved	5,891	-	-0.03	-0.25	Some concerns
Almanzar (2017) [89]	El Salvador	DID	Time for self mins per day	Rural	Women	Improved	5,891	-	0.00	0.01	Some concerns
Almanzar (2017) [89]	El Salvador	DID	Time spent caring for children mins per day	Rural	Women	Improved	2,174	-	-0.04	-0.38	Some concerns
Anthonj (2018)[103]	Ethiopia	XS means	Time to reach water, collect, and return minutes	Rural	All	Improved	80	-	-	0.00	High risk
Arku (2010)[88]	Ghana	BA	Time to collect water: <1 hours per day vs 2+	Rural	Married women	Unimproved	190	-	-	-3.84	High risk
Arku (2010) [88]	Ghana	BA	Time to collect water: <1 hours per day vs 2+	Rural	Married men	Unimproved	13	-	-	-3.40	High risk
Arku (2010) [88]	Ghana	BA	Time spent on social and religious activities hours per week	Rural	Married women	Unimproved	190	-	1.62	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on production hours per week	Rural	Married Women	Unimproved	190	-	1.98	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on education hours per week	Rural	Married Women	Unimproved	190	-	0.83	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on relaxation hours per week	Rural	Married Women	Unimproved	190	-	0.78	-	High risk

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<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Arku (2010) [88]	Ghana	BA	Time spent on social and religious activities hours per week	Rural	Married men	Unimproved	13	-	1.18	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on production hours per week	Rural	Married men	Unimproved	13	-	1.63	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on education hours per week	Rural	Married men	Unimproved	13	-	-0.02	-	High risk
Arku (2010) [88]	Ghana	BA	Time spent on relaxation hours per week	Rural	Married men	Unimproved	13	-	1.02	-	High risk
Barstow (2016)*[96]	Rwanda	XS	Time saved from boiling water in minutes	Rural	All	Improved	195	-	-0.13	-	High risk
Beath (2015)[104]	Afghanistan	Cluster-RCT IV	Time to get to the water source, take it, and come back hours	Rural	Female	N/S	7,987	-	-0.47	-0.13	Some concerns
Bisung (2018)[90]	Kenya	XS adjusted	Minutes per round trip	Peri-urban	All	Unimproved	444	-4.17	-	-0.36	High risk
Bisung (2018)[90]	Kenya	XS adjusted	Minutes per round trip	Peri-urban	All	Unimproved	158	-4.28	-	-0.47	High risk
Bisung (2018) [90]	Kenya	XS adjusted	Minutes per round trip	Peri-urban	All	Unimproved	602	-4.23	-	-0.40	High risk
Briand (2017)[93]	Burkina Faso	XS PSM	Average water collection time mins per day	Peri-urban	All	N/S	549	-	-1.21	-0.19	High risk
Dansabo (2019)[105]	Nigeria	BA	Time to collect water per trip: <30 mins vs 30+ mins	Rural	All adults aged 18+	Unimproved	378	-	-	-0.53	High risk
Deal (2020)*[94]	Ghana	XS	Share with <30 mins per trip to fetch water	Rural	All	Improved	1,114	-	-	0.10	High risk

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<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Devoto (2011)[92]	Morocco	Cluster-RCT	Time spent fetching water mins per week	Urban	All	Improved	845	-	-1.11	-0.17	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Time spent on social activities while fetching water mins per week	Urban	All	Improved	845	-	-0.05	-0.08	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Time spent on leisure hours per week	Urban	All	Improved	845	-	0.09	0.25	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Num times child <15 fetched water past 3 days	Urban	Children <15 years	Improved	845	-	-	-0.44	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Num times grownup fetched water past 3 days	Urban	Adults >15 years	Improved	845	-	-	-0.44	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Male head generated income past 30 days	Urban	Males	Improved	845	-	-	0.00	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Female head generated income past 30 days	Urban	Females	Improved	845	-	-	-0.11	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Share of children completing school year	Urban	Children 5–15 years	Improved	363	-	-	-0.05	Some concerns
Devoto (2011) [92]	Morocco	Cluster-RCT	Share of girls completing school year	Urban	Girls 5–15 years	Improved	246	-	-	0.05	Some concerns
Foster (2012)[95]	Kenya	XS	Time to pay bill, including wait time and return trip minutes	Urban	All	Improved	193	-	-	-1.59	High risk
Foster (2012)[95]	Kenya	XS	Time to pay bill, including wait time and return trip minutes	Urban	Public transport users	Improved	193	-	-	-3.68	High risk
Hasan (2016)*[98]	Bangladesh	XS PSM	Time spent to collect drinking water mins per day	Rural	All	Unimproved	512	-	-	-0.37	High risk

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<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Jack (2016)* <a href="#">[97]</a>	Kenya	Cluster-RCT	Time spent fetching water by children mins per day	Rural	Girls	Unimproved	4,109	-	-0.26	-0.05	Low risk
Jack (2016)* <a href="#">[97]</a>	Kenya	Cluster-RCT	Time spent fetching water by children mins per day	Rural	Boys	Unimproved	4,109	-	-0.11	-0.03	Low risk
Kumar (2018) <a href="#">[106]</a>	India	Cluster-RCT	Time spent waiting for water hours per supply day	Urban	All	Improved	2,440	-2.4	-	0.00	High risk
Padmaja (2020) <a href="#">[107]</a>	India	BA	Time to fetch water mins per day	Rural	All	Unimproved	700	-	-7.0	-	High risk
Pattanayak (2010) <a href="#">[87]</a>	India	Cohort means	Time saved walking to main water source and waiting (dry season) mins	Rural	All	Unimproved	1,086	-8.0	-	-	High risk
Pattanayak (2010) <a href="#">[87]</a>	India	Cohort means	Time saved walking to main water source and waiting (wet season) mins	Rural	All	Unimproved	1,086	-1.0	-	-	High risk
Pattanayak (2010) <a href="#">[87]</a>	India	Cohort means	Time saved walking to main water source and waiting mins	Rural	All	Unimproved	1,086	-4.5	-	-	High risk
Peter (2010) <a href="#">[108]</a>	Eswatini	BA	Time to walk to water: <30 mins per trip versus 30 mins+	Rural	All	Unimproved	45	0.0	-	-2.67	High risk
Pories (2016) <a href="#">[91]</a>	India	BA	Travel to water source and waiting hours	Rural	All	Unimproved	294	-	-6.3	-	High risk

<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome measure</i>	<i>Location</i>	<i>Group</i>	<i>Counterfactual</i>	<i>N</i>	<i>Mins per trip</i>	<i>Hrs per week</i>	<i>d</i>	<i>Assessment</i>
Ruben (2011)[109]	Guatemala	DID	Time saved for a round trip to collect one container of water mins	Rural	All	Improved	3,688	-14.0	-	-0.08	High risk
Ruben (2011) [109]	Guatemala	DID	Time saved for a round trip to collect one container of water mins	Rural	Households in large localities	Improved	2,147	-7.0	-	-0.08	High risk
Ruben (2011) [109]	Guatemala	DID	Time saved for a round trip to collect one container of water mins	Rural	Households in small localities	Improved	1,541	-21.0	-	-0.12	High risk
Ruben (2011) [109]	Guatemala	DID with PSM	Girls' school enrolment rate	Rural	Girls of school age	Improved	200	39.0	-	0.29	High risk
Sakisaka (2015)[110]	Kenya	BA	Median time to fetch water mins per day	Rural	All	Unimproved	1,391	-15.0	-	-0.17	Some concerns
Sikder (2020)*[99]	Bangladesh	XS	Time spent in queue mins	Refugee camp	All	Unimproved	19	1.5	-	2.58	High risk
Sikder (2020)* [99]	Bangladesh	XS	Time spent in queue mins	Refugee camp	All	Unimproved	20	3.9	-	1.80	High risk
Schlegelmilch (2016)[111]	Kenya	BA	Time to fetch water (dry season) mins	Rural	All	Unimproved	250	-53.5	-	-0.40	High risk
Schlegelmilch (2016) [111]	Kenya	BA	Time to fetch water (wet season) mins	Rural	All	Unimproved	250	0.50	-	0.12	High risk
WaterAid (2015)[100]	Zambia	BA	Time collecting water: <30 mins vs 30+ mins	Rural	Vulnerable individuals	Unimproved	34	-	-	-2.31	High risk

Notes: \* includes water quality intervention: filtration (Barstow, 2016), treated water sold at kiosks (Deal, 2020), piped chlorinated water (Hasan, 2016), rainwater harvesting (Jack, 2016) [97], chlorination at water source (Sikder, 2020). BA = before after design, DID = difference in differences, PSM = propensity score matching, XS = cross-sectional design. Counterfactual scenarios defined by Joint Monitoring Programme (WHO/UNICEF, 2021) [1].

