

Women in research: A systematic re-review of WASH interventions to prevent diarrhea and acute respiratory infection in low and middle-income countries

Bethany Caruso (✉ bcaruso@emory.edu)

Emory University <https://orcid.org/0000-0001-9738-9857>

April Ballard

Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University

Julia Sobolik

Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University

Madeleine Patrick

Rollins School of Public Health, Emory University <https://orcid.org/0000-0002-5599-8459>

Janice Dsouza

Hubert Department of Global Health, Rollins School of Public Health, Emory University

Sheela Sinharoy

Hubert Department of Global Health, Rollins School of Public Health, Emory University

Oliver Cumming

London School of Hygiene and Tropical Medicine

Jennyfer Wolf

Department of Environment, Climate Change and Health, World Health Organization

Isha Ray

University of California, Berkeley <https://orcid.org/0000-0002-9966-8822>

Article

Keywords:

Posted Date: December 2nd, 2023

DOI: <https://doi.org/10.21203/rs.3.rs-3594151/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: There is **NO** Competing Interest.

Abstract

Water, sanitation, and hygiene interventions significantly reduce health risks in low- and middle-income countries. Many rely on women for their success but the extent of women's engagement remains unclear.

We conducted a re-review of papers from two systematic reviews that assessed effectiveness of water, sanitation, and/or handwashing with soap interventions on diarrheal disease and acute respiratory infections to assess women's roles in WASH research and intervention activities (PROSPERO registration: CRD42022346360).

133 studies were included. Among studies that specified gender, women were the most targeted group for engagement in research (n = 91/132; 68.9%) and intervention (n = 49/120; 40.8%) activities. Reporting time burden for research (n = 1; 1%) and intervention activities (n = 3; 2.5%) was rare. All interventions were classified as gender-unequal (36.7%) or gender-blind (63.3%) according to the WHO Gender Responsiveness Assessment Scale, indicating exploitative engagement.

Women play a critical but instrumental role in advancing WASH, which requires change to enable, not hinder, gender equality.

Introduction

Water, sanitation, and hygiene (WASH) services are foundational to human health and wellbeing. Results from two recent systematic reviews found that WASH services can significantly reduce the risk of diarrhea and acute respiratory infections in low- and middle-income countries (LMICs).^{1,2} Recent disease burden estimates suggest that 1.4 million deaths and 74 million disability-adjusted life years were attributable to unsafe WASH in 2019.³ However, due to a paucity of evidence, these estimates do not account for multiple other health outcomes related to WASH, including bodily injury, violence, and stress,³ which are often of particular concern for women and girls.⁴⁻⁷

In 2022, an estimated 27% of the global population (2.2 billion) lacked access to safely managed drinking water services, 43% (3.5 billion) to safely managed sanitation services, and 25% (2 billion) to basic hygiene services.⁸ Because women and girls play a central, and sometimes outsized,⁹ role in managing household WASH resources, these inadequate conditions place considerable burdens on them.⁴ Due to gender norms, women and girls often bear responsibility for household WASH: time-consuming and physically arduous activities like water fetching, latrine cleaning, and keeping children clean.⁹⁻¹³ While these activities may produce improvements in overall health, they can demand women's time and energy, limit opportunities¹⁴ and result in risks to their own health and safety.^{4,15} Further, they have the potential to perpetuate gender inequity.¹⁶

Whilst these unpaid burdens and norms have been acknowledged, they also have been exploited by research and practice initiatives,¹⁵ as women are often intentionally targeted by those delivering WASH

programs as key instruments for their success. Women have been trained to carry out water treatment, safe child feces management, and hand hygiene promotion.^{12,17–19} Yet assessment of the extent of women's engagement in WASH programs and the impact of this engagement on their own health and wellbeing has been limited. A recent review of adoption of point-of-use chlorination for treating household drinking water found most studies deliberately targeted women to perform water treatment tasks, leveraging their household water management and caregiving roles. The time burden associated with this work was often reported to be a barrier to use but seldom quantified.¹⁸ Similarly, women have been targeted to participate in research activities as part of largescale WASH evaluations to provide detailed data about family members' behaviors (e.g., defecation practices)¹⁹ and health (e.g., diarrhea).^{20–22} These examples point to the need for comprehensive assessment of the central part that women play in WASH research and practice.

Despite heavily involving women, rarely have WASH interventions and evaluations been designed and delivered to explicitly improve or even understand their impact on women's lives. WASH interventions should, however, be evaluated to understand if and how potential burdens and benefits from these interventions have been distributed, and if and how participants' engagement reinforces existing gender roles. While some WASH interventions, such as household water treatment, place demands on women, others could relieve them. For example, piped water systems or passive chlorination devices may not only reduce child illness, they also could eliminate the time and labor required to fetch and treat water and the time, financial, and psychosocial costs of caring for sick household members. Yet, these co-benefits are rarely assessed.²³

The aim of this re-review is to assess how women are engaged in WASH research and intervention activities. Through a re-review of the interventions designed to improve diarrheal disease and acute respiratory infection in LMICs, we: 1) identify the gender of the individual(s) targeted for research and intervention activities; 2) determine if time required for engagement was reported and, if so, compensated; 3) discern if additional intervention impacts specific to women were assessed; and 4) characterize intervention engagement overall and by intervention type using the WHO Gender Responsiveness Assessment Scale.²⁴

Methods

To understand women's engagement in research and intervention activities, we conducted a re-review of papers from two recent systematic reviews that assessed effectiveness of water, sanitation, and/or handwashing with soap interventions on diarrheal disease¹ and acute respiratory infections². The protocol is registered with PROSPERO (CRD42022346360). We report findings following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Tables S1 & S2).

Inclusion criteria and eligibility

All papers included in the two previously published systematic reviews and published in English or Spanish were eligible for inclusion. The original search strategies, including eligibility criteria, for the two reviews, have been described previously^{1,2}.

