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Women's Health and Empowerment for Sustainable Development: Linking Sanitation Burden and Agency in Asia and Africa

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ABSTRACT

This paper aims to explore a research gap at the intersection of public health and empowerment literatures concerned with women's health-related sanitation experiences and their sanitation-specific agency. We shift focus from prevalent scholarly engagement with women's wellbeing as an outcome of their agency by asking an unexplored question in the opposite direction: what is the association between women's physical and mental health-related sanitation burden and their household-level and community-level agency outcomes? Data for this study come from a comprehensive socio-demographic and sanitation-specific empowerment survey of 5744 women across eight cities in Asia and Africa. Health-related sanitation burden is operationalized using a validated health scale that measures women's perceived and actual physical and mental wellbeing as affected by sanitation options and conditions at or outside their homes. Household-level agency outcomes are assessed by women's sanitation-specific decision-making and freedom of movement. Community-level agency outcomes are assessed by decision-making and collective action related to community sanitation. Data are analyzed using a novel hierarchical regression model that accommodates multi-level fixed effects and clustered standard errors. We find that lower sanitation burden is significantly associated with higher household-level decision-making but lower freedom of movement, community-level decision-making, and collective action. Findings matter for public health because they systematically assess the sanitation burden borne by women in their everyday lives and the extent to which it can demobilize them from living a full life. Findings inform policy recommendations that can reduce women's sanitation burden toward achieving Sustainable Development Goals 5 (gender equality) and 6 (safe sanitation).

1 | Introduction

Target 6.2 of the Sustainable Development Goal (SDG) 6 emphasizes "paying special attention to the needs of women and girls" in ensuring access to adequate and equitable sanitation and hygiene for all and ending open defecation by 2030 (WHO/UNICEF Joint Monitoring Programme 2023). The special focus on women and girls for achieving sanitation-specific sustainable development recognizes them as a population that disproportionately bears the burden of inadequate sanitation. And yet, global monitoring for SDG 6 does not currently include any gender-specific indicators. According to SDG data from 2022, over 50% of the population in Bangladesh, India, and Senegal used "at least a basic sanitation service, such as improved sanitation facilities that is not shared with other households." In Uganda and Zambia, only 21% and 36.3% had access to

improved sanitation facilities, respectively (Sachs et al. 2024). These aggregate statistics across the five countries that are the focus of this study invisibilize gender inequalities in access to a human need service and gender inequities in usage even when "improved facilities" are available (Caruso et al. 2021; Kimutai et al. 2023; Kwiringira et al. 2014; Routray et al. 2015). Public health research has also largely ignored the effects of unsafe sanitation on women's health, wellbeing, and quality of life outcomes (Caruso et al. 2024, 2022). Emerging work has begun to focus on women's mental health (Sclar et al. 2018), though largely as an outcome of latrine access and experiences with sanitation conditions (Caruso et al. 2017, 2018; Sahoo et al. 2015; Routray et al. 2017).

SDG 5 strives to "achieve gender equality and empower all women and girls." Using Target 5.5 for a comparative assessment of progress across our five study sites, Senegal and Uganda had a much higher representation of women in their national parliaments (46.1% and 34%, respectively) compared to Bangladesh (21%), Zambia (15%), and India (14.7%) in 2024 (Sachs et al. 2024). However, much less is known about sanitation-specific empowerment across these contexts despite growing recognition of water, sanitation, and hygiene (WASH) services and conditions being critical enablers of gender equality (Caruso et al. 2021; Oxfam 2020). The difficulty in collecting gender data even for existing SDG 5 indicators has meant that linkages with SDG 6 have been largely overlooked (Caruso et al. 2021, 43). The literature on women's empowerment is also replete with studies that investigate the role of gender norms, financial assets, and educational achievements as major constraints on their ability to have a voice in matters and to participate in activities without fear of sanctions (see Chang et al. 2020 for a summary review across low- and middle-income countries) but rarely focus on sanitation.

Our research draws on the foregoing literatures in public health and empowerment to study women's sanitation-specific agency as an outcome of their health-related burden imposed by precarious sanitation conditions. Such an examination remains missing in development research. We take the first step to study this knowledge deficit which is important for two reasons. First, we move beyond the dominant constructions of women as child-bearers and caregivers in research to examine the extent to which their *personal* physical and mental health matters for their agency. Second, women's health-related sanitation burden may be an equally important factor as discriminatory gender norms and socio-economic resource constraints in shaping their ability to participate in household and community sanitation decisions and activities that, in turn, can have implications for their wellbeing.

This study aims to investigate the association between women's health-related sanitation burden and their sanitation-specific agency outcomes at the household and community levels. Our framing of health-related sanitation burden and sanitation-specific agency is based on a conceptual framework of empowerment that was originally developed by van Eerdewijk et al. (2017) and adapted by our team to be sanitation-specific based on a systematic review of 270 articles on water, sanitation, and empowerment (see Caruso et al. 2022 and Sinharoy et al. 2022 for more details). To measure health-related sanitation burden, we utilize a comprehensive and validated health scale that measures the intensity of physical illness, stress and fear of injury or sexual harassment, and feelings of shame and embarrassment experienced by women in accessing and using their sanitation location. We argue that inadequate and unsafe sanitation conditions are a burden on—not merely a barrier to—women's wellbeing. The term "burden" centers and problematizes the disproportionately negative impact of poor sanitation on women's physical and mental wellbeing *because* of their gender.

Using cross-sectional survey data of 5744 women collected for the Measuring Urban Sanitation and Empowerment (MUSE) project from eight cities across India, Bangladesh, Senegal, Uganda, and Zambia, we investigate whether women who report a higher health-related sanitation burden experience lower (or higher) agency across four domains of household-level and community-level agency (Sinharoy et al. 2022, 2023). Women's household-level agency outcomes are assessed by two measures: (1) women's participation and influence in *decision-making related to household sanitation*, and (2) the extent of women's *freedom of movement* to meet personal sanitation needs and achieve related goals. Community-level agency outcomes are assessed by two measures: (1) women's ability to participate in and influence *decision-making related to community sanitation* and (2) women's ability to establish trust and solidarity with community members for *collective action* on shared sanitation issues. The results of our high-dimensional fixed effects (HDFE) regression analyses show that lower health-related sanitation burden is strongly associated with higher household-level decision-making agency but lower freedom of movement, community-level decision-making, and collective action outcomes. These results are robust to our tests of endogeneity or reverse causality that use a two-stage least-squares (2SLS) estimation approach with an instrumental variable. Overall, our findings are important for two reasons. They advance cross-disciplinary scholarship on women's health-related sanitation experiences as a critical factor in the *process of* empowering them to have a voice and make choices about their wellbeing. Unlike extant research that examines how women's health behaviors and outcomes are influenced by their decision-making agency (e.g., James-Hawkins et al. 2018; Leight et al. 2022), our study is perhaps the first to investigate the reverse relationship. The results also have implications for policy agenda-setting and service provision that can address women's health-related sanitation burden by understanding their needs and experiences with sanitation. By establishing strong linkages between SDG 6 (*Clean Water and Sanitation*) and SDG 5 (*Gender Equality*), this study adds to a growing body of evidence that advocates for an interconnected approach to public policymaking (Diep et al. 2021; Guaita-Fernández et al. 2024; Song and Jang 2023).

This paper has the following structure. Section 2 engages the literature on women's agency and public health, and situates the discussion on sanitation-related health as a critical component in women's empowerment processes. Section 3 describes data collection procedures, study variables that draw from the literature summarized in the previous section, and data analysis methodologies. Section 4 presents the descriptive results and the main analytical results. Section 5 presents a discussion, including the policy relevance of our results. Section 6 concludes.

2 | Literature Review

This section presents a summary of and a critical dialogue between two major strands of development literature—women's empowerment and public health research related to sanitation. Such a cross-disciplinary engagement is critical to understanding women's sanitation-specific physical and mental health status as an important resource that can shape their agency to live a full life.

2.1 | Women's Agency in Empowerment Research

Women's agency, defined as the ability to have a voice and to influence or make decisions about their lives and wellbeing without fear of violence and retribution, is central to understanding the *process* of their empowerment (Kabeer 1999; Van Eerdewijk et al. 2017). According to Kabeer (1999, 437, 441), the capacity to choose necessarily entails having the opportunities or acquiring the resources to make strategic life choices. These resources are not limited to individual-level processes such as having access to education, employment, or a sense of self-efficacy but include broader social resources such as access to peer networks and group membership that are governed by formal rules and cultural norms which define the realm of possibilities for exercising one's agency. This dynamic and interactive framework of empowerment theory, therefore, suggests that the potential for agency is shaped by, and in turn shapes, access to and control over various material, cognitive, and socio-normative "action resources" in bargaining for improved outcomes within and outside the household (Doss and Meinzen-Dick 2015). However, control over resources may not be sufficient for empowerment unless such control is linked to transformations in power structures in one's social environment that produce and perpetuate gender inequality (Kabeer 2001, 66). Kabeer's (1999) framework of empowerment can also be understood as a multi-level concept such that the opportunities or resources that individuals may or may not have in their larger social environment can shape household-level agency outcomes and vice versa. For example, Gopalakrishnan et al. (2024) use a nationally representative demographic health survey data for India to show that an increase in community-level inequitable gender norms related to wife beating was associated with women's reduced intra-household decision-making power and freedom of movement (see also Marcus 2021). As Zimmerman (2000, 50, 58) observes, one's belief in the ability to influence decisions about one's life is connected with the critical awareness of one's social and political environment, and the experiential learnings through participation in community activities can be harnessed to improve individual wellbeing.