Table 5: Sanitation interventions

<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome detail</i>	<i>Group</i>	<i>N</i>	<i>mins/trip</i>	<i>h/week</i>	<i>d</i>	<i>Assessment</i>
Biran (2018)[112]	Malawi	Cluster-RCT	Time saved walking to toilet mins	People with disability >2 years	171	-0.2	-	-0.04	Some concerns
Cha (2020)[101]	Ethiopia	Cluster-RCT	Time saved walking to place of defecation hours per household	5–14s	3,804	-	-5.6	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved walking to place of defecation hours per household	Over-15s	4,608	-	-4.0	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved walking to place of defecation hours per household	Over-5s	8,412	-	-4.7	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved in regard to being sick or caring for sick hours per household	Under-5s	1,301	-	-2.4	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved in regard to being sick or caring for sick hours per household	5–14s	3,804	-	-0.7	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved in regard to being sick or caring for sick hours per household	Over-15s	4,608	-	-0.5	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved in regard to being sick or caring for sick hours per household	All	9,713	-	-0.8	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved hours per household	5–14s	3,804	-	-6.2	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved hours per household	Over-15s	4,608	-	-4.5	-	High risk
Cha (2020) [101]	Ethiopia	Cluster-RCT	Time saved hours per household	All	9,713	-	-4.9	-	High risk
Dickinson (2015)[113]	India	Cluster-RCT	Time saved walking to place of defecation mins	Men	984	-3.5	-	-0.16	Some concerns
Dickinson (2015) [113]	India	Cluster-RCT	Time saved walking to place of defecation mins	Women	988	-3.6	-	-0.19	Some concerns

<i>Study</i>	<i>Country</i>	<i>Method</i>	<i>Outcome detail</i>	<i>Group</i>	<i>N</i>	<i>mins/trip</i>	<i>h/week</i>	<i>d</i>	<i>Assessment</i>
Dickinson (2015) [113]	India	Cluster-RCT	Time saved walking to place of defecation mins	Children <5 years	882	-2.2	-	-0.18	Some concerns
Dickinson (2015) [113]	India	Cluster-RCT	Time saved walking to place of defecation mins	All	2,854	-3.1	-	-0.18	Some concerns
Pattanayak (2010)[87]	India	Prospective cohort	Time saved walking to place of defecation mins	All	1,086	-4.7	-	-0.14	Some concerns
WaterAid (2015)[100]	Zambia	BA	Time saved to walk to latrine mins	Vulnerable people	34	-	-	-1.04	High risk

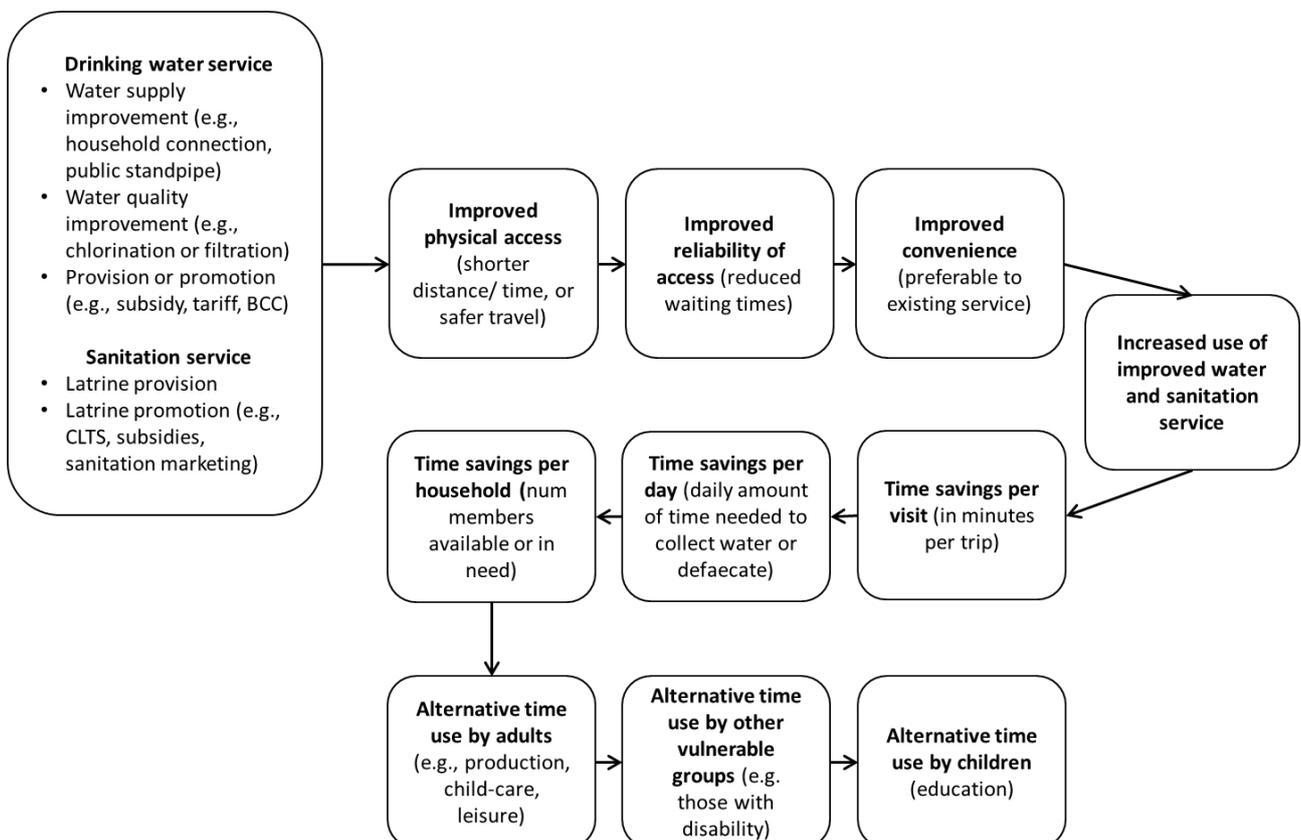
Note: All studies were conducted in rural areas of latrine provision or promotion, and used counterfactual scenarios where most households used sanitation that was 'unimproved' (WHO/UNICEF, 2021) [1]. BA = before after design.

## Findings

We were able to identify 155 measures of effects on time savings or time use from the 28 included studies, of which for 85 measures, sampling and statistical information on an effect size measure (d) could be calculated. Where studies provided statistical information, the data were synthesised in meta-analysis; otherwise, they were synthesised narratively. The studies used a range of measures of time use, including one-way travel time in the case of latrine use, and round-trip travel time in the case of water supply, usually including wait times. Some studies measured time use at the individual trip level, while others summed up time use for the whole day or more, at individual or household levels.

These different measures can be seen as components in the theory of change, designed prior to data collection. Figure 18 presents the steps along the causal pathway from the provision or promotion of improved drinking water and sanitation services, through improved access and use, to time savings at individual and household levels, and alternative time uses by different household members. It shows how it is not just physical access that is important, but also wait times, which determine the time taken to access the new WASH facility, as well as its perceived convenience, which determines its use. Time savings may be measured per trip, per day, at individual and household levels. Alternative uses of time may accrue to different groups and may be more strongly felt by those with particular needs, such as people with disability and the elderly.

Figure 18 Theory of change: drinking water and sanitation interventions and time use (BCC = behaviour change communication, CLTS = community-led total sanitation)



### Synthesis of evidence on time savings measured in natural units

Table 6 presents summary information about time use following drinking water and sanitation interventions. It indicates mean reductions in time of around 11 minutes per trip for water supply interventions, and around three minutes per trip for latrine interventions. However, due to multiple trips for water and sanitation each day, these add up to mean savings of around three hours per week following water supply interventions and 3.5 hours following sanitation interventions. Owing to the differences in types of water supply interventions and counterfactual scenarios, there is a large variation in findings for water supply, ranging between 0.7 hours per week as a result of community-driven development incorporating general water supply projects (e.g. deep wells, water supply systems) in Afghanistan (Beath *et al.*, 2015) [104] and as much as seven hours per week for community-driven development in El Salvador (Almanzar *et al.*, 2017) [89]. The maximum minutes per trip saved was approximately one hour following installation of roof water catchments, small farm reservoirs, public taps, and community pipelines in Kenya (Schlegelmilch *et al.*, 2016) [111]. For sanitation, all studies related to latrine promotion (community-led total sanitation) in Ethiopia, where mean weekly time savings varied between 0.5 hours caring for the sick and six hours, including time savings from avoiding open defecation and caring for the sick (Cha *et al.*, 2020) [101]. There were small increases in time allocated to water treatment (chlorine provided at the water source), and only one study estimated the time saved from filtration over traditional water treatment practices (boiling water and collecting firewood).