Data extraction

To identify the gender of individuals targeted in research and intervention activities, two reviewers first independently extracted data on whether or not intervention and evaluation activities required individual-level participation from the target households/communities. Among studies that required individual-level participation, they identified the target demographic groups (women, men, men and/or women, girls, boys, girls and/or boys, other specified and/or unspecified individuals/populations). The dataset provides more detail on terms used and categorization assumptions (e.g., mother, caregiver, categorized as ‘women’) (appendix). They further extracted data on the time required for engagement and compensation provided (if reported), who reported the study’s focal outcome (e.g., child diarrhea), if any additional intervention impacts specific to women, men, girls, or boys were assessed, and if the intervention activities included messages that involved shame or honor (e.g., establishing norms of “good” parenting).

To categorize engagement in intervention activities, we leveraged the WHO Gender Responsiveness Assessment Scale (GRAS)²⁴ for assessing gender responsiveness in health interventions, policies, and programs, and its elaboration by Pederson et al.²⁵ The WHO GRAS presents a spectrum of five gender approaches, from those that should be avoided (gender-unequal and gender-blind) to those that are more desirable (gender-sensitive, gender-specific, and gender-transformative). The modification by Pederson et al.²⁵ includes all five gender approaches and also shows how health programs, policies, and interventions along these various levels can either exploit, accommodate, or transform gender inequities, depending on how they are designed and delivered. Our slightly modified scale includes the definition of each approach as presented by the WHO²⁴ and Pederson et al.,²⁵ builds upon the definition of gender-unequal, and provides hypothetical WASH examples along the scale (Fig. 1).

We used this adapted figure as a tool to assess gender responsiveness in those interventions that required individual-level participation. Two reviewers independently reviewed intervention descriptions from the included studies and categorized them using the definitions noted in the figure. Inconsistencies in categorization were reconciled through discussion with a third team member. Interventions with multiple components can have different GRAS categories for each component,²⁴ thus we categorized each water, sanitation, and/or hygiene component in an intervention separately, and provided an overall categorization of the intervention. We did not assess any non-WASH (e.g., nutrition) intervention components.

Analysis

We used R Studio v4.0.5 to generate descriptive statistics about which individuals were engaged in the research and interventions assessed, how they were engaged, what additional outcomes, if any, were evaluated, and how the interventions were categorized using the GRAS categories. We further organized

the GRAS data by the water, sanitation, and hygiene exposure scenarios presented by Wolf et al (2022). These exposure scenarios were informed by the definitions and exposure levels of the service ladders created by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) to assess progress against SDG targets 6.1 and 6.2, and were adapted based on available evidence. Wolf et al (2022) used the exposure scenarios to determine diarrhea risk at the various WASH service levels and concluded that higher service levels provided increased protection from diarrheal pathogens. We engaged the same exposure scenarios to determine if and how gender responsiveness varied at the different service levels.

All data will be made available upon publication in the appendix.

Role of the funding source

The funders of the study had no role in study design, data collection, analysis, interpretation, writing of the report, nor decision to publish.

Results

We assessed all 150 studies included in the two reviews; 14 were duplicates and 3 were excluded due to language, resulting in a final sample of 133 studies (See Flow Diagram Figure S1). Interventions focusing solely on drinking water (n = 64; 48.1%) or hygiene (n = 46; 34.6%) were the most common. The majority of studies took place in rural settings (n = 80; 60.2%) and in Asia (n = 51; 38.3%) and Africa (n = 43; 32.3%). Only 8 (6.0%) studies presented sex-disaggregated outcome data (Table 1). Table S3 presents a list of included studies and key characteristics.

Engagement in Research Activities

Individual-level participation in research activities was almost universal. Nearly all studies (n = 132; 99.2%) included at least one research activity that necessitated individual-level participation (Table 2). Of those, 92 (69.7%) studies targeted multiple groups to engage in research activities and over half (n = 89; 67.4%) did not clearly specify who was targeted for at least one research activity. Overall, among participants specified, women were the most targeted, followed by children. Women were reported to be targeted in 91 (68.9%) studies for research activities, and were the only group targeted in 14 (10.6%) studies. The most common research activities that women were engaged in included surveys (e.g., baseline, endline) (n = 63; 47.7%); diarrhea recall (independent of other surveys) (53; 40.2%); behavior/practice recall (independent of other surveys) (18; 13.6%) and observation (18; 13.6%) (Table S4). Children were targeted in 47 (35.6%) studies and were never the only group targeted. Their participation was most sought for biological specimens, including stool or rectal swabs (15; 11.4%) and sera samples (9; 6.8%). Only two (1.5%) studies reported targeting men for any research activities (survey, qualitative research).

The majority of studies depended on women to report the primary outcome (e.g., child diarrhea), yet few reported additional outcomes related to women's own health or co-benefits (if any) such as time savings. In 83 (63.4%) studies, women—specifically mothers—were noted to have reported the study's focal outcome. Most studies (111; 83.5%) reported additional outcomes other than diarrhea and/or ARI. These additional outcomes related mainly to children (n = 60; 54.1%); almost all (n = 59; 98.3%) reported on well-being outcomes (e.g., growth, parasitic infection, school absence) and 10 (16.7%) reported on program-related outcomes (e.g., hand hygiene, defecation behavior). Sixteen studies (14.4%) reported outcomes specific to women; three reported outcomes related to women's well-being (e.g., childcare hours saved, satisfaction with sanitation, water fetching time), while the rest focused on program-related compliance (e.g., hand hygiene, water treatment behaviors, etc.). Four (3.6%) studies reported outcomes specific to men; two focused on men's well-being (e.g., time fetching water, satisfaction with sanitation) and two on programmatic outcomes (e.g., defecation behaviors). Only one study (0.8%) comprehensively reported how much time was required for participants to engage in the research activities²⁶ and five (3.8%) studies compensated those engaged in research for their time (Table S3; also dataset).