Across development sectors, existing research on quantitative measurements of agency—essential for tracking progress on women's empowerment under SDG 5 (gender equality)–has broadly operationalized the "power to" define their own goals and act upon them, and the achievement of goals through acting collectively or "power with" others, respectively, as women's ability to (i) participate and make or influence household-level decisions, (ii) move freely to participate in activities and meet personal needs outside their homes, (iii) participate and make or influence community-level decisions, and (iv) organize with community members to take collective action in pursuit of shared goals or objectives (see Chang et al. 2020 for a summary review).

The most common approach to operationalizing women's household-level agency has been to study their participation and influence as sole or joint decision-makers in matters such as their own employment (Heath 2014), investments in children's education (Bonilla et al. 2017), household purchases (Anderson and Eswaran 2009; Hanmer and Klugman 2016), and access to and control over productive assets such as land and livestock (Alkire et al. 2013). Research shows that the domain and extent of women's involvement in household decision-making is significantly associated with their socio-economic status (e.g., marital status, employment status), household characteristics (e.g., number of household members, including young children), entrenched gender norms, and their perception of self-efficacy and motivational autonomy (Bonilla et al. 2017; Donald et al. 2020; Seymour and Peterman 2018). Another common indicator of women's household-level agency is the extent to which they can independently travel outside their homes to pursue interests and activities, without the fear of sanctions or violence from family members or outsiders. Restrictions on women's freedom of movement due, in part, to unsafe and unreliable public transit systems (Belhaj et al. 2023; Nasrin and Bunker 2021) and normative expectations around women's time and labor (Bussolo et al. 2024; Deshpande and Kabeer 2024) have been shown to be strongly associated with their economic disempowerment in the form of limited engagement in paid work outside the home, or accepting low-paying informal jobs closer to home.

Women's participation in collective decision-making and collective action by establishing trust and solidarity with community or group members is frequently used to measure community-level agency in empowerment research (e.g., Agarwal 2000; Klein 2016; Mudege et al. 2015). These forms of agency can be influenced by and can influence women's empowerment through endowments of social capital resources that may be mobilized to access pertinent information on healthcare services or jobs (Bolin 2020; Shankar et al. 2019), and to asset endowments and public resources which, in turn, can also transform power relations within the household (Burchi and Vicari 2014; Doss and Meinzen-Dick 2015; Pandolfelli et al. 2007).

The foregoing literature on women's voice and influence in household-level and community-level empowerment processes centers the salience of gender norms, self-efficacy, social capital, and social demographics in advancing or restricting their agency. But, research is remiss in exploring whether women's self-reported physical and mental health status can be an important resource or a necessary condition for exercising their instrumental and collective agency, specifically their decision-making at home and outside, autonomous movement, and collective action.

2.2 | Women's Agency in Health Research

The dominant frames in health research have focused on women's reproductive and caregiving roles by studying vulnerabilities in maternal and child health, on the one hand (e.g.,

Baron et al. 2016; Duh-Leong et al. 2024; Lasater et al. 2017; Wachs et al. 2009) and sexual and reproductive health, on the other (e.g., Ahmed et al. 2012; Joshi and Schultz 2013; Lasater et al. 2017). A longitudinal study of 134 countries covering almost seven decades found mixed results of women's economic empowerment on child health in low-and middle-income countries (LMICs) where women's labor force participation and financial inclusion were associated with reduced under-5 child mortality rate, but running a business had the opposite effect (Kellard et al. 2024). The intersectional research on women's health and agency has largely focused on these traditional framings, and especially on sexual and reproductive health, to show that household decision-making agency and freedom of movement tend to be positively associated with current contraception use for family planning (Bogale et al. 2011; James-Hawkins et al. 2018; Senarath and Gunawardena 2009; Upadhyay et al. 2014). However, evidence on the impact of women's political agency on maternal and child health remains mixed (Shammama and Brazys 2024; Bhalotra and Clots-Figueras 2014). Some studies use key socio-economic demographics such as age, education, and employment status, and household composition to operationalize women's empowerment in the reproductive health domain (see Upadhyay et al. 2014 for a summary literature review). In other cases, these individual and household-level demographics are studied as significant predictors of women's nutritional health and sexual and reproductive healthcare-seeking behaviors (Amporfu and Grépin 2019; Mal and Saikia 2024), though emerging research is beginning to show null results in some low-income contexts (Bapolisi et al. 2024).

Other emerging research on the linkages between women's health and agency tends to measure health indirectly via adoption of clean cooking fuels (proxy for improved respiratory health) and investigates its effect on participation in household decision-making and autonomous mobility outside the home (Akter and Pratap 2022; Lee et al. 2024). These effects also tend to be mediated by women's socio-economic demographics such as education and employment status. Overall, we find that the analytical focus of intersectional research on health and empowerment is limited to studying women's healthcare behaviors and health conditions as an outcome of their agency (see also, Furuta and Salway 2006; Leight et al. 2022; Yount et al. 2014), thus ignoring the research and policy implications of a potential reverse association.

2.3 | Women's Health and Agency in Sanitation Research

Despite the WHO's Constitution defining health as not just the absence of disease but as a "state of complete physical, mental and social well-being" (WHO 1946), public health research on sanitation has framed the "burden of disease" as relating to the prevalence of infectious diseases such as diarrhea, acute respiratory infections, undernutrition, and soil-transmitted helminthiases due to inadequate water, sanitation, and hygiene services (Wolf et al. 2023; Clasen et al. 2012). However, there is growing evidence of inadequate sanitation which disproportionately affects non-infectious disease outcomes among women and girls (Caruso et al. 2022). These adverse outcomes include anxiety, fear, and shame in sanitation access and use (Caruso et al. 2018; Hulland et al. 2015; Sclar et al. 2018). Achieving access to safe sanitation and hygiene for all (SDG 6) would require research on the health impact of inadequate sanitation to be more inclusive of sanitation conditions and experiences, especially of women.

In this paper, health-related sanitation burden is understood as the severity of women's perceptions or experiences of negative health (including physical and mental health) related to their everyday access and use of a sanitation location at home or outside the home. This re-framing of "burden" more accurately captures not only the acute impacts of poor sanitation conditions, such as infectious diseases, but many additional ways in which poor sanitation conditions can be a type of structural oppression that can prevent women from achieving their goals. This concept is particularly relevant for South Asian and African contexts because of well-documented evidence of women perceiving and experiencing sexual harassment and violence enroute to and at sanitation facilities, shame of being seen while defecating or urinating, and sickness when forced to use an unclean facility in the absence of an alternative or withholding food and water intake and/or suppressing the need to urinate or defecate to avoid using an unclean or a non-private sanitation location especially at night (Caruso et al. 2021, 2022; Hulland et al. 2015; Sahoo et al. 2015; Shiras et al. 2018).

Despite the unique and serious physical and mental health burden borne by women due to poor sanitation conditions, research exploring the role that women's health can play in advancing or curtailing their agency capabilities has been limited. Instead, the focus has predominantly been to investigate the effect of women's participation and influence on their household's decision to construct latrines as a proxy for improved personal or household health. Studies on women's agency in sanitation-related collective action have also tended to focus on such engagement as a means to achieving better personal or community health by monitoring sanitation-related harassment (Kulkarni et al. 2017) and open defecation (e.g., von Medeazza et al. 2015). This paper departs from extant research in sanitation-specific empowerment and public health to explore the association of women's health-related sanitation burden on their household-level and community-level agency outcomes. Figure 1 presents a visual representation of the hypothesized associations.

We expect women's higher health-related sanitation burden to be associated with diminished voice and influence in household sanitation decisions (i.e., *negative association*). This hypothesis is adapted from Kabeer (1999, 437) whereby physical and mental distress may be seen as a critical "human resource" constraint that can impair women's agency to articulate their voice and engage in household activities. For the same reason, we also expect a higher sanitation burden to be associated with a decrease in women's freedom of movement outside their homes (i.e., *negative association*) (see Nasrin and Bunker (2021) and Gonzalez et al. (2020) for social constraints on women's mobility). For community-level agency outcomes, we hypothesize that a higher health-related sanitation burden borne by women may be associated with higher community-level decision-making and collective action (i.e., *positive*