Table 6 Change in time for water collection associated with WASH improvement

<i>Intervention</i>	<i>Outcome</i>	<i>Mean</i>	<i>SD</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Number of estimates</i>
Water supply	Minutes per trip	-11.4	16.7	0	-53.5	9
	Hours per week	-2.9	2.4	-0.7	-7.0	9
Water treatment	Minutes per trip	1.5	-	1.5	1.5	1
	Hours per week	-0.2	0.1	-0.1	-0.3	3
Sanitation	Minutes per trip	-2.5	1.4	-0.0	-3.6	5
	Hours per week	-3.4	2.2	-0.5	-6.2	10

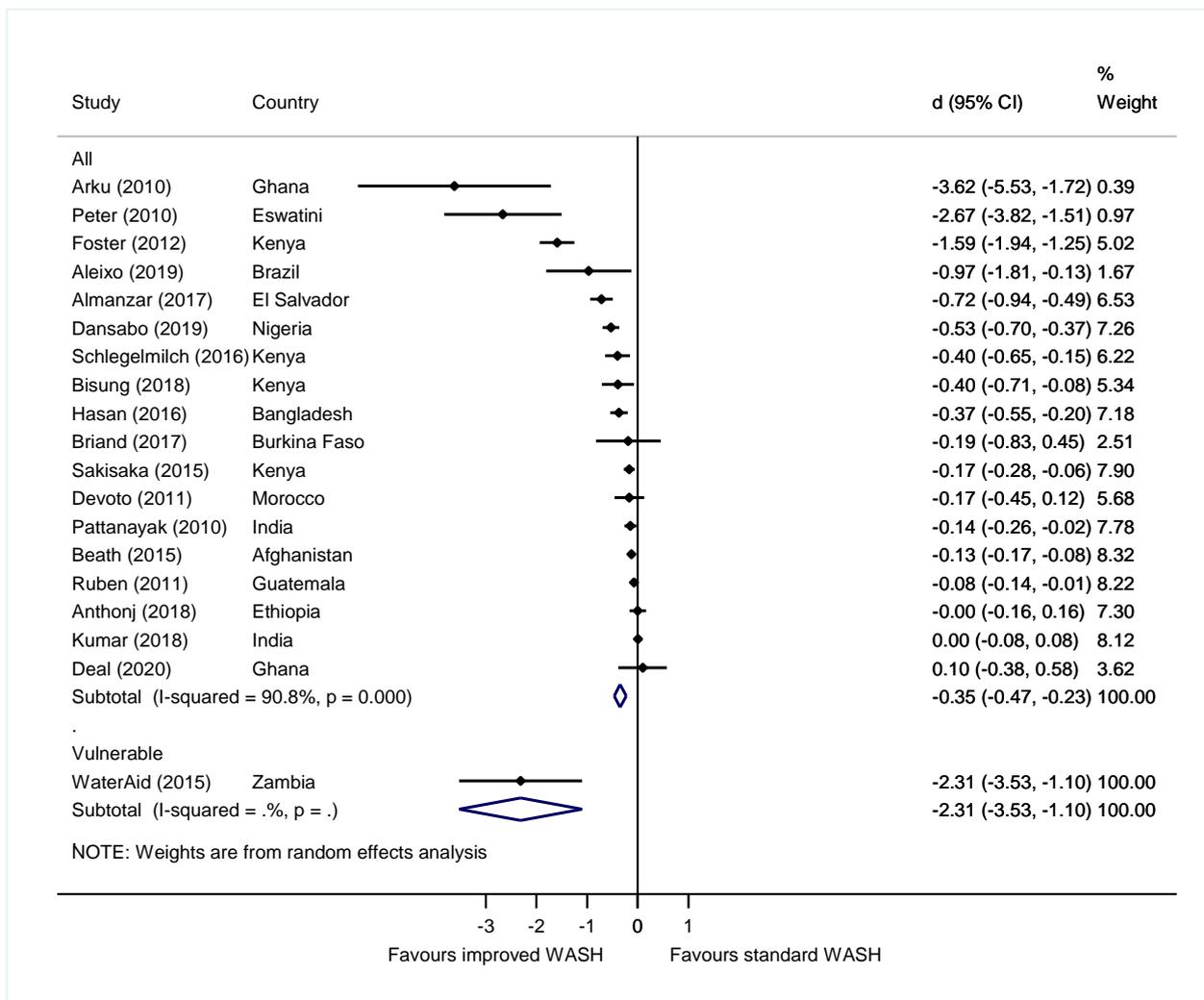
Notes: Values of mean < 0 indicate time saved following intervention; SD = standard deviation.

We examined whether there were any differences in time when studies were grouped by global region (Latin America, South and Western Asia, sub-Saharan Africa), and found that time savings tended to be larger in Africa. We found on average 18 minutes saved per trip in sub-Saharan Africa (SD=24, range=0, 54; four estimates) and four minutes saved per trip in Asia (SD=3, range=1, 8; four estimates), following water supply interventions. For sanitation, on average 27 minutes were saved per trip in sub-Saharan Africa (SD=38, range=0, 54; two estimates) and three minutes were saved in South and Western Asia (SD=0.9, range=2, 5; five estimates).

### **Meta-analysis of time savings associated with water supply interventions**

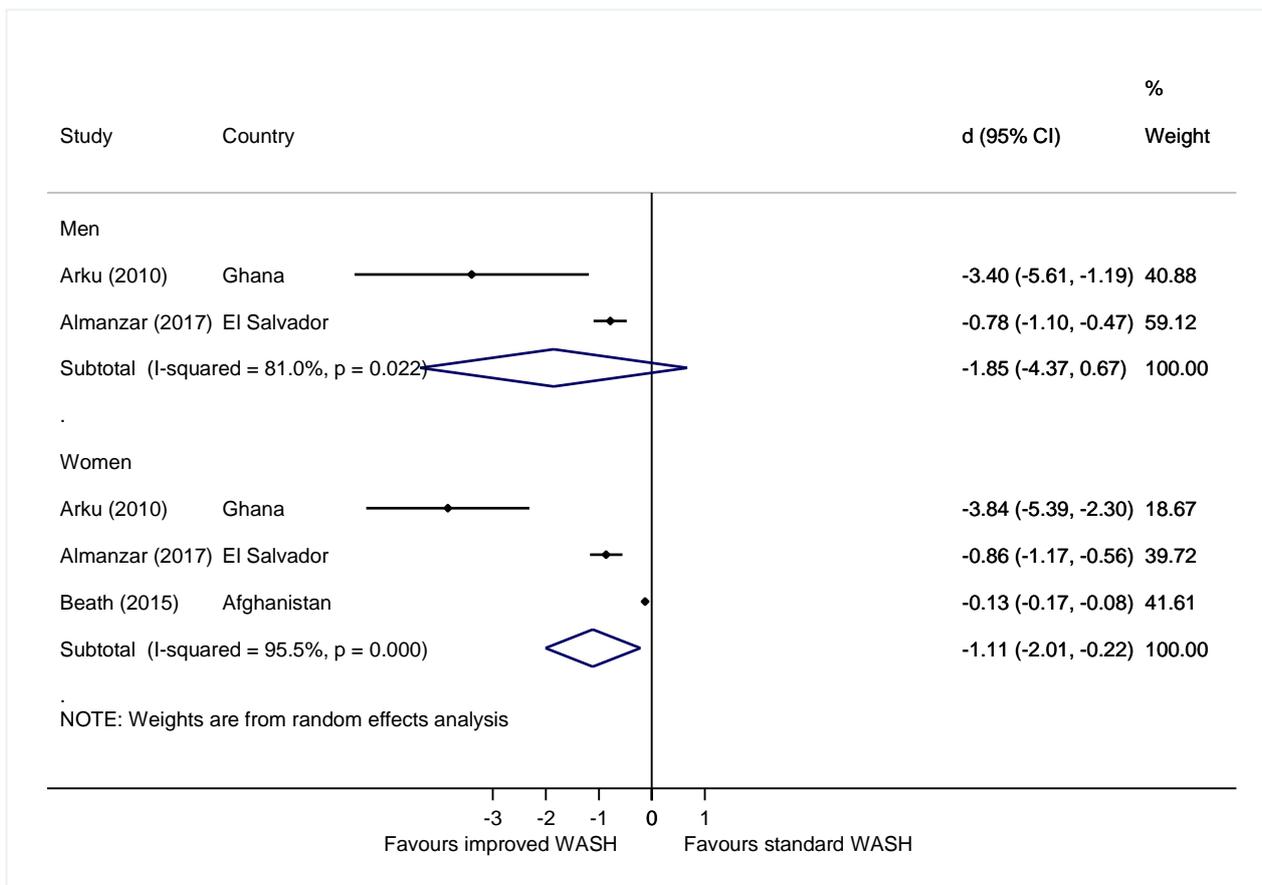
The meta-analysis of time saved from water supply interventions found large effects for households on average ( $d=-0.35$ , 95%CI=-0.50, -0.25, 19 estimates) (Figure 19). There was also noticeable heterogeneity in the findings ( $I^2=91\%$ ;  $\tau^2=0.05$ ), particularly for three studies with large effects. Peter *et al.* (2010) [108] measured time savings (<30 mins versus 30+ mins) from the installation of a community standpost in rural Swaziland (now Eswatini). Foster *et al.* (2012) [95] measured time savings from mobile water tariff payments versus payment at the bank (including wait time and return trip) in urban Kenya. Aleixo *et al.* (2019) [102] measured the time savings from household piped water connections by comparing those who spent time against those spending no time to access the water supply service. There was a very large effect for the WaterAid (2015) [100] study measuring time savings in rural Zambia (<30 mins versus 30+ mins) for 'vulnerable individuals' ( $d=-2.31$ , 95%CI=-3.53, -1.10, one estimate). We would expect the effect for vulnerable groups like wheelchair users and older people to be greater than that for other groups.