Engagement in Intervention Activities

The majority of interventions required individual-level participation and most depended on women. One hundred twenty studies (90.2%) included at least one intervention activity that necessitated individual-level participation. Of those, 48 (40.0%) studies targeted multiple groups to engage in intervention activities but over half of the studies (n = 76; 63.3%) did not specify who was engaged. Among those that specified, women were the most targeted for intervention engagement, followed by children. Forty-nine (40.8%) studies targeted women for participation, including 21 (17.5%) studies that targeted only women. Women were the most targeted group for all water- (46; 38.3%), sanitation- (15; 12.5%), hygiene- (35; 29.2%), and health promotion-related (29; 24.2%) activities, which included WASH-related health education, water treatment, and child feces management, among other activities. Twenty (16.7%) intervention activities targeted children, including 2 (1.7%) that only targeted children. Children were most engaged in activities focused on hygiene practices and education. Only two (1.7%) studies reported targeting men for any intervention activities (hygiene-related health education; health promoter). Table S5 summarizes all intervention activities by populations engaged.

Despite the near ubiquitous need for individual-level participation in the WASH interventions assessed, reporting time burden or compensation was rare; only 3 (2.5%) reported the time burden of engaging in intervention activities and 13 (10.8%) reported providing compensation to individuals for their time (Table 2). From the information reported, ten (8.4%) interventions explicitly leveraged gender norms as an intentional part of their intervention; these referenced shame, honor, or upholding traditional values (for example, campaigns that promoted handwashing as practiced by 'good mothers'). Table S5 presents intervention activities by population engaged.

Characterization of Interventions using the WHO Gender Responsiveness Assessment Scale

We classified all interventions as either gender-unequal (36.7%) or gender-blind (63.7%) (Table 3), categorizations which are termed exploitative by WHO and which are by extension not recommended.

Of the 77 studies that included water interventions, 9 (11.7%) did not require any individual participation and among the remaining 68 that did, 24 (35.3%) are gender-unequal and 44 (64.7%) are gender-blind (Table 3). Table 4 presents examples of gender-unequal and gender-blind water intervention activities. Disaggregating by different levels of drinking water services, 57 (74.0%) involved point-of-use water treatment for sources off-premises, a low level of service according to the exposure scenario. Among these, 22 (38.6%) are categorized as gender-unequal and 35 (61.4%) as gender-blind. The one intervention that provided improved, on premises, continuous water supply—one of the higher levels of water service represented by the exposure scenario—was not evaluated using the GRA framework as it did not require individual-level involvement (Fig. 2).

Of the 18 studies that included sanitation interventions, five (27.8%) did not require any individual involvement and among the remaining 13 that did, all provided basic sanitation services without sewage connection with three (23.1%) categorized as gender-unequal and 10 (76.9%) as gender-blind. (See Table 4). The four interventions that provided basic sanitation with sewer connections were not evaluated using the GRA framework as they did not require individual-level involvement (Fig. 3a).

Of the 57 studies that included hygiene interventions, all required individual-level involvement and involved some type of hand hygiene promotion, though only 34 (59.6%) provided soap. Fewer interventions that provided soap were gender-unequal ($n = 10$; 29.4%) than were gender-blind ($n = 24$; 70.6%). Conversely, a greater proportion of the hand hygiene promotion interventions that did not provide soap were gender-unequal ($n = 13$; 56.5%) rather than gender-blind ($n = 10$; 43.5%) (Fig. 3b; Table 4).

Discussion

In this re-review of 133 studies from two systematic reviews assessing effectiveness of water, sanitation, and/or handwashing with soap interventions on diarrheal disease¹ and acute respiratory infections,² we evaluated the reported engagement of individuals in the evaluation and delivery of WASH interventions.

We find that, in many instances, the interventions that were the subject of these studies relied entirely on women as the agents of delivery and as the source of study data. WASH interventions were overwhelmingly gender-unequal or gender-blind and, therefore, classified as gender exploitative under the GRAS framework (Fig. 1). Any costs to women's own time or benefits to their own lives were rarely mentioned. Women appear to play a critical but purely instrumental role in advancing WASH. The often unacknowledged role of women in the evaluation and implementation of health-related WASH studies has several unintended, yet detrimental, consequences that require change for WASH to enable gender equality and not hinder it.

Perhaps the most insidious consequence of taking for free and for granted women's time and cooperation in WASH is that it cements existing and unequal gender norms. Maintaining family health,

which includes WASH tasks, is considered to be women's work, and women's labor is "understood" to be of low value. When WASH implementers and researchers not only avoid playing an equalizing role, but actively exploit gender-unequal roles, then existing inequalities are reproduced³² or even strengthened¹⁶. These observations—that women perform unpaid WASH labor and that this renders the research itself exploitative—are not new; this bias has been described since the early 1980s.^{33–35} Nonetheless, the exploitation of gender stereotypes and acceptance of numerous hours of unpaid labor by women has persisted. While occurring in both research and intervention delivery, the impact of engagement is likely quite different; the demand for women's unpaid labor in intervention delivery, in particular, could be sustained indefinitely or even scaled up if deemed effective at improving child health. Moving forward, WASH programs and interventions should be evaluated using the GRAS tool before implementation so those classified as exploitative can be redesigned or abandoned. Exploitative interventions should not be funded for evaluation.

Regardless of the effectiveness of the WASH interventions assessed, the full implementation costs have not been transparently acknowledged in evaluations or reflected in subsequent recommendations. Many WASH approaches, especially household-based approaches, are touted as "low-cost" by depending on women's "free" time and labor. These falsely low costs are routinely highlighted as a benefit for—and even a stipulation by—policy makers and donors, who often demand evidence of cost-effectiveness, put caps on the total costs allowed for an intervention, and restrict the types of allowable expenses (e.g., participant compensation). We acknowledge that the extent and nature of compensation must be context-specific so as not to place undue burdens on low-income communities and NGOs, and we recommend that WASH actors (i) budget appropriate compensation for those who shoulder the burdens of making these interventions "work," (ii) transparently report who is engaged, and (iii) rigorously evaluate participant time and opportunity costs.