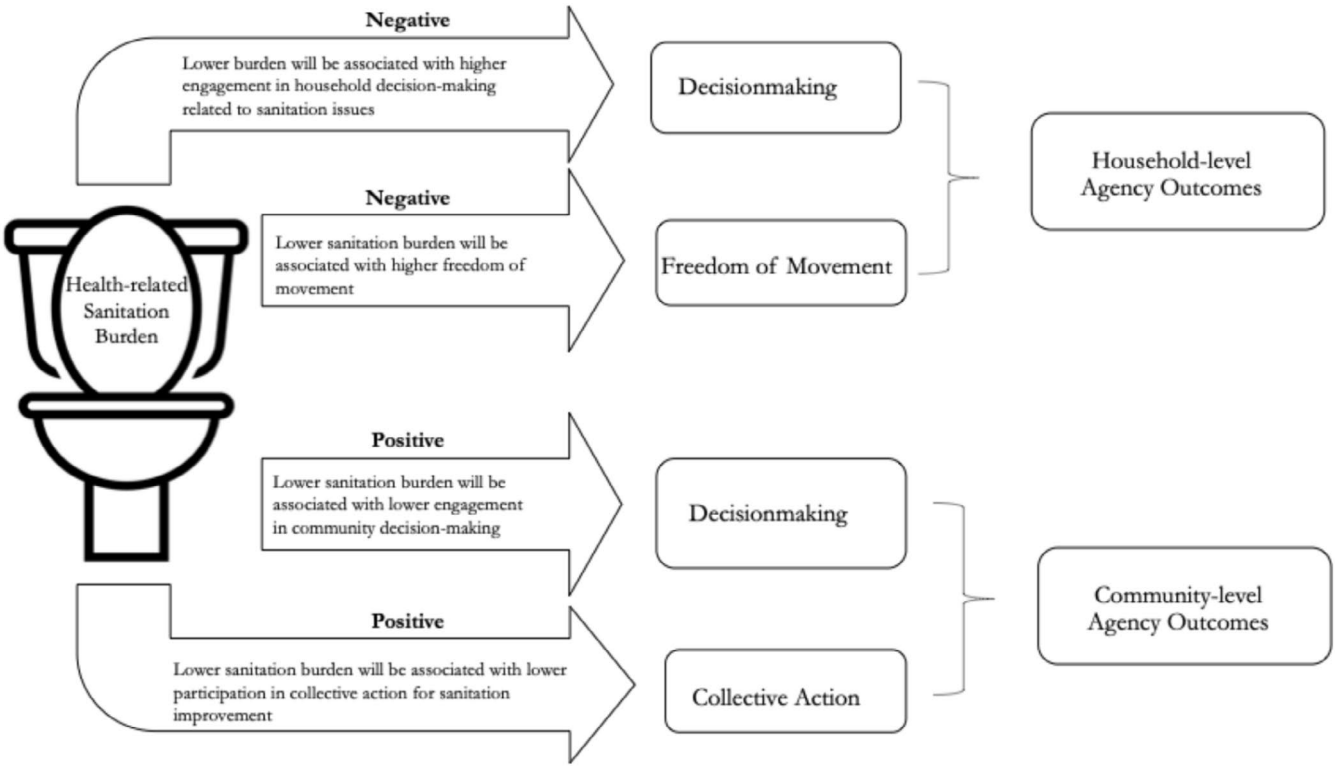

FIGURE 1 | Expected associations between burden and agency.

association). These hypotheses are adapted from existing research which suggests that, given the normative constraints on their time, women's interest or capacity to participate in community engagements may be shaped by their perception of personal benefit from such activities (e.g., Agarwal 2000; Bolin 2020; Doss and Meinzen-Dick 2015; Mudege et al. 2015). Therefore, we contend that when women perceive or experience higher health-related sanitation burden, they may be more amenable to participate in collective decision-making and taking action for shared problem-solving.

3 | Materials and Methods

3.1 | Study Background

This paper presents secondary analyses of cross-sectional data collected through the MUSE project, which aimed to develop and validate quantitative survey instruments to measure subdomains of women's empowerment specific to urban sanitation in low- and middle-income countries (Sinharoy et al. 2022). The MUSE project implemented a comprehensive cross-sectional survey among women in eight cities: Tiruchirappalli (Trichy), Warangal, and Narsapur, India; Meherpur and Saidpur, Bangladesh; Lusaka, Zambia; Dakar, Senegal; and Kampala, Uganda. The following sections on sampling and recruitment, survey instrument design, and study variables reflect the research design components and procedures for implementing the MUSE project (ibid.). Data collected under the MUSE project are available on FigShare at https://doi.org/10.6084/m9.figshare.c.7590713.v3.

3.2 | Sampling and Recruitment

The sampling strategy proceeded along the following steps. First, the five countries and eight cities in the MUSE project were purposively selected in collaboration with the study funder (Bill & Melinda Gates Foundation, BMGF) based on the funder's geographic priorities, the cities' participation in the Citywide Inclusive Sanitation (CWIS) program, and the interest of local partner organizations. Next, we identified wards or precincts within each city with the help of CWIS implementation partners and local government officials. We then undertook purposive sampling of communities in each city, except Bangladesh, in a way that maximized variation along income profile (formal vs. informal communities), geographic location in the city, prevalence of social infrastructure (e.g., distance to nearest school, hospital), and type of sanitation outcomes (e.g., number of community toilets, or public toilets in the precinct). In Bangladesh, the sampling frame comprised all precincts in the city. Since the precincts varied in population size and socio-economic profile (i.e., number of slum and non-slum communities in each precinct), each precinct was divided into clusters of communities with 150 households per cluster. To determine the representation of communities within each cluster, proportional probability sampling based on the share of population of a community in the total precinct population was used. One cluster per precinct was randomly chosen.

Data were collected by trained female enumerators employed by reputed local survey firms in each city. To identify households and recruit respondents from each household, the enumerators used a random walk technique to sample every third household

TABLE 1 | Sampling across eight cities.

Country	City	Number of informal/slum communities (1)	Number of informal/slum households recruited (2)	Number of formal/non-slum communities (3)	Number of formal/non-slum households recruited (4)	Total sample size [(2) + (4)]
India	Trichy	7	244	4	491	735
India	Warangal	16	703	0	0	703
India	Narsapur	26	720	0	0	720
Bangladesh	Meherpur	4	79	31	641	720
Bangladesh	Saidpur	4	94	39	635	729
Zambia	Lusaka	4	320	3	395	715
Senegal	Dakar	0	0	9	709	709
Uganda	Kampala	11	445	4	268	713
Total		**72**	**2605**	**90**	**3139**	**5744**

Note: Important statistics are in bold.

in the community that had an adult woman (18 years or older) who spoke the local language, was a permanent member of the household, and appeared mentally competent to take the survey. Enumerators recruited the first eligible woman who responded to the door knock. A detailed description of the data collection protocol followed by survey agencies across different cities is published elsewhere (Sinharoy et al. 2022).

Table 1 provides details of the number of communities and households sampled in each city. The survey was launched on a rolling basis in these cities beginning in August 2021, and administered by the enumerators in each city in the local language. Data collection ended in June 2022, and a total of 5744 surveys were completed across eight cities.

3.3 | Survey Instrument Design

In addition to questions on individual and household-level demographics such as age, marital status, employment status, household composition, and access to water and sanitation, the MUSE survey instrument comprised modules on three domains of empowerment—Agency, Resources, and Institutional Structures—that included questions which measured 16 sub-domains across these three latent constructs. Under each sub-domain, the survey questions (items) deliberately adopted a disaggregated view of individual-level, household-level, and community-level empowerment because the barriers that constrain women's agency, for example, at the community level (say, family restrictions on participation in mixed-gender forums with strangers) may not demobilize their participation in household-level sanitation decision-making. The items for these sub-domains together constitute a set of 16 independent scales, known as the Agency, Resources, and Institutional Structures for Empowerment (ARISE) scales. The ARISE scales were developed and validated over two prior phases of research (October 2018—July 2021) using standard qualitative and quantitative methods to assess the psychometric properties of the survey items, including exploratory factor analysis, confirmatory factor analysis, internal consistency analyses, and longitudinal measurement invariance and test–retest analyses (see Caruso et al. 2022 for a systematic literature review and sanitation-related empowerment framework; and Sinharoy et al. 2022, 2023, 2024 for details on scale development and validation). Appendix A provides a sanitation-specific definition for each scale or empowerment sub-domain.

3.4 | Research Question and Study Variables

The question anchoring this research study is as follows:

What is the association between health-related sanitation burden and women's household-level and community-level agency?

3.4.1 | Outcome Variables

The survey instrument included a set of "index" questions that were designed to capture women's actual experiences across household-level and community-level agency vis-à-vis sanitation-related matters and activities.[1] We consider four outcome variables measured by indices of women's household and community-level agency. At the household-level, the two outcome variables (indices) measure: (i) women's ability to participate and influence *household decision-making* on sanitation matters (11 items); and (ii) women's *freedom of movement* to access facilities to meet personal sanitation needs and to attend sanitation-related events (6 items). At the community-level, the two outcome variables (indices) measure: (iii) women's ability to speak up and influence *community decision-making* on sanitation matters (6 items); and (iv) women's ability to define, gain solidarity, and take *collective action* on shared sanitation goals and interests (11 items). Response options for items in all indices were "Yes" or "No" and were coded on a binary scale ("Yes" coded as 1, "No" coded as 0). The freedom of movement index

items were reverse-coded. For all four outcomes, index scores were generated by computing an equal-weighted mean of the items.[2] For household decision-making, a higher score means higher influence or voice in household sanitation matters. For freedom of movement, a higher score corresponds with higher agency for sanitation-related autonomous movement. For community decision-making, a higher score means higher influence or voice in community sanitation matters. For collective action, a higher score means higher influence or voice in organizing with community members to take action to solve shared sanitation problems. See Appendix B for the full list of questions.