Figure 19 Forest plot of time savings from water supply interventions



Two studies measured time savings for men and women (Arku, 2010 [88]; Almanzar *et al.*, 2017 [89]) and one was conducted among women only (Beath *et al.*, 2015) [104]. The meta-analysis suggested large and significant effects for women ( $d = -1.11$ , 95%CI = -2.01, -0.22, three estimates). The findings were also large and significant in the two individual studies measuring time savings for men; the pooled effect, however, overlapped the null because of the heterogeneity in effects and small sample size (Figure 21). A further study measured time savings from water collection for children in Kenya (Jack *et al.*, 2016) [97], finding small effects for girls ( $d = -0.05$ , 95%CI = -0.11, 0.01) and boys ( $d = -0.03$ , 95%CI = -0.09, 0.03).

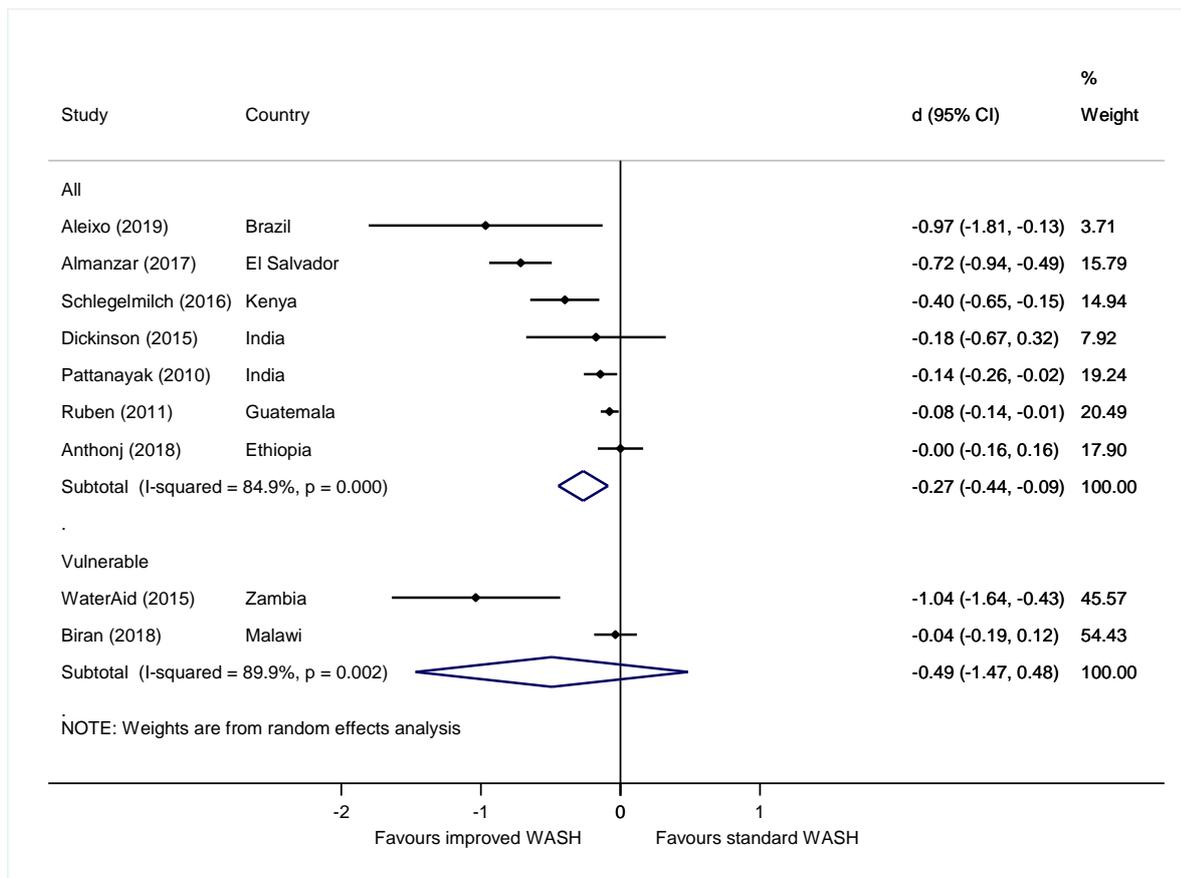
Figure 21 Forest plot of time savings from water supply interventions by gender



### Meta-analysis of time savings associated with sanitation interventions

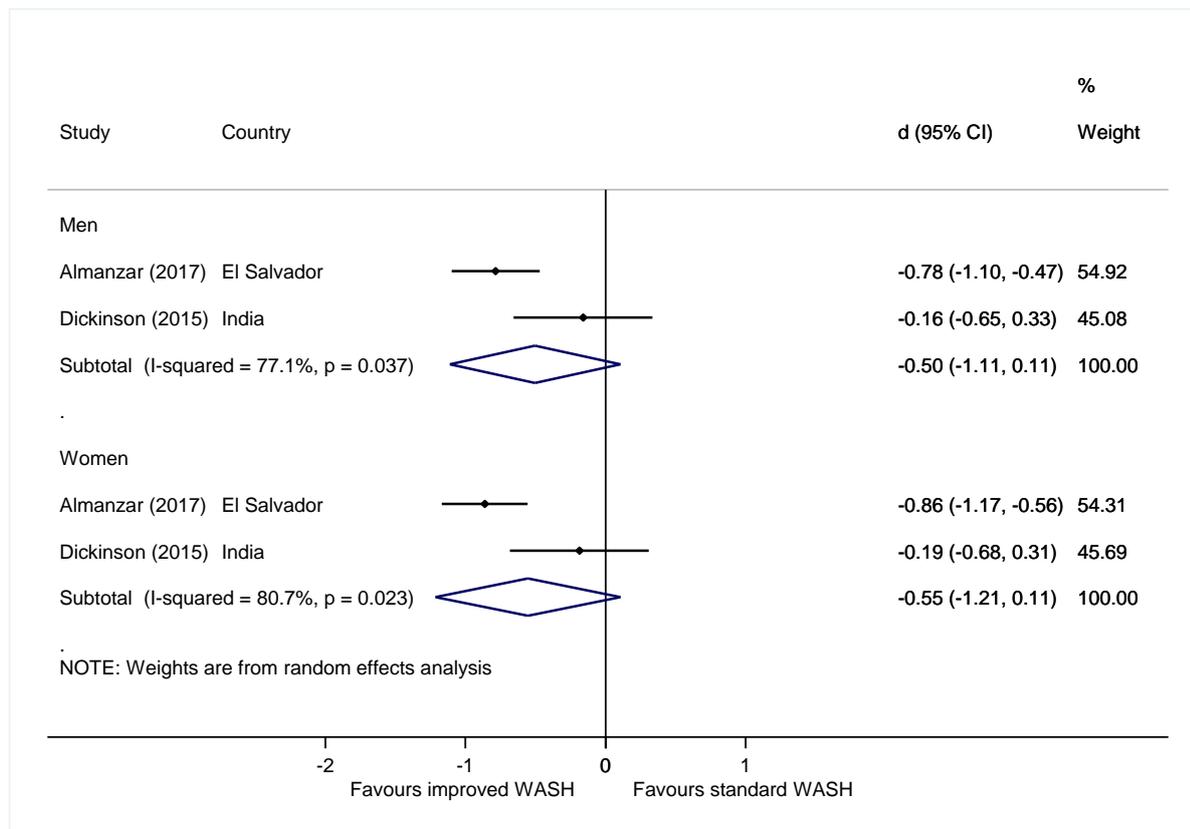
The meta-analysis of time saved from sanitation interventions found large effects for households on average ( $d = -0.27$ ,  $95\%CI = -0.44, -0.09$ , seven estimates) (Figure 22). The effects for vulnerable groups were large and statistically significant in one study (WaterAid, 2015) [100]. There was heterogeneity in the findings ( $I^2 > 85\%$ ), which suggested that further analysis to explain the heterogeneity was needed.