The gender-unequal or gender-blind interventions were largely among interventions that represent lower levels of service, illuminating how these allegedly low-cost interventions not only demand "free" labor, but extract this labor to provide services or promote approaches that are often inferior. Interventions at the lowest service levels often emphasize behavior change, and as we and others¹⁸ have shown, most target women's behavior change. Yet, behavior change approaches are 'generally the least effective type of intervention'.³⁶ Furthermore, 'the need to urge behavioral change is symptomatic of failure to establish contexts in which healthy choices are default actions.'³⁶ As a result, the women conscripted to perform (or enforce) WASH behaviors are likely living in the least enabling environments and therefore may have little chance for impact despite their efforts. Failed behavior change interventions tend to be ascribed to poor "compliance", which blames individuals—largely women—for intervention failure as opposed to the possible inappropriateness of the approach itself.³⁷ Our data show that factors that shape individual ability to adopt interventions (e.g., time, finances) —which are useful to assess intervention appropriateness—were rarely documented. In contrast, the most common reported outcomes related to women were about their 'compliance' behaviors. Higher WASH service levels are critical for health³ and

for establishing contexts that enable healthy choices including relieving women's labor, saving energy costs and time, and lowering stress.

WASH provision at higher service levels does tend to require less household work, but cannot guarantee that women will not be burdened, or that their needs will be met. WASH approaches therefore need to be intentionally gender-sensitive, at a minimum. The JMP service ladders, which function as the benchmark by which to evaluate the quality of WASH services, are notably gender-blind³⁸ and therefore insufficient as the only benchmark. As an example, toilets can be categorized to be at the highest service level (safely managed) even if they lack a superstructure or a door because the ladder does not assess privacy. The global WASH community is already calling for a paradigm shift in how WASH services are delivered and evaluated.³⁹ Consistent with this call, we recommend that potential gender-related needs, burdens, and benefits are formally included when assessing the quality of WASH services, as well as in WASH evaluations when assessing their effectiveness in preventing disease.

A shift is also needed in how evaluations of WASH interventions are conceived, conducted and communicated to prevent further gender exploitation. As with intervention delivery, studies are not always explicit about who is engaged in research activities, women are routinely targeted, compensation is rare, and few report the time participation required. Women, in effect, act as unpaid research assistants. While there remain debates about research compensation⁴⁰, researchers and donors should be deliberate about time required from research participants and justify compensation decisions transparently.

These conclusions are limited by the information reported in the papers assessed, did not consider studies that may have been published elsewhere, excluded evaluations in languages other than English or Spanish, and may have a restricted sample because of the sources from which included studies were identified. Our re-review nonetheless takes a gender lens to prominent studies used to determine intervention effectiveness on key health outcomes. This lens should be considered when assessing the health impacts of WASH interventions. Specifically, women have been critical to evaluation research and intervention delivery and yet are often invisible and undervalued in the public health literature. Greater awareness and reflexivity are needed within WASH research and practice to elevate and value gender equity alongside health impacts.

Declarations

Declaration of interests

BAC and SSS report having received funding from the Bill & Melinda Gates Foundation, UNICEF, USAID, and World Vision for research related to gender and WASH. OC has received funding from the Bill & Melinda Gates Foundation related to gender and sanitation.

Acknowledgments

This work was supported, in whole or in part, by the Bill & Melinda Gates Foundation [INV-028835; to BAC and SSS]. Under the grant conditions of the Foundation, a Creative Commons Attribution 4.0 Generic License has already been assigned to the Author Accepted Manuscript version that might arise from this submission.

References

1. Wolf J, Hubbard S, Brauer M, et al. Effectiveness of interventions to improve drinking water, sanitation, and handwashing with soap on risk of diarrhoeal disease in children in low-income and middle-income settings: a systematic review and meta-analysis. *Lancet* 2022; 400(10345): 48–59.
2. Ross I, Bick S, Ayieko P, et al. Effectiveness of handwashing with soap for preventing acute respiratory infections in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet* 2023.
3. Wolf J, Johnston RB, Ambelu A, et al. Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. *The Lancet* 2023.
4. Caruso BA, Conrad A, Patrick M, et al. Water, Sanitation, and Women's Empowerment: A systematic review and qualitative metasynthesis. *PLOS Water* 2022; 1(6): e0000026.
5. Sclar GD, Penakalapati G, Caruso BA, et al. Exploring the relationship between sanitation and mental and social well-being: A systematic review and qualitative synthesis. *Soc Sci Med* 2018; 217: 121–34.
6. Crider YS, Ray I. Water and Development: A Gender Perspective. *Oxford Research Encyclopedia of Environmental Science*; 2022.
7. Venkataramanan V, Geere J-AL, Thomae B, Stoler J, Hunter PR, Young SL. In pursuit of 'safe'water: the burden of personal injury from water fetching in 21 low-income and middle-income countries. *BMJ global health* 2020; 5(10): e003328.
8. World Health Organization/ UNICEF. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs. 2021.
9. Caruso BA. Water is life, particularly for women. *Nature Water* 2023; 1(2): 124-.
10. Sorenson SB, Morssink C, Campos PA. Safe access to safe water in low income countries: water fetching in current times. *Soc Sci Med* 2011; 72(9): 1522–6.
11. Graham JP, Hirai M, Kim SS. An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries. *PLoS One* 2016; 11(6).
12. Cavill S, Huggett C. Good mums: a gender equality perspective on the constructions of the mother in handwashing campaigns. *WH20: The Journal of Gender and Water* 2020; 7(1): 4.
13. Kwiringira J, Atekyereza P, Niwagaba C, Günther I. Gender variations in access, choice to use and cleaning of shared latrines; experiences from Kampala Slums, Uganda. *BMC Public Health* 2014; 14(1): 1180.