3.4.2 | Independent Variable and Covariates

Our main independent variable of interest is the health-related sanitation burden borne by women. Although sanitation-specific burden may be defined in several ways such as financial hardship or dependency (Guittar et al. 2022; Witter et al. 2017), time-related burden of balancing work and home responsibilities (Deshpande and Kabeer 2024; Eissler et al. 2022), or the burden of normative expectations in sanitation labor (Cooper-Vince et al. 2018; Prasad et al. 2015), our rationale for focusing on health-related burden draws primarily from this study's theme of analysis—sanitation. Furthermore, research on sanitation and health has insufficiently recognized the gendered burdens borne by women in the form of stress and harm to physical and mental health due to inadequate sanitation that should be seen as a burden and not merely a barrier to their wellbeing.

We operationalize our health-related sanitation burden variable using the ARISE health scale. The health scale comprises 16 items that ask women to report on their perceived or actual physical and mental wellbeing as affected by sanitation options and conditions. Women were asked how often ("Always" coded as 1, "Often" coded as 2, "Sometimes" coded as 3, and "Never" coded as 4) they experienced health-related sanitation burdens such as: "In the past 30 days, I used a sanitation location that I believed might make me ill"; "In the past 30 days, I have felt stress or frustration related to the sanitation conditions in my community." We calculate a simple, equal-weighted mean score for the health scale such that the highest health score of 4 corresponds with the lowest sanitation burden (i.e., never having a negative health-related sanitation experience) and the lowest health score of 1 corresponds with the highest sanitation burden borne by women (i.e., always having a negative health-related sanitation experience).

We control for respondents' socio-economic status (i.e., age, employment status, marital status, religion, and educational achievement) and variables related to their sanitation-related behaviors for others in the household, specifically: sanitation-related care provided by women to children under the age of 5 years, to children aged between 5 and 17 years, and to adults in the household. Each of these three carework variables was coded as a binary variable, where "Yes" responses were coded as 1, and "No" responses were coded as 0.

We use the ARISE scales to control for other variables that the literature deems salient for understanding women's agency. The *self-efficacy* scale (6 items) measures women's confidence in their own ability to influence sanitation behaviors or solve a sanitation-related problem at home and in their community. The *time* scale (6 items) asks women to report their agreement or disagreement with statements on the opportunity costs associated with time spent on meeting personal sanitation needs and completing household sanitation tasks. The *financial and productive assets scale* (8 items) measures the extent to which women had control over money or reported to have the ability to acquire money to meet their basic sanitation needs (e.g., paying for soap, money for pay-per-use toilets) and undertake sanitation repairs at home or in the community. We also control for the effect of normative constraints on women's household and community-level agency through the *norms scale* (21 items). This scale measures gendered division of sanitation-related labor at home, appropriateness of participating and expressing divergent opinion from men in household and in public discussions, and social acceptability of participating and speaking at sanitation-related public events with male presence. Finally, because the existence of support networks has been shown to matter to solve problems and engage in collective action, we also include the *social capital scale* (8 items) as a covariate. This scale asks women whether they have or know someone at home or in their community to support them with sanitation chores/tasks, and about their connections with local leaders and service providers who could help them address sanitation issues. All the five scales discussed thus far have ordered 4-point Likert-type responses to item statements going from "strongly disagree" to "strongly agree". A simple mean score was computed for each scale ranging from 1 to 4. See Appendix C for the full list of questions and coding scheme for the six scales (health scale and covariate scales). Using the above parameters, we estimate the following empirical model:

$$Y_{ijml} = \beta_0 = \beta_1 X_{ijml} + \beta_2 Z_{ijml} + \sigma_j + \mu_m + \theta_l + \varepsilon \quad (1)$$

where Y measures agency outcome(s) for respondent i in community j, city m, and country l; X is the independent variable of health-related sanitation burden borne by women at home and in the community; Z is a vector of respondents' individual-level and household-level demographics and the five scales. Next, we include three hierarchical levels of fixed effects: σ controls for heterogeneity at the community level (for 162 communities); μ is the city fixed effects (for eight cities); and θ is the country fixed effects (for five countries). Finally, ε is the error term.

3.5 | Analytic Method

Given the nested structure of our data, we utilize an HDFE regression model to account for unobserved heterogeneity across multiple levels (community, city, and country). An HDFE regression estimates a linear regression model and also supports instrumental variable specifications with multiple levels of fixed effects (Correia 2016). In the data analysis software STATA v.17 used in this study, linear HDFE regression is estimated using the *reghdfe* package, and the instrumental variable model is estimated using the *ivreghdfe* package. The strength of this innovative hierarchical regression model over other models is its computational capability to absorb three (or more) levels of fixed effects with clustered standard errors. HDFE is also more efficient in terms of faster computations (because it imposes

TABLE 2 | Descriptive statistics.

	Means/proportions
Health-related sanitation burden	
Health score (mean, SD)	3.81, 0.33
Agency	
Decision-making (mean, SD)	2.76, 0.47
Freedom of movement (mean, SD)	4.30, 0.65
Collective action (mean, SD)	2.54, 0.59
Employment status	
Engaged in paid work outside home	26.55
Engaged in paid work inside home	27.95
Engaged in paid work and outside home	1.07
Not engaged in paid work	44.43
n	5706
Respondent age	
Mean [min, max]	35.60 [18, 93]
Standard deviation 12.00	
Shared sanitation with non- household members	
No	69.70
Yes	30.30
n	5700
Education completed	
Less than primary [pre-school/ kindergarten]	9.59
Primary [up to grade 5]	24.10
Lower secondary [grade 6 to grade 10]	28.52
Upper secondary [grade 11 to grade 12]	21.65
Short-cycle tertiary [vocational training/diploma]	4.24
Graduate and above	11.69
Other (unclassified)	0.20
n	4909
Religion	
Christian: Catholic	9.01
Christian: Protestant	17.43
Muslim	41.85
Hindu	30.84
Buddhist	0.05
Jewish	0.05
n	5665
Household size	
Mean [min, max]	5.07 [1, 20]
Standard deviation	3.39
Marital status	
Single/never married	11.91
Married	71.41
Unmarried/living with partner	4.79
Divorced/separated	3.89
Widowed	8.00
n	5702
Sanitation-related support at home to	
Children under 5 years of age	76.0
Children between 5 and 17 years of age	52.5
Adults	41.0
n	5744
Time score (mean, SD)	3.01, 0.54
Financial and productive assets score (mean, SD)	2.41, 0.53
Self-efficacy score (mean, SD)	2.74, 0.55
Social capital score (mean, SD)	2.53, 0.47
Norms score (mean, SD)	2.53, 0.26
N	**5744**

Note: Important statistics are in bold.

minimal memory requirements on STATA v.17) and fewer dropped variables due to reduced losses in the degrees of freedom (Correia 2016). This analytic method calculates degrees of freedom lost due to fixed effects by accounting for nested fixed effects within clusters and for possible sources of collinearity within these fixed effects (Correia 2014).

To check the robustness of our regression results, we test for endogeneity by using a 2SLS estimation approach with a binary variable—whether sanitation facility is shared with non-household members—as an instrument. We performed identification tests to confirm the validity of our instrument (see Appendix F). As a further robustness check, we calculate Pearson's correlations and tests of significant difference among and across household and community-level agency outcomes (see Appendix G).

4 | Results

4.1 | Descriptive Results

Table 2 summarizes the dataset along key characteristics of the respondents and their households. Our sample of women is predominantly married and in their mid-30s. Nearly two-thirds of the women in our survey are educated up to the lower secondary level (grade 10), and 55% are engaged in paid work inside their homes (e.g., tailoring shops) and outside. The average household in our sample comprises five members, and the respondents predominantly reside in a nuclear family. Most households have access to flush/pour-flush toilet facilities at home, and only 30% share their sanitation location with outsiders. We provide disaggregated descriptive statistics by city in Appendix D.

In our dataset, women in general reported experiencing a low health-related sanitation burden (i.e., high mean health score of 3.8) that could be due to better sanitation conditions obtained through policy interventions under the CWIS program. Despite this high average score, we observe small but statistically significant variations across bivariate associations with key demographic characteristics (Table 3). Women who were engaged in income-earning activities outside the home reported the highest health-related sanitation burden (i.e., lowest health score) compared to those who were not employed in paid work. We also find that women using shared sanitation facilities outside their homes experienced significantly higher health-related sanitation burden and observe no significant association between household size constraints on women having to use shared facilities and their perceived or actual burdens. Contrary to theoretical and empirical expectations, we find that married women reported the lowest health-related sanitation burden in their cohort. Finally, we observe that women who occupied leadership positions in formal or informal sanitation-related groups in their communities experienced significantly higher health-related sanitation burden relative to women who were not community leaders.

TABLE 3 | Bivariate associations between key demographics and health-related sanitation burden.

Variables	Mean health score	Mean difference (p)	Health-related sanitation burden (inversely related to health score)
Employment status			
Engaged in paid work outside home	3.70		**Highest**
Engaged in paid work inside home	3.80	< 0.000	Lower
Engaged in paid work outside and inside home	3.80		Lower
Not engaged in paid work	3.84		Lowest
Marital status			
Single/never married	3.80		Lower
Married	3.82		Lowest
Unmarried/living with partner	3.70	< 0.000	**Highest**
Divorced/separated	3.71		Higher
Widowed	3.82		Lowest
Leadership in community-based sanitation groups			
Yes	3.6	< 0.000	**Higher**
No	3.8		Lower
Household size			
Up to four members	3.80	0.266	
Five or more members	3.81		
Shared sanitation location with non-household members			
No	3.90	< 0.000	Lower
Yes	3.70		**Higher**
Household size × Sharing sanitation location with non-household members			
Up to four members	3.67	0.235	
Five or more members	3.69		

Note: Important statistics are in bold.