Figure 22 Forest plot of time-savings from sanitation interventions



The analysis suggested that women and men benefited from sanitation interventions, although only two studies disaggregated by sex. One study found large and significant effects for men and women (Almanzar *et al.*, 2017) [89] but the overall pooled effects were not statistically significant (Figure 23). In the case of Almanzar *et al.*, the intervention involved the decentralised delivery of latrines, whereas for Dickinson *et al.* (2015) [113] it involved latrine promotion. This might explain the differences in effects found, with smaller effects from promotion than from delivery. Two studies reported time savings by sex (Almanzar *et al.*, 2017 [89]; Dickinson *et al.*, 2015 [113]), which were not found to be significant (Figure 24). Dickinson *et al.* (2015) [113] also reported insignificant time savings for children (d=-0.18, 95%CI=-0.69. 0.33).

Figure 23 Forest plot of time savings from sanitation interventions for men and women



### Changes in time use associated with WASH interventions

In this section, we turn to the opportunity costs of time spent fetching water and defecating, measured as the time reallocated to other activities following WASH interventions. Forest plots were estimated for men, women, and children separately. One study (Almanzar *et al.*, 2017) [89] reported time use for women, finding a large and significant reduction in socialising following the water supply improvement, which would occur for example where women had previously socialised at the water source, and a reduction in time spent on childcare, possibly due to less infection (Figure 24). There were no differences in time spent working or leisure time for women, on average. In contrast, for men, one study measured leisure time following the WASH interventions (Almanzar *et al.*, 2017) [89], finding a reduction in availability of time (Figure 25). As this evidence is from a single study of community-driven development in El Salvador, it is not possible to draw more generalisable conclusions.

Figure 24 Forest plot of women’s time use following water supply and sanitation interventions

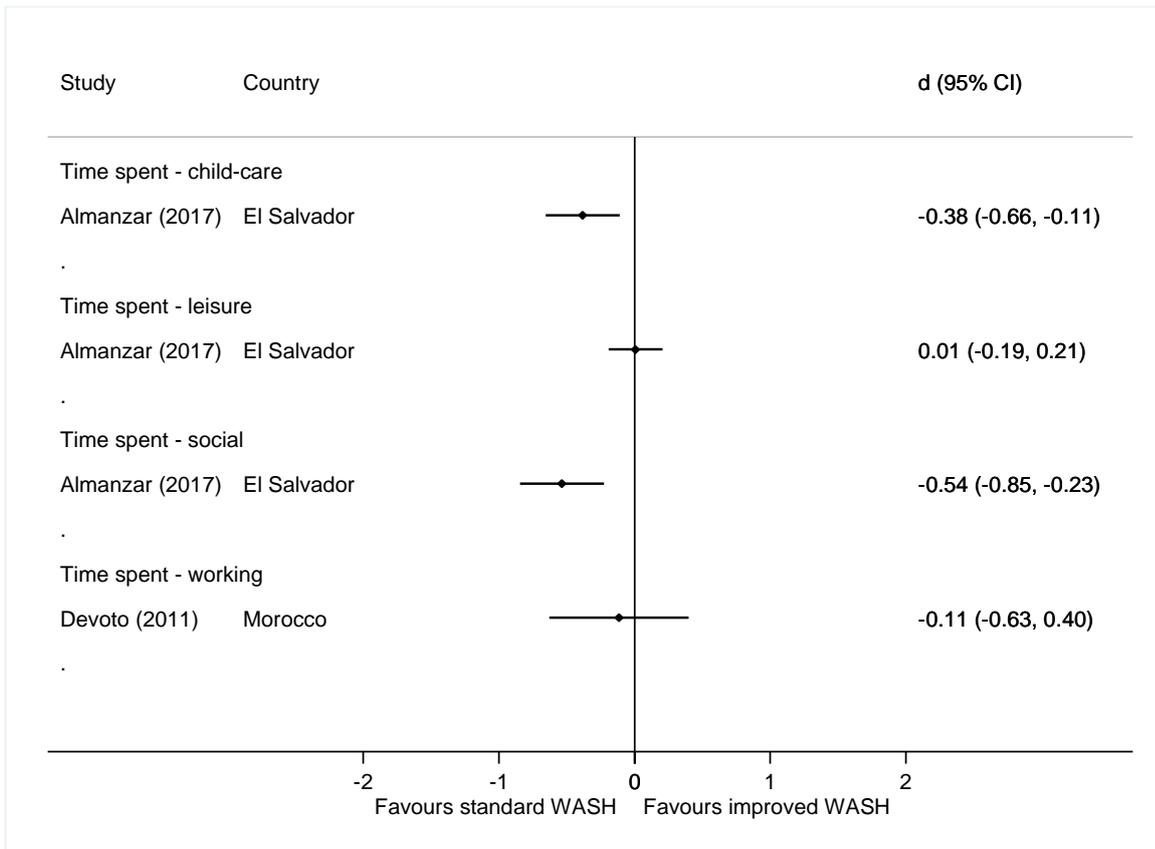
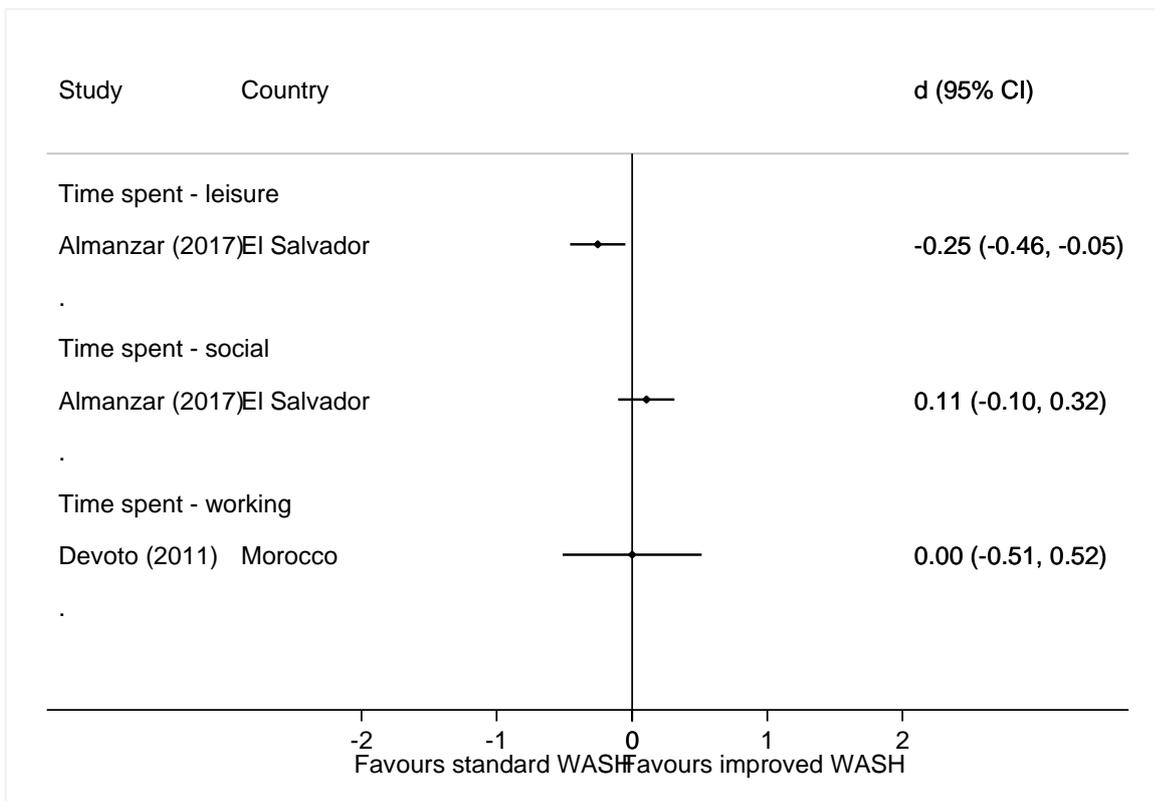
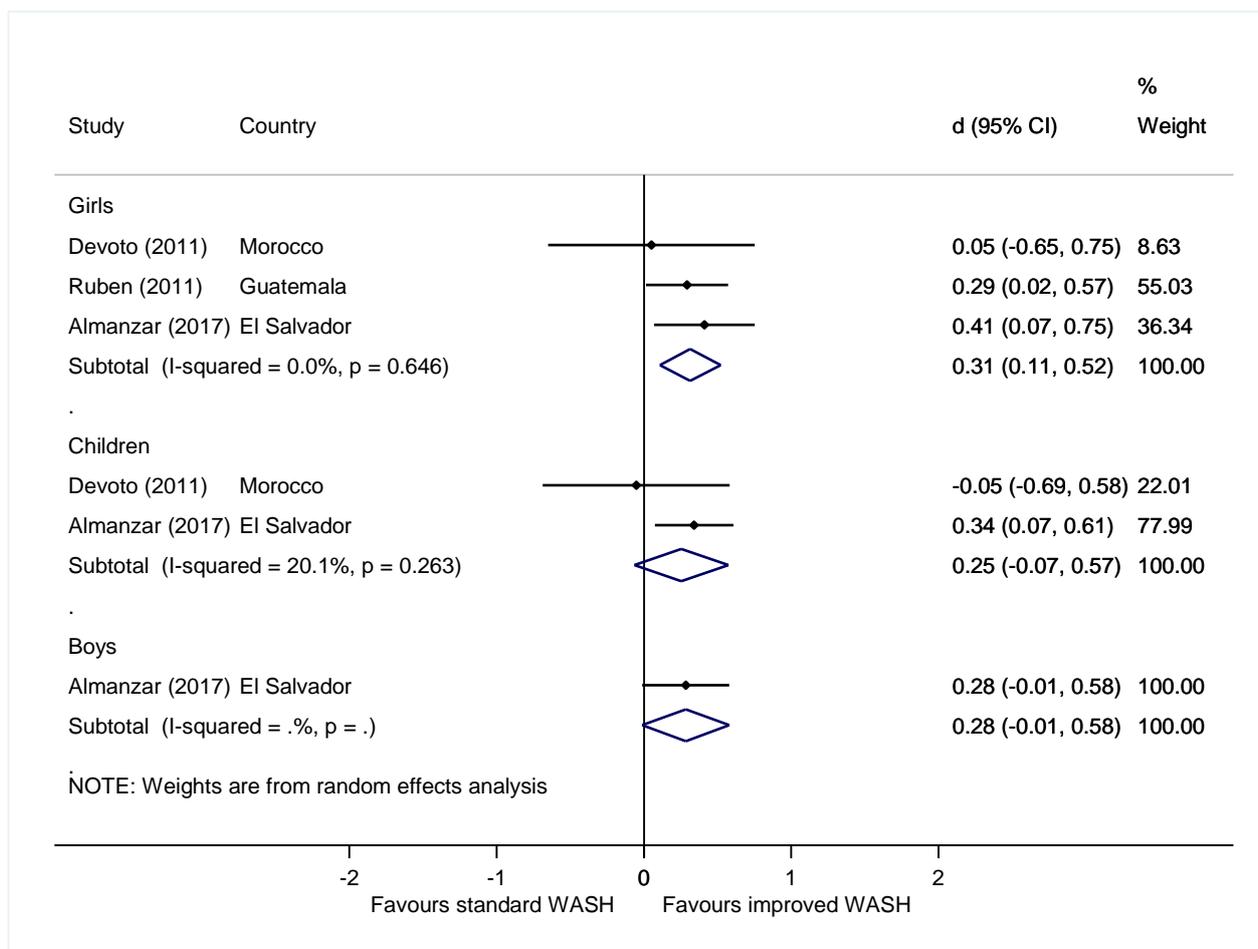