14. Cherukumilli K, Ray I, Pickering AJ. Evaluating the hidden costs of drinking water treatment technologies. *Nature Water* 2023; 1–9.
15. Caruso BA, Chipungu J, Kulkarni S, Ray I. Women, work, and water. *Lancet* 2023.
16. Michalak AM, Xia J, Brdjanovic D, et al. The frontiers of water and sanitation. *Nature Water* 2023; 1(1): 10–8.
17. Fisher J, Cavill S, Reed B. Mainstreaming gender in the WASH sector: dilution or distillation? *Gender & Development* 2017; 25(2): 185–204.
18. Crider YS, Tsuchiya M, Mukundwa M, Ray I, Pickering AJ. Adoption of point-of-use chlorination for household drinking water treatment: a systematic review. *Environmental Health Perspectives* 2023; 131(1): 016001.
19. Caruso BA, Sclar GD, Routray P, et al. Effect of a low-cost, behaviour-change intervention on latrine use and safe disposal of child faeces in rural Odisha, India: a cluster-randomised controlled trial. *The Lancet Planetary Health* 2022; 6(2): e110-e21.
20. Arnold BF, Null C, Luby SP, et al. Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits study design and rationale. *BMJ open* 2013; 3(8): e003476.
21. Reese H, Routray P, Torondel B, et al. Design and rationale of a matched cohort study to assess the effectiveness of a combined household-level piped water and sanitation intervention in rural Odisha, India. *BMJ open* 2017; 7(3): e012719.
22. The Sanitation Hygiene Infant Nutrition Efficacy Trial Team, Humphrey JH, Jones AD, et al. The Sanitation Hygiene Infant Nutrition Efficacy (SHINE) Trial: Rationale, Design, and Methods. *Clinical Infectious Diseases* 2015; 61(suppl_7): S685-S702.
23. Caruso BA, Sinharoy SS. Gender data gaps represent missed opportunities in WASH. *The Lancet Global Health* 2019; 7(12): e1617.
24. World Health Organization. Gender mainstreaming for health managers: a practical approach: Geneva: World Health Organisation; 2011.
25. Pederson A, Greaves L, Poole N. Gender-transformative health promotion for women: a framework for action. *Health promotion international* 2014; 30(1): 140–50.
26. Harshfield E, Lantagne D, Turbes A, Null C. Evaluating the sustained health impact of household chlorination of drinking water in rural Haiti. *The American journal of tropical medicine and hygiene* 2012; 87(5): 786.
27. Mäusezahl D, Christen A, Pacheco GD, et al. Solar drinking water disinfection (SODIS) to reduce childhood diarrhoea in rural Bolivia: a cluster-randomized, controlled trial. *PLoS medicine* 2009; 6(8): e1000125.
28. Aiken BA, Stauber CE, Ortiz GM, Sobsey MD. An assessment of continued use and health impact of the concrete biosand filter in Bonao, Dominican Republic. *The American journal of tropical medicine and hygiene* 2011; 85(2): 309.

29. Humphrey JH, Mbuya MN, Ntozini R, et al. Independent and combined effects of improved water, sanitation, and hygiene, and improved complementary feeding, on child stunting and anaemia in rural Zimbabwe: a cluster-randomised trial. *The Lancet Global Health* 2019; 7(1): e132-e47.

30. Clasen T, Boisson S, Routray P, et al. Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: a cluster-randomised trial. *The Lancet Global Health* 2014; 2(11): e645-e53.

31. Luby SP, Agboatwalla M, Painter J, Altaf A, Billhimer WL, Hoekstra RM. Effect of intensive handwashing promotion on childhood diarrhea in high-risk communities in Pakistan: a randomized controlled trial. *Jama* 2004; 291(21): 2547–54.

32. Tough H, Abdallah A-K, Zemp E, Molesworth K. Gender dynamics of community-led total sanitation interventions in Mpwapwa District, Tanzania. *Global Public Health* 2022: 1–15.

33. Ilahi N, Grimard F. Public infrastructure and private costs: water supply and time allocation of women in rural Pakistan. *Economic development and cultural change* 2000; 49(1): 45–75.

34. Ray I. Women, water, and development. *Annu Rev Environ Resour* 2007; 32: 421–49.

35. Beneria L, Sen G. Class and gender inequalities and women's role in economic development: Theoretical and practical implications. *Feminist Studies* 1982; 8(1): 157–76.

36. Frieden TR. A framework for public health action: the health impact pyramid. *American journal of public health* 2010; 100(4): 590–5.

37. Levy K. Invited perspective: environmental health interventions are only as good as their adoption. *Environmental Health Perspectives* 2023; 131(1): 011303.

38. UN Women. Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development. New York: UN Women; 2018.

39. Haque SS, Freeman MC. The applications of implementation science in Water, Sanitation, and Hygiene (WASH) research and practice. *Environmental health perspectives* 2021; 129(6): 065002.

40. Pandya M, Desai C. Compensation in clinical research: The debate continues. *Perspectives in clinical research* 2013; 4(1): 70.