TABLE 4 | High-dimensional fixed effects regression estimates.

	Household-level agency		Community-level agency	
	Decision-making	Freedom of movement	Decision-making	Collective action
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Sanitation burden				
Health	0.071***	−0.100***	−0.050**	−0.070***
	(0.022)	(0.020)	(0.022)	(0.022)
Age	0.013***	0.005**	0.010***	0.006***
	(0.002)	(0.002)	(0.002)	(0.001)
Marital status (base: single/never married)				
Married	0.038**	−0.020	−0.002	−0.01
	(0.171)	(0.147)	(0.012)	(0.010)
Unmarried/living with partner	0.060**	−0.025	−0.054**	−0.011
	(0.025)	(0.026)	(0.027)	(0.023)
Divorced/separated	0.054**	−0.038**	−0.023	−0.025
	(0.024)	(0.018)	(0.026)	(0.018)
Widowed	0.061**	−0.027	−0.03	−0.040**
	(0.026)	(0.023)	(0.022)	(0.020)
Work status (base: not working for income)				
Earns income outside home	0.033***	−0.022*	0.012	0.027***
	(0.011)	(0.011)	(0.011)	(0.010)
Earns income inside home	−0.003	−0.038**	−0.017	−0.014
	(0.011)	(0.015)	(0.011)	(0.010)
Earns income inside and outside home	−0.023	−0.044	0.002	0.033
	(0.033)	(0.040)	(0.046)	(0.040)
Sanitation-related support at home to:				
Children under 5 years old	−0.010	0.026**	−0.006	0.007
	(0.011)	(0.012)	(0.012)	(0.010)
Children aged 5–17 years	−0.041***	−0.032**	−0.009	−0.031***
	(0.013)	(0.012)	(0.015)	(0.011)
Adults	0.030	0.073	0.039	0.030
	(0.027)	(0.050)	(0.027)	(0.020)
Time	−0.036***	−0.054**	−0.046***	−0.027**
	(0.011)	(0.022)	(0.015)	(0.010)
Financial and productive assets	0.078***	−0.020*	0.051***	0.028***
	(0.001)	(0.012)	(0.010)	(0.010)
Norms	0.014	0.008	−0.03	0.040***
	(0.015)	(0.022)	(0.019)	(0.010)

(Continues)

TABLE 4 | (Continued)

	Household-level agency		Community-level agency	
	Decision-making	Freedom of movement	Decision-making	Collective action
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Self-efficacy	0.150***	0.032***	0.084***	0.040***
	(0.016)	(0.012)	(0.011)	(0.010)
Freedom of movement	—	—	0.066***	0.070***
			(0.020)	(0.020)
Social capital	—	0.469	0.126***	0.090***
		(0.013)	(0.013)	(0.010)
N	**4565**	**4524**	**4519**	**4523**

Note: These models also control for women's religion, education, and rate of growth in age (age-squared). Important statistics are in bold.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Standard errors are in parentheses, are robust, and are clustered at the community level.

4.2 | Regression Results

Table 4 presents the aggregate results of the HDFE regression of the associations between women's household-level and community-level agency outcomes and their health-related sanitation burden and a set of covariates.[3] We provide disaggregated results by city in Appendix E.

Across household-level agency outcomes (models (1) and (2)), we find that health-related sanitation burden has heterogeneous associations. A lower health-related sanitation burden borne by women (i.e., higher health score) is associated with a 7-percentage-point increase in their decision-making agency at home. This result supports our hypothesis presented in Section 2. On the other hand, a lower health-related sanitation burden is associated with lower sanitation-related freedom of movement outside the home, which is in the opposite direction of our hypothesis. Since the freedom of movement index included items related to travel outside the community more broadly, we suspect this result to suggest that even when women may experience a lower health-related burden due to good sanitation conditions at home, the presence of poor sanitation conditions outside their homes or communities, such as their workplace, may lead to restricted movement to better manage their sanitation needs at home.

Across community-level agency outcomes (models (3) and (4)), we find support for our hypotheses that women reporting lower health-related sanitation burden (or, higher health score) may be less likely to participate in collective decision-making and collective action around community sanitation issues. With a high prevalence of household-level toilets that, in turn, is associated with a lower sanitation-related burden (see Table 2), these results may be moderated by low latent motivation for engagement in shared problem-solving activities that are often time- and labor-intensive.

Our ancillary results for associations between covariates and agency outcomes are largely consistent with the existing literature. We find evidence of positive associations between all four agency outcomes and women's self-efficacy vis-à-vis sanitation-related issues, and control over financial and productive assets to meet their sanitation needs and interests (Agarwal 2000; Alkire et al. 2013; Donald et al. 2020). Compared to unemployed women, engagement in paid work is found to be positively associated with household decision-making agency and collective action agency (Bolin 2020; Evans and Nambiar 2016; Heath and Mobarak 2015). Notably, and contrary to other studies (e.g., Deshpande and Kabeer 2024; Gopalakrishnan et al. 2024), prevalence of more liberal sanitation-related gender norms at home and in the community is positively associated only with women's collective action agency and not with sanitation-specific household or community-level decision-making or freedom of movement. Similarly, women's marital status is largely positively associated only with their household-level decision-making agency on sanitation matters. Our consistently negative associations between sanitation-related time-use and agency outcomes suggest that while women are able to accomplish their sanitation-related tasks in a timely manner, they may still be less likely to engage in sanitation-related decisions and activities at home and outside. Given other non-sanitation-related demands on women's time on any given day, we suspect that perhaps women's general workload at home and outside may be moderating the association between their sanitation-related time use and agency outcomes.

The results of our robustness analysis using 2SLS estimation with an instrumental variable show endogeneity in the relationship between health-related sanitation burden and household-level decision-making and collective agency domains, respectively (see Tables F1–F4 in Appendix F). Compared to our main model results in Table 4, we find the magnitude of association between health-related sanitation burden and agency outcomes to be higher without any change in the statistical significance or the direction of association in the instrumental variable high-dimensional fixed effects regression models (see Figure F1 in Appendix F). These results further strengthen our research hypotheses in Figure 1. The results of our robustness analysis using Pearson's correlations and tests of significance difference support our analytic approach of testing associations between women's sanitation burden and their household-level and community-level agency domains separately (see Appendix G).

5 | Discussion

5.1 | Health-Related Sanitation Burden and Women's Agency

In this study, we undertake the first systematic and direct assessment of the relationship between the burden of women's *personal* physical and mental health conditions related to sanitation and four agency outcomes at the household- and community-levels. Using data on 5744 women from eight cities across five countries in South Asia and Africa, we find support for our hypothesis that a lower health-related sanitation burden is strongly associated with higher decision-making agency in household sanitation matters. This finding resonates with existing research which finds that higher wellbeing outcomes can strengthen women's agency to make strategic choices through bargaining, persuasion, and negotiation in decision-making processes (Kabeer 1999; Buller et al. 2016; Dupuis et al. 2022). Our finding also supports existing research that finds a positive association between women's decision-making agency and their general health (James-Hawkins et al. 2018; Lee et al. 2024; Upadhyay et al. 2014; Yount et al. 2014). Therefore, we are able to argue that better physical and mental health (i.e., experiencing a low health-related sanitation burden) may serve as an enabling resource for women to better engage in household sanitation issues that matter for their personal wellbeing. Understanding women's health-related sanitation burden as a human resource constraint on their capacity for decision-making agency, our finding is consistent with other studies that reveal similar effects of constrained environmental resources such as discriminatory gender norms (Bussolo et al. 2024; Deshpande and Kabeer 2024) and time-use poverty (Eissler et al. 2022).

Our finding on sanitation-specific freedom of movement contradicts our hypothesis of a negative association with burden. A dominant perspective in extant research posits that fewer social and resource constraints would support women's autonomous movement (Belhaj et al. 2023; Nasrin and Bunker 2021). Our result, however, is supported by other emerging studies which show that if women and girls have good sanitation facilities at home but poor facilities at schools or workplaces, they may be more likely to remain at home to better manage their sanitation and menstruation needs (Hennegan et al. 2021; Starr et al. 2024).

At the community level, we find consistent support for our hypotheses that lower health-related sanitation burden is associated with women reporting lower engagement in collective decision-making and action. Since we do not measure non-sanitation-related time use on domestic work or gender norms that may potentially have some moderating effect on lowering women's engagement in community-level activities, we are unable to attribute normative constraints on women's time and mobility as a potential explanation for the observed association. However, given the high level of household toilet ownership in our sampled communities and its association with lower health-related sanitation burden, we are able to speculate that women's decision to engage in community-level activities may be moderated by their limited interest or motivation in deliberation and mobilizing for improving community sanitation when they are not burdened by its negative effects. This claim finds support in existing research in Asia and Africa which shows that women's interest in time and labor-intensive community-level activities can be shaped by the extent to which the perceived benefits of such participation could outweigh the costs of pushing back against gendered power dynamics within the household (Evans and Nambiar 2016; Mudege et al. 2015). Other studies such as Vaz et al. (2016) and Seymour and Peterman (2018) have explored this domain of motivational autonomy in measurements of women's agency. It is important to point out that our finding of a positive association between health-related sanitation burden and women's community-level agency outcomes should not be construed as support for letting sanitation conditions worsen and exposing families to severe health risks as a way to spur women's agency in community sanitation matters.