Figure 25 Forest plot of men’s time use following water supply and sanitation interventions



Regarding children’s time use, the studies found large and significant effects of WASH interventions for girls ( $d=0.31$ ,  $95\%CI=0.11, 0.52$ , three estimates), with no estimated heterogeneity across studies in the effects ( $I^2=0$ ,  $\tau^2=0$ ) (Figure 26). We did not find significant pooled effects for boys or children overall owing to heterogeneity and small numbers of studies.

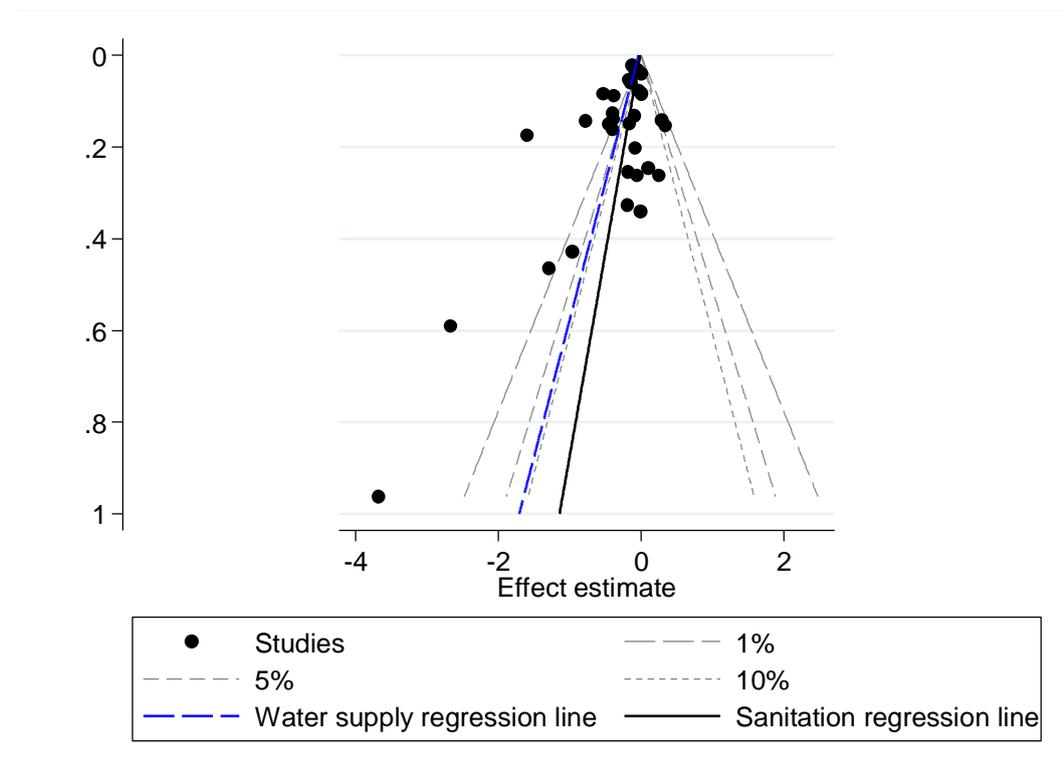
Figure 26 Forest plot of children’s time in school following water supply and sanitation interventions



### Publication bias in WASH impact evaluations

Publication bias tests suggested there was some evidence for small study effects, which may be related to publication bias. For example, overall, the Egger *et al.* (1998) test slope coefficient associated with small study effects was significant at  $p<0.01$  (coeff=-1.57,  $95\%CI=-2.88, -0.26$ , 32 estimates). When splitting the sample by WASH intervention, the coefficient for water supply was significant at  $p<0.05$  (coeff=-1.67,  $95\%CI=-3.05, -0.29$ , 30 estimates) but for sanitation it was not significant (coeff=-1.12,  $95\%CI=-3.51, 1.25$ , 13 estimates). The funnel graph below presents the distribution of effects and standard errors, together with the regression lines (Figure 27).