Tables

Table 1: Summary information about included studies (N=133)

	N	%
Source		
Diarrhea Review Only	107	80.5%
ARI Review Only	12	9.0%
Both Diarrhea and ARI	14	10.5%
Intervention Focus		
Water	64	48.1%
Sanitation	8	6.0%
Hygiene	46	34.6%
Water, Sanitation, & Hygiene	4	3.0%
Water & Sanitation	4	3.0%
Water & Hygiene	5	3.8%
Sanitation & Hygiene	2	1.5%
Total interventions that address water	77	57.9%
Total interventions that address sanitation	18	13.5%
Total interventions that address hygiene	57	42.9%
Population Targeted by Intervention for Primary Outcome		
Children<=5years	111	83.5%
Other children ¹	10	7.5%
All ages	12	9.0%
Sex disaggregated primary outcome data	8	6.0%
Study Region		
Africa	43	32.3%
Asia	51	38.3%
Europe	3	2.3%
Latin America & Caribbean	25	18.8%
Middle East	4	3.0%
North America	6	4.5%
Oceania	1	0.8%

Study Setting		
Rural	80	60.2%
Urban	40	30.1%
Peri-urban	1	0.8%
Mixed	12	9.0%
Study Sub-Setting		
Domestic	116	87.2%
Institutional	16	12.0%
Both domestic and institutional	1	0.8%

1. Includes: children 4th-5th grade, children 5-15 years old, children less than 7 years old, child 9-11, children <=7 years old, children >5, kindergarten children, school-aged children

Table 2: Assessment of Research and Intervention Engagement in Included Studies (N=133)

	N	%
Research activities necessitated involvement of a person for data collection	132	99.2%
Only Targeted Women	14	10.6%
Only Targeted Men	0	0.0%
Only Targeted Women or Men ¹	2	1.5%
Only Targeted Other Specified Individuals ²	7	5.3%
Only Targeted Unspecified Individuals	17	12.9%
Targeted Multiple Groups	92	69.7%
Total Targeting Women	91	68.9%
Total Targeting Men	2	1.5%
Total Targeting Women or Men ¹	8	6.1%
Total Targeting Children	47	35.6%
Targeted Girl & Boy Children (n=47)	14	29.8%
Targeted Unspecified Children (n=47)	37	70.2%
Total Targeting Other Specified Individuals ³	24	18.2%
Total Targeting Unspecified Individuals	89	67.4%
Individual who reported study's focal outcome (n=131)³		
Women (Mothers)	83	63.4%
Children	3	2.2%
School/ Daycare Staff	7	5.3%
Parents	8	6.1%
Multiple types of people (doctors, etc.)	2	1.5%
Unspecified	28	21.4%
Study reported time required of participant for research activities⁴	1	0.8%
Compensation provided for engaging in research activities	5	3.8%
Studies that reported additional outcomes	111	83.5%
Specific to Women (n=111)	16	14.4%
Specific to Men (n=111)	4	3.6%

Specific to Children (n=111)	60	54.1%
Specific to Other Populations (n=111) ⁵	92	82.9%
Intervention activities necessitated involvement of a person	120	90.2%
Only Targeted Women	21	17.5%
Only Targeted Men	0	0.0%
Only Targeted Women or Men ¹	0	0.0%
Only Targeted Children	2	1.7%
Targeted Girl & Boy Children (n=2)	1	50.0%
Targeted Unspecified Children (n=2)	1	50.0%
Only Targeted Other Specified Individuals ⁶	10	8.3%
Only Targeted Unspecified Individuals	39	32.5%
Targeted Multiple Groups	48	40.0%
Total Targeting Women	49	40.8%
Total Targeting Men	2	1.7%
Total Targeting Women or Men	1	0.8%
Total Targeting Children	20	16.7%
Targeted Girl & Boy Children (n=20)	7	35.0%
Targeted Unspecified Children (n=20)	13	65.0%
Total Targeting Other Specified Individuals ⁶	31	25.8%
Total Targeting Unspecified Individuals	76	63.3%
Study reported time required of participant for intervention activities⁴	3	2.5%
Compensation provided for engaging in intervention activities	13	10.8%
Intervention communications include references to shame, honor, upholding gender norms	10	8.3%

1. For interventions or research activities listed as targeting 'Women or Men', these studies specifically indicated that either adult women or men were targeted.

2. Examples of 'Other Specified Individuals' targeted for research activities include: Daycare administrators and staff, teachers, key informants

3. For two studies, diagnostic tests or medical records were used to retrieve data on the focal outcome.

4. Studies only counted if information reported was clear and specific. Studies were considered to not have reported time if information provided was unclear, not specific enough, or not reported at all.
5. Examples of 'Other Populations' include daycare staff, household members, parents as a unit, households as a unit, and schools as a unit
6. Examples of 'Other Specified Individuals' targeted for intervention activities include: Daycare administrators and staff, teachers, field-based staff

Table 3: Gender Responsiveness Assessment of Included Studies by Type of Intervention and Population Engagement (N=133)

	Did not require individual-level participation		Required individual-level participation		GRAS Classification among those that required individual-level participation			
					Gender Unequal		Gender Blind	
	n	%	n	%	n	%	n	%
Interventions (133)	13	9.8%	120	90.2%	44	36.7%	76	63.3%
Water (n=64)	8	12.5%	56	87.5%	19	33.9%	37	66.1%
Sanitation (n=8)	4	50.0%	4	50.0%	0	0.0%	4	100.0%
Hygiene (n=46)	0	0.0%	46	100.0%	17	37.0%	29	63.0%
Water, Sanitation, & Hygiene (n=4)	0	0.0%	4	100.0%	3	75.0%	1	25.0%
Water & Sanitation (n=4)	1	25.0%	3	75.0%	1	33.3%	2	66.7%
Water & Hygiene (n=5)	0	0.0%	5	100.0%	3	60.0%	2	40.0%
Sanitation & Hygiene (n=2)	0	0.0%	2	100.0%	1	50.0%	1	50.0%
Type of water intervention (n=77)	9	11.7%	68	88.3%	24	35.3%	44	64.7%
Improved, on premise, continuous supply (n=1)	1	100.0%	0	0.0%	0	0.0%	0	0.0%
Improved, on premise, higher WQ (n=2)	0	0.0%	2	100.0%	0	0.0%	2	100.0%
Improved, on premise (n=9)	6	66.7%	3	33.3%	0	0.0%	3	100.0%
Improved, not on premise (n=8)	2	25.0%	6	75.0%	2	38.6%	4	61.4%
Point-of-use treatment of water from unimproved water source or improved source not on premise (n=57)	0	0.0%	57	100.0%	22	28.9%	35	46.1%
Type of sanitation intervention (n=18)	5	27.8%	13	72.2%	4	30.8%	9	69.2%
Sewer connection (n=4)	4	100.0%	0	0.0%	0	0.0%	0	0.0%
Basic sanitation/improved sanitation (n=14)	1	7.1%	13	92.9%	3	23.1%	10	76.9%
Type of hygiene intervention (n=57)	0	0.0%	57	100.0%	23	40.4%	34	59.6%