In sum, our findings underscore the importance of examining the association between health-related sanitation burden and an expanded set of agency domains in development research. Overall, we find the magnitude and directionality of association between health-related sanitation burden and women's household-level and community-level agency to be largely consistent. Given the physical and mental wellbeing implications of sanitation, we contend that any investigation into women's agency will be incomplete without accounting for the health-specific burden associated with their everyday sanitation experience. In addition to extending the application of empowerment theory to an under-studied public health domain, our results contribute to better understanding the role that sanitation can play in the process by which individuals gain power. While women's reduced health-related sanitation burden can enable them to gain "power to" make household-level decisions, we find that this access to a critical human resource (i.e., better personal health) may not be sufficient to outweigh other socio-cognitive considerations that can limit their exercise of "power with" others in community-level decision-making and activism (Kabeer 2001). Our finding on the positive association between women's sanitation-related freedom of movement and community-level agency outcomes also supports the theory of empowerment as a multi-level and an interactive conceptual framework by showing that wellbeing experienced at an individual level can be harnessed to achieve improvements at a collective level (Zimmerman 2000).

Readers should, however, note some methodological limitations when considering our results. First, the cross-sectional design of our study does not allow us to make causal inferences. Second, our analyses of decision-making agency are based on women's self-perception of autonomy. There is now growing evidence that men and women may report on autonomous decision-making on the same question differently. In this study, we cannot distinguish between sanitation matters where women influenced decisions that were agreeable to other members (e.g., male head of household or community leader) and those where there were divergent opinions but women had veto power. Despite these limitations, we make a strong case for rigorous testing of the effect that health-related sanitation burden may have on women's agency. Researchers can build on our work and use the ARISE scales in longitudinal studies to arrive at more robust conclusions based on causal relationships.

5.2 | Policy Recommendations

The disproportionate health-related burden of precarious sanitation conditions borne by women in their everyday lives merits its consideration by policymakers for two main reasons. First, as evidence on bivariate associations in Table 3 shows, women that reported using shared sanitation locations were more likely to perceive and/or experience greater risk of physical harm and shame, embarrassment, and violence in accessing and using unsafe, unreliable, or unclean facilities. Second, women's lower participation in community-level decision-making and collective action on sanitation issues, even when they likely bear a low health burden of sanitation (see Table 4), indicates that their needs and experiences may not be reflected in sanitation policymaking and the resulting policy outcome (i.e., type and quality of service delivered). Therefore, progress on achieving the 2030 Agenda for SDG 6 would require policymakers to be more intentional in recognizing, understanding, and incorporating gender specificities and scrutiny in defining policy agendas and designing the delivery of a basic needs service like sanitation.

This study's findings summarized in Tables 3 and 4 show that women's health-related sanitation burden matters in the exercise of agency, particularly their voice and influence in household decisions on sanitation matters. Based on this evidence of association, we are able to propose *two* major recommendations for sanitation policy that may play a role in improving women's physical and mental health related to sanitation in an effort to advance their capacities for agency.

First, sanitation agencies should formulate new rules, or amend existing ones, to institutionalize household-level sanitation as the default policy in low-income communities. Our findings on bivariate associations in Table 3 show that ownership of household toilets is associated with a higher health score, or a lower health-related sanitation burden among women (see also, Heijnen et al. 2014, 2015). Our recommendation is informed by substantial evidence from other studies which supports that ownership of functional household latrines is significantly associated with higher mental wellbeing in Kenya (Winter et al. 2019), India (Caruso et al. 2018), and Mozambique (Shiras et al. 2018). And yet, despite growing evidence of the inadequacy and unsustainability of shared toilets in achieving safe sanitation especially for women (Corburn and Karanja 2016; Hubbard et al. 2020; Nyambe et al. 2020; Sahoo et al. 2015), provision of community-level toilet blocks continues to be the default policy outcome in informal settlements in much of the global South (Contreras et al. 2022; Okolimong et al. 2020). However, we want to note two key considerations related to this policy recommendation. First, ownership of household latrines may also increase women's workload because of the time spent on cleaning household toilets. Second, having a functional latrine may not be sufficient to minimize the symptoms of anxiety, depression, or depression associated with sanitation (Caruso et al. 2018). This is because time constraints may still force women to use public facilities or defecate in the open to avoid making long or regular trips to fetch water for managing their sanitation at home.

Our policy recommendation for building household toilets, however, should not be construed as a recommendation for disinvestments in public sanitation facilities. As our bivariate results in Table 3 demonstrate, women engaged in paid work outside their homes report the highest health-related sanitation burden among their cohort. For low- and middle-income countries like India where 80% of female workers in urban areas are employed in informal work, access to affordable, convenient, and clean public facilities at bus stops and other transit hubs, and at centers of economic activities, such as marketplaces and construction sites, can help reduce the burden of physical illness and mental stress of limiting trips to the toilet in order to avoid pausing or even stopping work (Chakraborty 2021; Sommer et al. 2016; see Carr 2019 for economic costs borne by working women due to inadequate public sanitation in some African cities).

Second, gender quotas for increasing women's representation in sanitation bureaucracies can ensure *mandatory* inclusion of their voices and experiences in setting the policy agenda and shaping the policy formulation and implementation processes. Our bivariate results in Table 3 show that women who may be more motivated to take action and so obtain leadership positions in community-level sanitation groups still experience significantly higher health-related burden compared to non-leaders. This seems to suggest that unless community-based organizations are given the authority and resources from the government to design and implement their own needs-based sanitation, or to hold poorly performing service providers to account, symbolic representation of women on such groups that execute a pre-determined sanitation agenda via pre-determined rules may be insufficient to deliver improvements in sanitation-specific health outcomes. One way in which women's health needs and their sanitation experiences can be formally integrated into the policymaking process is for governments to institutionalize affirmative action in the recruitment policies of sanitation bureaucracies. All countries in our sample, except Zambia, have taken the first step towards remedying unequal gender relations by legislating quotas for women in elected office (United Nations 2022). However, these reforms have not been replicated for sanitation bureaucracies that remain male-dominated. There is now growing evidence that having a critical mass of women in positions of power can facilitate an evaluation of male bias in policymaking norms (Lim 2006), investments in public goods and services that directly address the needs of women, and a transformation of discriminatory gender norms at the grassroots level (Chattopadhyay and Duflo 2004). We would even argue that some semblance of gender parity in bureaucratic representation could spur grassroots participation by women by signaling that their voices matter and by building trust that these voices will be heard, understood, and acted upon.

6 | Conclusion

To our knowledge, this is the first study to systematically test the association between health-related sanitation burden and women's agency. Our findings facilitate a critical dialogue between public health and empowerment literatures in development research and show that women's physical and mental health status can influence their agency outcomes. Our study revealed heterogenous effects across household-level and

community-level domains. Women who bear a lower burden of sanitation in terms of perceived or actual experiences with harm to physical and mental wellbeing due to sanitation conditions are more likely to engage in household-level decision-making on sanitation matters. However, a lower health-related sanitation burden is associated with lower sanitation-specific freedom of movement, community-level decision-making agency, and collective action. Our results advance empowerment theory by showing that women's improved sanitation-related health status can play an important role in the "process" by which they may gain the "power to" make household-level decisions about their wellbeing, and at the same time may be unable to gain "power with" others when countervailing socio-cognitive considerations seemingly limit their agency to act collectively. We also find that women engaged in paid work and holding leadership positions in community-based sanitation groups can experience higher health burden of sanitation. These results matter for policy engagement toward achieving the 2030 SDG Agenda of "adequate and equitable sanitation for women" (Target 6.2) under Goal 6 and gender equality under Goal 5 in so far as investments in household-level and public sanitation facilities as well as substantive representation of women in formal policymaking may help reduce their health-related sanitation burden. This may, in turn, improve their agency at least with respect to household decision-making. Our overall findings are consistent with existing research on women's economic empowerment which shows that access to financial assets and social networks, and a strong sense of self-efficacy can also be potential mechanisms to enhance women's agency within the household and in the community. Future research can integrate our comprehensive and validated empowerment scales into longitudinal designs to investigate causal determinants of women's agency that our cross-sectional study could not achieve.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] Indices are different from Scales. Indices measure observable constructs or actual experiences, whereas scales measure latent (unobserved) constructs.

[2] The empirical justification for computing an equal-weighted mean score for the scales, instead of weighting by factor loadings, is described elsewhere (Sinharoy et al. 2023).

[3] These estimates are unweighted because sampling weights were missing in 3 out of 8 cities (see Patel et al. 2014 for weighting formula). The reason being that in 3 cities, the sample either comprised only slum communities (Warangal and Narsapur, India) or only formal/non-slum communities (Dakar, Senegal). When we adjusted our estimates by using sampling weights for only five cities, the effective sample size dropped by almost 50% ($N = 2684$). Therefore, we decided against weighting our models.

References

Agarwal, B. 2000. "Conceptualising Environmental Collective Action: Why Gender Matters." *Cambridge Journal of Economics* 24, no. 3: 283–310. https://doi.org/10.1093/cje/24.3.283.