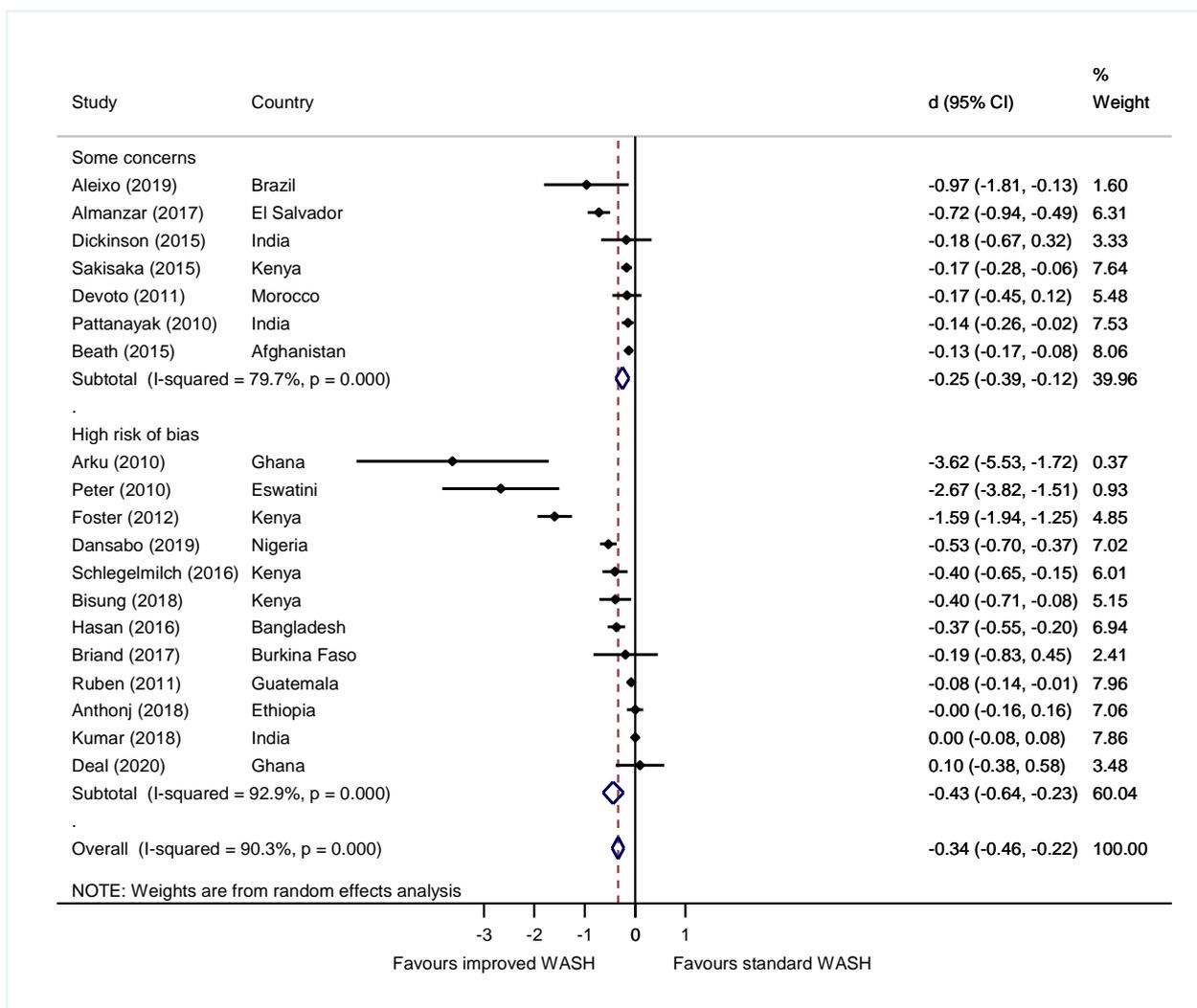
Figure 27 Funnel graph with regression lines by WASH improvement



### Exploration of heterogeneity

We attempted to explain the heterogeneity in the findings: firstly by re-estimating the meta-analysis for all participants by risk-of-bias rating (Figure 28). These findings did not suggest significant differences in effects between studies rated as giving rise to 'some concerns' and those at 'high risk of bias', as the confidence intervals overlapped, although the point estimate for studies rated as giving rise to 'some concerns' ( $d=-0.25$ , 95%CI=-0.39, -0.12, seven estimates) was slightly smaller than that for studies at 'high risk of bias' ( $d=-0.44$ , 95%CI=-0.64, -0.23, 12 estimates). Further exploration of heterogeneity was undertaken in meta-regression analysis.

Figure 28 Time savings from water supply interventions by risk of bias



We attempted to explain the heterogeneity in findings according to contextual factors and study design. To maximise the explanatory power of the regression, we included both time saving and time use outcomes. The explanatory variables chosen included the outcome measure, the type of WASH improvement, whether the location was rural,<sup>3</sup> whether the measure was among female study participants only, and the critical appraisal assessment. Given the strong evidence for publication bias, we also included whether the study had been published in a peer-reviewed journal, and the standard error of the effect estimate (equivalent to the Egger test reported above).

Owing to the limited sample size, we estimated two specifications: one focusing on the contextual explanatory variables, the other focusing on publication bias testing. The results for contextual factors (Table 7 specification 1) indicated that water treatment was associated with significant increases in time taken (e.g., using the water filter) compared to water supply and

<sup>3</sup> We also estimated meta-regressions with global region dummies, but did not find that these variables improved the specification. Results are available on request from the authors.

sanitation interventions ( $p < 0.1$ ). Other coefficients, although not significant, were in the expected direction, so studies in rural locations and among women tended to have larger effects. The findings also suggested direct evidence for publication bias, including significant coefficient on the standard error of  $d$  and absolutely (although not significantly) greater effects on desired outcomes in published studies (positive effects on time use and negative effects on time saved) (Table 7 specification 2).

Table 7 Meta-regression results

	(1)			(2)		
	Coef.	95% CI		Coef.	95% CI	
Time use outcome <sup>^</sup>						
Time saving outcome	-0.331	-0.996	0.333	-0.399*	-0.813	0.015
Water supply improvement	-0.215	-1.220	0.790			
Water treatment	0.753*	-0.119	1.624			
Sanitation improvement	0.295	-0.413	1.004			
Urban, peri-urban, refugee camp <sup>^</sup>						
Rural	-0.381	-1.064	0.302			
Male <sup>^</sup>						
Female	-0.366	-1.079	0.347			
Some concerns about bias <sup>^</sup>						
High risk of bias (time use outcome)	0.640	-0.678	1.958			
High risk (time savings outcome)	-0.846	-2.327	0.636			
Unpublished study <sup>^</sup>						
Published (time use outcome)				0.451	-0.111	1.013
Published (time savings outcome)				-0.322	-0.964	0.320
Standard error				-2.985***	-4.315	-1.656
Constant	0.319	-0.907	1.546	0.348**	0.000	0.697
<i>Test information</i>						
Number of observations	32			32		
Tau-squared	0.21			0.10		
I-squared	89%			81%		
Adj R-squared	-37%			37%		
Model F	1.08			6.72		
Prob > F	0.41			0.00		

Notes: <sup>^</sup> reference category for dichotomous variable; \*\*\*, \*\* coefficient significance at  $p < 0.01$  and  $p < 0.05$ , respectively.

## Conclusions

This synthesis of evidence on time savings from water and sanitation interventions suggests very large effects of both water supply and sanitation interventions. These effects were large, both compared to usual thresholds of  $d$  (absolute values of  $d > 0.25$  are considered big) and when expressed in hours per week. While time savings from water supply interventions are well known (e.g. [22]), time savings from sanitation do not appear to be. For example, economic evaluations of sanitation have traditionally incorporated modelled time savings from sanitation based on distance multiplied by an assumed number of trips [114]. The results presented here provide empirical evidence on time savings which suggest that the savings from sanitation are substantial: in the region of multiple hours per household week. These results provide important evidence about the economic effects of water supply and sanitation interventions, beyond the health effects that have been more commonly estimated.

The findings are supported by other assessments of time savings due to WASH interventions in low-income contexts. For example, Sorenson *et al.* (2011) [115] found that the time taken to fetch water and return was 12 minutes in Bangladesh and typically 30 minutes in sub-Saharan Africa (where the majority of the studies contained in this review were conducted), and that this task was often done by women. While that study is purely observational, we note that the time savings following water supply interventions found in the synthesis presented here are comparable to those estimates.