Promotion of handwashing with soap provision (n=34)	0	0.0%	34	100.0%	10	29.4%	24	70.6%
Promotion of handwashing with no provision of soap (n=23)	0	0.0%	23	100.0%	13	56.5%	10	43.5%

Classification by Group Targeted for Intervention Engagement (n=120)

Specific to Women (n=21)	21	100.0%	0	0.0%
Specific to Men (n=0)	0	0.0%	0	0.0%
Specific to Children (n=2)	0	0.0%	2	100.0%
Specific to Other Specified Individuals (n=10) ¹	0	0.0%	10	100.0%
Specific to Unspecified Populations (n=39)	0	0.0%	39	100.0%
Multiple populations (n=48)	23	47.9%	25	52.1%

1. Examples of 'Other Specified Individuals' targeted for intervention activities include: Daycare administrators and staff, teachers, field-based staff

Table 4. Examples of gender-unequal and gender-blind water, sanitation, and hygiene intervention activities from included studies

	Gender unequal	Gender blind
Water	To reduce childhood diarrhea, a solar drinking water disinfection intervention was implemented. In intervention households, field workers visited biweekly for a year to emphasize the use of solar disinfection. Mothers and primary caregivers were specifically targeted to integrate the water treatment into their daily life. Other promotion activities occurred with the entire community and primary schools on a less frequent basis (i.e., monthly and three times, respectively). ²⁷	To prevent child diarrhea, a household biosand filter intervention was implemented. Intervention households received concrete biosand filters, education on how to use and maintain the filter, and a five-gallon narrow mouth bottle and base that allowed water to filter directly into the container for safe storage. Some intervention households had two follow-up visits post-installation. ²⁸
Sanitation	To reduce child stunting and anemia, independent and combined water, sanitation, and hygiene interventions were implemented. Women were enrolled in the study and scheduled to receive 15 behavior-change modules from village health workers over 12 months based on their 'treatment' group assignment (i.e., standard of care; infant and young child feeding; water, sanitation, and hygiene; infant and young child feeding plus water, sanitation, and hygiene). A sequential longitudinal intervention was also delivered, and reviewed modules with mothers monthly for six months. Household sanitation and hygiene infrastructure was also built and chlorine for water treatment was distributed. ²⁹	To prevent diarrhea, soil-transmitted helminth infection, and child malnutrition, India's Total Sanitation Campaign was delivered, combining social mobilization and a post-hoc latrine subsidy. The Government of India provided subsidies for the construction of latrines that met specified criteria in below-poverty-line households. Motivators in every village were trained to help mobilize the community as a whole. ³⁰
Hygiene	To prevent childhood infections and growth faltering, a community-based handwashing program that targeted mothers was implemented. In intervention communities, the program was launched at a community meeting that included an interactive educational session, discussion, and short play. Then, community motivators conducted home visits with mothers to encourage the establishment of new handwashing routines for six months. Daily visits were conducted for two weeks, and then decreased in frequency until the mothers were visited just once or twice a week. Group meetings were also held for mothers in each study area every two weeks to promote handwashing behaviors and distribute new bars of soap. ³¹	To prevent childhood diarrhea, an intervention to promote handwashing with soap after defecation and before preparing food, eating, and feeding a child was implemented. Field workers from local communities conducted weekly neighborhood meetings about handwashing for approximately one year, using slideshows, videotapes, and pamphlets. Field workers encouraged all household members who were old enough to understand to wash their hands at key times and provided soap to families, as needed. ³¹