Ahmed, S., Q. Li, L. Liu, and A. O. Tsui. 2012. "Maternal Deaths Averted by Contraceptive Use: An Analysis of 172 Countries." *Lancet* 380, no. 9837: 111–125. https://doi.org/10.1016/S0140-6736(12)60478-4.

Akter, S., and C. Pratap. 2022. "Impact of Clean Cooking Fuel Adoption on Women's Welfare in India: The Mediating Role of Women's Autonomy." *Sustainability Science* 17, no. 1: 243–257. https://doi.org/10.1007/s11625-021-01069-9.

Alkire, S., R. Meinzen-Dick, A. Peterman, A. Quisumbing, G. Seymour, and A. Vaz. 2013. "The Women's Empowerment in Agriculture Index." *World Development* 52: 71–91. https://doi.org/10.1016/j.worlddev.2013.06.007.

Amporfu, E., and K. A. Grépin. 2019. "Measuring and Explaining Changing Patterns of Inequality in Institutional Deliveries Between Urban and Rural Women in Ghana: A Decomposition Analysis." *International Journal for Equity in Health* 18, no. 1: 123. https://doi.org/10.1186/s12939-019-1025-z.

Anderson, S., and M. Eswaran. 2009. "What Determines Female Autonomy? Evidence From Bangladesh." *Journal of Development Economics* 90, no. 2: 179–191. https://doi.org/10.1016/j.jdeveco.2008.10.004.

Bapolisi, W. A., J. Makelele, G. Ferrari, et al. 2024. "Engaging Men in Women's Empowerment: Impact of a Complex Gender Transformative Intervention on Household Socio-Economic and Health Outcomes in the Eastern Democratic Republic of the Congo Using a Longitudinal Survey." *BMC Public Health* 24, no. 1: 443. https://doi.org/10.1186/s12889-024-17717-5.

Baron, E. C., C. Hanlon, S. Mall, et al. 2016. "Maternal Mental Health in Primary Care in Five Low- and Middle-Income Countries: A Situational Analysis." *BMC Health Services Research* 16, no. 1: 53. https://doi.org/10.1186/s12913-016-1291-z.

Belhaj, F., P. N. Um, and M. Alam. 2023. "World Bank Public Transport is Key to Strengthening Women's Economic Participation in MENA." https://blogs.worldbank.org/en/arabvoices/public-transport-key-strengthening-womens-economic-participation-mena.

Bhalotra, S., and I. Clots-Figueras. 2014. "Health and the Political Agency of Women." *American Economic Journal: Economic Policy* 6, no. 2: 164–197.

Bogale, B., M. Wondafrash, T. Tilahun, and E. Girma. 2011. "Married Women's Decision Making Power on Modern Contraceptive Use in Urban and Rural Southern Ethiopia." *BMC Public Health* 11, no. 1: 342. https://doi.org/10.1186/1471-2458-11-342.

Bolin, A. 2020. *Women's Empowerment Through Collective Action: How Can Forest and Farm Producer Organisations Can Make a Difference*, 126. FAO. https://doi.org/10.4060/ca8713en.

Bonilla, J., R. C. Zarzur, S. Handa, et al. 2017. "Cash for Women's Empowerment? A Mixed-Methods Evaluation of the Government of

Zambia's Child Grant Program." *World Development* 95: 55–72. https://doi.org/10.1016/j.worlddev.2017.02.017.

Buller, A. M., M. Hidrobo, A. Peterman, and L. Heise. 2016. "The Way to a Man's Heart Is Through His Stomach?: A Mixed Methods Study on Causal Mechanisms Through Which Cash and In-Kind Food Transfers Decreased Intimate Partner Violence." *BMC Public Health* 16: 488. https://doi.org/10.1186/s12889-016-3129-3.

Burchi, F., and S. Vicari. 2014. "To be or Not to be a Member of a Primary Co-Operative in Brazil: Any Difference in Household Decision-Making and Gender Equality?" *Oxford Development Studies* 42, no. 3: 343–364. https://doi.org/10.1080/13600818.2014.905523.

Bussolo, M., J. A. Ezebuihe, A. M. Muñoz Boudet, S. Poupakis, T. Rahman, and N. Sarma. 2024. "Social Norms and Gender Disparities With a Focus on Female Labor Force Participation in South Asia." *World Bank Research Observer* 39, no. 1: 124–158. https://doi.org/10.1093/wbro/lkad010.

Carr, C. 2019. "For Street Vendors, Finding Water and Toilets Isn't Just a Nuisance, It's Cutting Into Earnings." Women in Informal Employment: Globalizing and Organizing. https://www.wiego.org/blog/street-vendors-finding-water-and-toilets-isnt-just-nuisance-its-cutting-earnings#:~:text=cutting%20into%20earnings-,For%20street%20vendors%2C%20finding%20water%20and%20toilets%20isn't%20just,nuisance%2C%20it's%20cutting%20into%20earnings&text=The%20daily%20grind%20of%20street,take%2Dhome%20pay%20to%20survive.

Caruso, B. A., A. M. Ballard, J. Sobolik, et al. 2024. "Systematic Re-Review of WASH Trials to Assess Women's Engagement in Intervention Delivery and Research Activities." *Nature Water* 2, no. 9: 827–836. https://doi.org/10.1038/s44221-024-00299-2.

Caruso, B. A., T. F. Clasen, C. Hadley, et al. 2017. "Understanding and Defining Sanitation Insecurity: Women's Gendered Experiences of Urination, Defecation and Menstruation in Rural Odisha, India." *BMJ Global Health* 2, no. 4: e000414. https://doi.org/10.1136/bmjgh-2017-000414.

Caruso, B. A., A. Conrad, M. Patrick, et al. 2022. "Water, Sanitation, and Women's Empowerment: A Systematic Review and Qualitative Metasynthesis." *PLOS Water* 1, no. 6: e0000026. https://doi.org/10.1371/journal.pwat.0000026.

Caruso, B. A., A. Conrad, A. Salinger, M. Patrick, A. Youm, and S. Sinharoy. 2021. "WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene. A Conceptual Framework to Inform National and Global Monitoring of Gender Equality in WASH."

Caruso, B. A., H. L. F. Cooper, R. Haardörfer, et al. 2018. "The Association Between Women's Sanitation Experiences and Mental Health: A Cross-Sectional Study in Rural, Odisha India." *SSM—Population Health* 5: 257–266. https://doi.org/10.1016/j.ssmph.2018.06.005.

Chakraborty, S. 2021. "Women in the Indian Informal Economy." https://www.indiaspend.com/uploads/2021/03/26/file_upload-446784.pdf. ISST, IWWAGE, LEAD at Krea University.

Chang, W., L. Díaz-Martin, A. Gopalan, E. Guarnieri, S. Jayachandran, and C. Walsh. 2020. "What Works to Enhance Women's Agency: Cross-Cutting Lessons From Experimental and Quasi-Experimental Studies." Abdul Lateef Jameel Poverty Action Lab, MIT. https://www.povertyactionlab.org/sites/default/files/research-paper/gender_womens-agency-review_2020-march-05.pdf.

Chattopadhyay, R., and E. Duflo. 2004. "Women as Policy Makers: Evidence From a Randomized Policy Experiment in India." *Econometrica* 72, no. 5: 1409–1443.

Clasen, T., S. Boisson, P. Routray, et al. 2012. "The Effect of Improved Rural Sanitation on Diarrhoea and Helminth Infection: Design of a Cluster-Randomized Trial in Orissa, India." *Emerging Themes in Epidemiology* 9, no. 1. https://doi.org/10.1186/1742-7622-9-7.

Contreras, J. D., M. Islam, A. Mertens, et al. 2022. "Influence of Community-Level Sanitation Coverage and Population Density on Environmental Fecal Contamination and Child Health in a Longitudinal Cohort in Rural Bangladesh." *International Journal of Hygiene and Environmental Health* 245: 114031. https://doi.org/10.1016/j.ijheh.2022.114031.

Cooper-Vince, C. E., H. Arachy, B. Kakuhikire, D. Vořechovská´, R. C. Mushavi, and C. Baguma. 2018. "Water Insecurity and Gendered Risk for Depression in Rural Uganda: A Hotspot Analysis." *BMC Public Health* 18, no. 1: 1143. https://doi.org/10.1186/s12889-018-6043-z.

Corburn, J., and I. Karanja. 2016. "Informal Settlements and a Relational View of Health in Nairobi, Kenya: Sanitation, Gender and Dignity." *Health Promotion International* 31, no. 2: 258–269. https://doi.org/10.1093/heapro/dau100.

Correia, S. 2014. "Stata Module to Perform Linear or Instrumental-Variable Regression Absorbing Any Number of High-Dimensional Fixed Effects." https://EconPapers.repec.org/RePEc:boc:bocode:s457874.

Correia, S. 2016. "A Feasible Estimator for Linear Models With Multi-Way Fixed Effects." https://scorreia.com/research/hdfe.pdf.

Deshpande, A., and N. Kabeer. 2024. "Norms That Matter: Exploring the Distribution of Women's Work Between Income Generation, Expenditure-Saving and Unpaid Domestic Responsibilities in India." *World Development* 174: 106435. https://doi.org/10.1016/j.worlddev.2023.106435.

Diep, L., F. P. Martins, L. C. Campos, et al. 2021. "Linkages Between Sanitation and the Sustainable Development Goals: A Case Study of Brazil." *Sustainable Development* 29, no. 2: 339–352. https://doi.org/10.1002/sd.2149.