## Limitations

There was a limited measurement of time used in performing tasks relating to WASH interventions in the majority of studies in the evidence map, and even those studies that purported to provide information on time savings or time use did not provide statistical information (e.g. sample sizes, standard deviation of the outcome variable) to enable statistical synthesis of the findings. Most interventions that did report time-related outcomes focused on water supply and sanitation interventions, with very limited information on time savings from water quality and no information on time savings from hygiene interventions. While a small number of studies did report time savings and time use for relevant sub-groups, including women, men, children, girls, boys, and vulnerable groups, the majority of studies did not report this information. Most studies collected time data through self-report survey. Only two studies used more reliable measurement, such as time diaries and observation. The studies represented South and West Asia (Afghanistan, Bangladesh, India) and sub-Saharan Africa (Burkina Faso, Eswatini, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Zambia), but represented a more limited range of geographies in Latin America (Brazil, El Salvador, Guatemala) and North Africa (Morocco), and there were no studies from East Asia and the Middle East.

## Implications for practice

Time savings and time use are an important outcome of WASH interventions that alone can justify their provision. More WASH interventions should include considerations of time in both intervention design and evaluation. The collection and synthesis of data on time savings and time use resulting from WASH interventions indicate that there are very large benefits for participants from water supply and sanitation interventions, for women, men, and children. The few studies measuring water treatment interventions suggested small increases in time associated with treating the water. No studies attempted to measure time use following improved hygiene hardware (e.g. handwashing stations) or software. Few studies attempted to measure the alternate uses of time associated with time savings, including time for productive activities, reproductive activities (including childcare), and leisure.

## Implications for research

Time savings and time use are relatively simple measures to collect and should ideally be incorporated as a standard outcome in evaluations of WASH interventions conducted in LMIC contexts. While there is a great focus in WASH evaluation research on behaviour change and health outcomes, most WASH evaluations do not assess outcomes related to time. Data can be collected in various ways: for example, through self-report survey, time diaries, or, most rigorously, observation. Studies are especially needed that collect observations on how people use the time saved due to WASH interventions, and which are able to address potential biases in time reporting (especially where done using recall). Studies evaluating time savings and time use following WASH interventions in East Asia and the Pacific, Latin America and the Caribbean, and the Middle East and North Africa global regions are also needed.

## Part 4

### Concluding thoughts

The results of our evidence synthesis highlight that the majority of studied WASH interventions (over the last 10 years) only focused on inclusive outcomes. For the most part, this encompassed safe water and sanitation provision, which has the potential to reduce WASH inequalities. However, fewer studies reported on interventions that resulted in transformative outcomes, and which dealt with broader societal power relations. This means that most studies in our evidence base did not show evidence of a transformational impact for different gender and social categories, such as eliminating violence against women, girls, or disabled people, reducing the time burden, ensuring education and economic empowerment opportunities, and ensuring participation and leadership in WASH services.

Furthermore, most interventions in our evidence base lacked a specific GESI component in the design. This might imply a low recognition of the importance of these components, even among WASH interventions aiming to measure related outcomes. Outside of our evidence base, the proportion of WASH interventions with GESI components is thus expected to be even lower.

### Implications for practice

This systematic review highlights a number of key implications for practice. While in the WASH sector there is an emphasis on gender mainstreaming, the review findings do not show widespread uptake of this approach, in light of the lack of GESI components in interventions. Overall, there is a greater need for mainstreaming GESI throughout intervention design and evaluation. In terms of the evaluation of WASH interventions and programmes, wider use of GESI outcomes should be incorporated by practitioners. As most outcomes reported were those with an inclusive impact, there was a missed opportunity in regard to demonstrating the wider potential for WASH interventions to have transformational impacts. This includes areas with particularly adverse impacts on women, such as the unequal burden of unpaid work related to water collection, management and care of sick family members, harassment and violence, and exclusion from decision-making processes and economic opportunities. The significant and substantial effects of water supply and sanitation interventions on time savings presented here include evidence from 15 countries in South Asia and sub-Saharan Africa, suggesting that the findings may be representative of those contexts, but it is difficult to generalise further without more evidence from other contexts. A further reason for targeting improved evaluation of inclusive and transformative outcomes is to ensure that interventions have positive outcomes and avoid unintended consequences. This evidence can in turn support learning to design better interventions. This may require the involvement of more gender experts as project evaluators, or in the design of evaluation approaches.

There is a need for wider use of GESI components in WASH interventions. This is in line with findings from the broader development sector showing that incorporating gender equality, social equity, and women's empowerment in sector interventions is associated with

improvements in development and health outcomes [73]. This will require cross-sector collaboration in many settings, going beyond the traditional view of WASH services as requiring technical or infrastructure expertise alone. Gender practitioners should be included in the design and implementation team where relevant.

## Implications for research

Overall, there are several research opportunities in regard to building on our results. It is important to highlight that our evidence synthesis only includes studies that measured GESI outcomes in some form. There is likely to be a much larger body of WASH research that includes any measurement of GESI outcomes, but our discussion focuses on the implications of our findings from the included studies.

First, more research is needed in the WASH sector to understand the transformational potential of WASH interventions. This requires broader efforts to measure outcomes such as economic opportunities, empowerment, and gender-based violence. More research is needed on social and gender norms, and on how they contribute to transformational change in a WASH context.

As indicated by our framework synthesis, there are few studies that describe interventions with outcomes related to gender-based violence and other forms of violence against marginalised groups in the WASH sector. Almost all of the interventions included in our framework synthesis were sanitation interventions, with a handful relating to menstrual hygiene management and water. The existing interventions largely focus on infrastructure upgrades (such as improved lighting), whereas interventions related to the built environment surrounding sanitation facilities could also address psychological and physical gender-based violence. There is a need for more research to test interventions that aim to reduce violence related to WASH, especially those with multiple components that address social and gender norms, as well as infrastructure design.

Disaggregated data focusing on women were the most commonly reported; more research reporting disaggregated outcomes for other groups is needed. This includes research measuring the impacts of interventions on GESI outcomes for men, which is particularly important in the context of transformative outcomes that seek to address gender and social relations, norms, and roles. This is relevant, for example, in the case of technical positions in water utilities, sanitation workers etc, and other roles that have previously excluded women, and where interventions targeting men could contribute to addressing gender inequalities in WASH sector employment. It is also relevant for studies reporting time savings and time use outcomes following WASH interventions, which are needed for men, women, children, and vulnerable groups like the elderly and people with disabilities, and in parts of the world where measurement of time use outcomes following WASH interventions is nil or very limited (e.g. East Asia, Latin America, and the Middle East).

More research examining the impacts of WASH interventions on other dimensions of social inclusion is needed as most research examines only gender. It is critical to understand the uneven effects of interventions among groups relating to other social categories, such as due

to ethnicity, disability status, class, and others. Applying an intersectional approach is also important to ensure that not only are women and men studied as homogenous groups but that their heterogeneity is also accounted for by collecting data disaggregated by sex as well as other factors.

A majority of the included research focused on households and schools: there is a need for research in other settings, such as healthcare facilities, workplaces, and public places. Most research in our evidence base occurred in certain geographical regions, such as in India, Kenya, and Bangladesh. In light of the importance of social and cultural drivers of GESI outcomes there is a need for greater understanding of these dynamics in other geographical settings.

Finally, research into WASH interventions should not be carried out by engineers, economists, or public health experts working alone in silos. Researchers who have a good depth of understanding about gender inequalities, social inclusion, and equity issues are needed as part of research teams, to enable this work. This will lead to a much broader evidence base on the wide range of health, social, and economic benefits provided by WASH services.

## Annex A: Attachments

Below is a list of all of the supplementary materials attached to this report.

1. Definitions used in the evidence synthesis for 1) eligible types of interventions and 2) study designs.
2. The initial theory of change for evidence mapping.
3. Bibliographic search record.
4. Grey literature search record (specialist websites).
5. Searches in bibliographies of relevant reviews.
6. Machine learning details: modelling with bespoke classifiers.
7. Excluded full texts (originating from bibliographic sources), with reasons for exclusion.
8. Browsable database of mapped studies.
9. Distribution of studies across WASH sectors, intervention components, and outcome themes.
10. Geographical distribution and economic context of studies included in the map database.
11. Screening and critical appraisal record for framework synthesis.
12. Initial framework for the synthesis of violence-related outcomes.
13. Coding sheet for framework synthesis with coding domains.

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