Figures

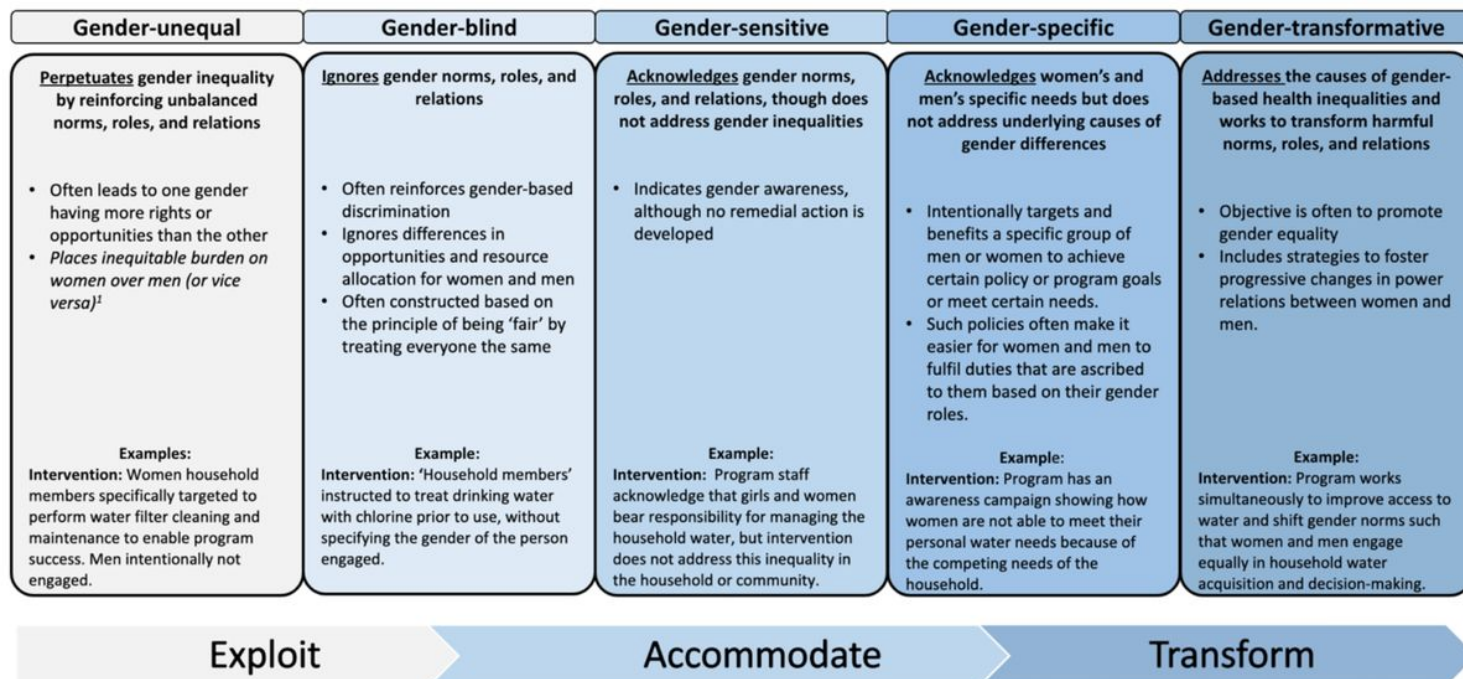


Figure 1

Gender responsiveness assessment scale and application to water, sanitation, and hygiene programming/interventions and research, as informed by World Health Organization (WHO), 2011 and Pederson et al. 2014.

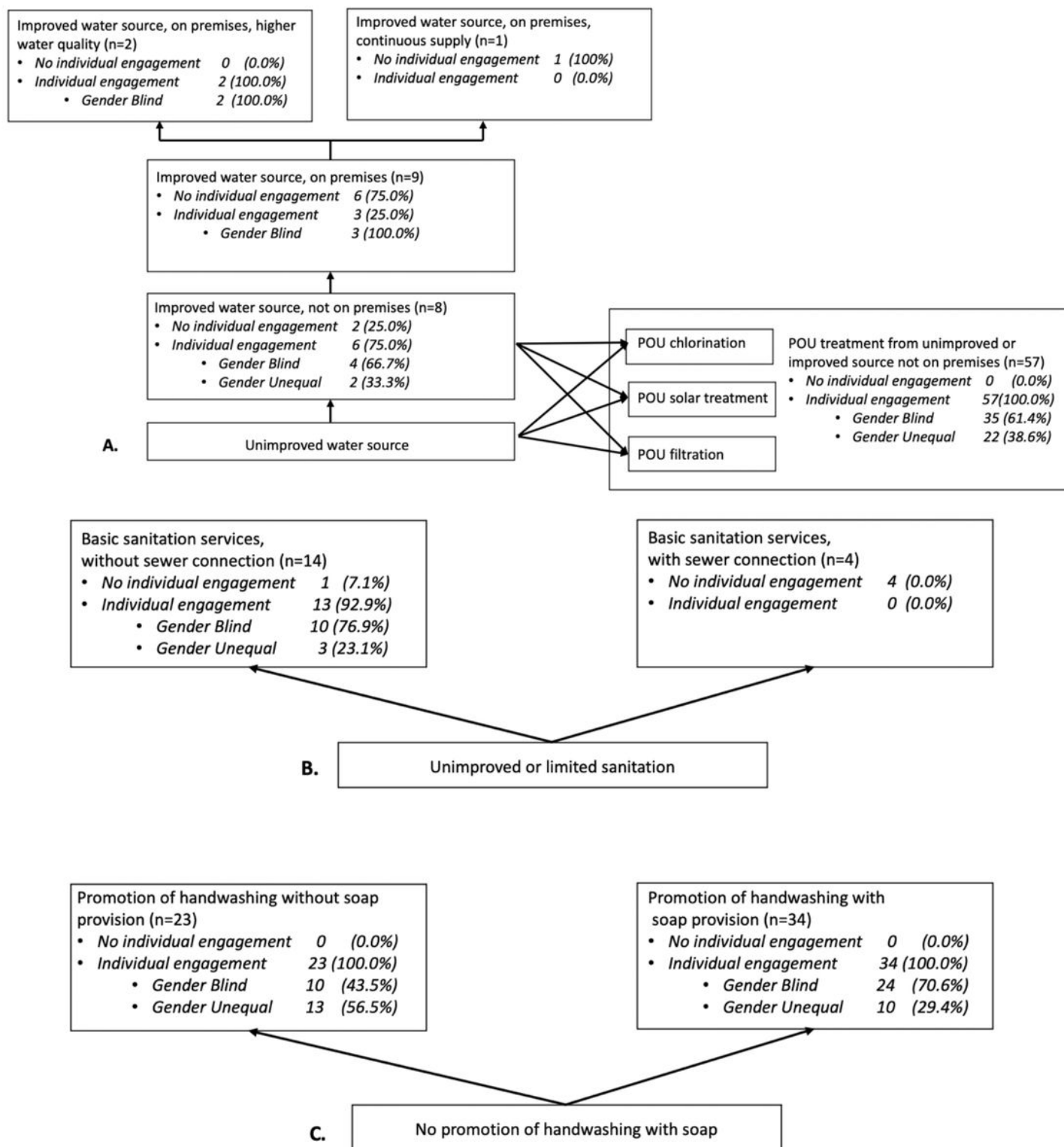


Figure 2

Exposure scenarios for drinking water (A), sanitation (B) and hygiene (C) services with GRA classifications

Image not available with this version

Figure 3

This image is not available with this version.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTablesandFiguresgenderreview21OCT23.docx](#)