Donald, A., G. Koolwal, J. Annan, K. Falb, and M. Goldstein. 2020. "Measuring Women's Agency." *Feminist Economics* 26, no. 3: 200–226. https://doi.org/10.1080/13545701.2019.1683757.

Doss, C. R., and R. Meinzen-Dick. 2015. "Collective Action Within the Household: Insights From Natural Resource Management." *World Development* 74: 171–183. https://doi.org/10.1016/j.worlddev.2015.05.001.

Duh-Leong, C., C. F. Canfield, A. E. Fuller, R. S. Gross, and N. E. Reichman. 2024. "Early Childcare Precarity and Subsequent Maternal Health." *Women's Health Issues* 34, no. 2: 115–124. https://doi.org/10.1016/j.whi.2023.10.002.

Dupuis, S., M. Hennink, A. S. Wendt, et al. 2022. "Women's Empowerment Through Homestead Food Production in Rural Bangladesh." *BMC Public Health* 22, no. 1: 134. https://doi.org/10.1186/s12889-022-12524-2.

Eissler, S., J. Heckert, E. Myers, G. Seymour, S. Sinharoy, and K. Yount. 2022. "Measuring Women's Empowerment: Gender and Time-Use Agency in Benin, Malawi and Nigeria." *Development and Change* 53, no. 5: 1010–1034. https://doi.org/10.1111/dech.12725.

Evans, A., and D. Nambiar. 2016. "Collective Action and Women's Agency: A Background Paper." Women's Voice, Agency, & Participation Research Series, World Bank. https://documents1.worldbank.org/curated/en/511631468154151855/pdf/927580NWP0Wome00Box385358B00PUBLIC0.pdf.

Furuta, M., and S. Salway. 2006. "Women's Position Within the Household as a Determinant of Maternal Health Care Use in Nepal." *International Family Planning Perspectives* 32, no. 01: 017–027. https://doi.org/10.1363/3201706.

Dominguez Gonzalez, K., A. L. Machado, B. Bianchi Alves, et al. 2020. *Why Does She Move? A Study of Women's Mobility in Latin American Cities*. World Bank. https://documents1.worldbank.org/curated/en/276931583534671806/pdf/Why-Does-She-Move-A-Study-of-Womens-Mobility-in-Latin-American-Cities.pdf.

Gopalakrishnan, L., A. E. Ayadi, and N. Diamond-Smith. 2024. "The Role of Community-Level Men's and Women's Inequitable Gender

Norms on Women's Empowerment in India: A Multilevel Analysis Using India's National Family Health Survey–5." *PLoS One* 19, no. 12: e0312465. https://doi.org/10.1371/journal.pone.0312465.

Guaita-Fernández, P., J. M. Martín Martín, S. Ribeiro Navarrete, and R. Puertas. 2024. "Analysis of Gender-Based Violence in the Context of the Sustainable Development Goals." *Sustainable Development* 32, no. 5: 4946–4958. https://doi.org/10.1002/sd.2940.

Guittar, S. G., L. Grauerholz, E. N. Kidder, S. D. Daye, and M. McLaughlin. 2022. "Beyond the Pink Tax: Gender-Based Pricing and Differentiation of Personal Care Products." *Gender Issues* 39: 1–23. https://doi.org/10.1007/s12147-021-09280-9.

Hanmer, L., and J. Klugman. 2016. "Exploring Women's Agency and Empowerment in Developing Countries: Where Do We Stand?" *Feminist Economics* 22, no. 1: 237–263. https://doi.org/10.1080/13545701.2015.1091087.

Heath, R. 2014. "Women's Access to Labor Market Opportunities, Control of Household Resources, and Domestic Violence: Evidence From Bangladesh." *World Development* 57: 32–46. https://doi.org/10.1016/j.worlddev.2013.10.028.

Heath, R., and A. M. Mobarak. 2015. "Manufacturing Growth and the Lives of Bangladeshi Women." *Journal of Development Economics* 115: 1–15. https://doi.org/10.1016/j.jdeveco.2015.01.006.

Heijnen, M., O. Cumming, R. Peletz, et al. 2014. "Shared Sanitation Versus Individual Household Latrines: A Systematic Review of Health Outcomes." *PLoS One* 9, no. 4: e93300. https://doi.org/10.1371/journal.pone.0093300.

Heijnen, M., P. Routray, B. Torondel, and T. Clasen. 2015. "Neighbour-Shared Versus Communal Latrines in Urban Slums: A Cross-Sectional Study in Orissa, India Exploring Household Demographics, Accessibility, Privacy, Use and Cleanliness." *Transactions of the Royal Society of Tropical Medicine and Hygiene* 109, no. 11: 690–699. https://doi.org/10.1093/trstmh/trv082.

Hennegan, J., F. M. OlaOlorun, S. Oumarou, et al. 2021. "School and Work Absenteeism due to Menstruation in Three West African Countries: Findings From PMA2020 Surveys." *Sexual and Reproductive Health Matters* 29, no. 1: 1. https://doi.org/10.1080/26410397.2021.1915940.

Hubbard, S. C., M. I. Meltzer, S. Kim, et al. 2020. "Household Illness and Associated Water and Sanitation Factors in Peri-Urban Lusaka, Zambia, 2016–2017." *Npj Clean Water* 3, no. 1: 26. https://doi.org/10.1038/s41545-020-0076-4.

Hulland, K. R. S., R. P. Chase, B. A. Caruso, et al. 2015. "Sanitation, Stress, and Life Stage: A Systematic Data Collection Study Among Women in Odisha, India." *PLoS One* 10, no. 11: e0141883. https://doi.org/10.1371/journal.pone.0141883.

James-Hawkins, L., C. Peters, K. VanderEnde, L. Bardin, and K. M. Yount. 2018. "Women's Agency and Its Relationship to Current Contraceptive Use in Lower- and Middle-Income Countries: A Systematic Review of the Literature." *Global Public Health* 13, no. 7: 843–858. https://doi.org/10.1080/17441692.2016.1239270.

Joshi, S., and T. P. Schultz. 2013. "Family Planning and Women's and Children's Health: Long-Term Consequences of an Outreach Program in Matlab, Bangladesh." *Demography* 50, no. 1: 149–180. https://doi.org/10.1007/s13524-012-0172-2.

Kabeer, N. 1999. "Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment." *Development and Change* 30, no. 3: 435–464. https://doi.org/10.1111/1467-7660.00125.

Kabeer, N. 2001. "Conflicts Over Credit: Re-Evaluating the Empowerment Potential of Loans to Women in Rural Bangladesh." *World Development* 29, no. 1: 63–84. https://doi.org/10.1016/S0305-750X(00)00081-4.

Kellard, N. M., Y. Makhlouf, A. Sarkisyan, and D. V. Vinogradov. 2024. "Women's Empowerment and Child Mortality." *World Development* 183: 106712. https://doi.org/10.1016/j.worlddev.2024.106712.

Kimutai, J. J., C. Lund, W. N. Moturi, S. Shewangizaw, M. Feyasa, and C. Hanlon. 2023. "Evidence on the Links Between Water Insecurity, Inadequate Sanitation and Mental Health: A Systematic Review and Meta-Analysis." *PLoS One* 18, no. 5: e0286146. https://doi.org/10.1371/journal.pone.0286146.

Klein, E. 2016. "Women's Agency and the Psychological Domain: Evidence From the Urban Fringe of Bamako, Mali." *Feminist Economics* 22, no. 1: 106–129. https://doi.org/10.1080/13545701.2015.1084867.

Kulkarni, S., K. O'Reilly, and S. Bhat. 2017. "No Relief: Lived Experiences of Inadequate Sanitation Access of Poor Urban Women in India." *Gender and Development* 25, no. 2: 167–183. https://doi.org/10.1080/13552074.2017.1331531.

Kwiringira, J., P. Atekyereza, C. Niwagaba, and I. Günther. 2014. "Gender Variations in Access, Choice to Use and Cleaning of Shared Latrines; Experiences From Kampala Slums, Uganda." *BMC Public Health* 14, no. 1: 1180. https://doi.org/10.1186/1471-2458-14-1180.

Lasater, M. E., M. Beebe, A. Gresh, K. Blomberg, and N. Warren. 2017. "Addressing the Unmet Need for Maternal Mental Health Services in Low- and Middle-Income Countries: Integrating Mental Health Into Maternal Health Care." *Journal of Midwifery and Women's Health* 62, no. 6: 657–660. https://doi.org/10.1111/jmwh.12679.

Lee, Y. J., Z. Husain, and M. Dutta. 2024. "Does Improved Cooking Fuel Empower Women? Evidence From India." *Sustainable Development* 32, no. 1: 574–587. https://doi.org/10.1002/sd.2695.

Leight, J., A. Pedehombga, R. Ganaba, and A. Gelli. 2022. "Women's Empowerment, Maternal Depression, and Stress: Evidence From Rural Burkina Faso." *SSM—Mental Health* 2: 100–160. https://doi.org/10.1016/j.ssmmh.2022.100160.

Lim, H. 2006. "Representative Bureaucracy: Rethinking Substantive Effects and Active Representation." *Public Administration Review* 66, no. 2: 193–204. https://doi.org/10.1111/j.1540-6210.2006.00572.x.

Mal, P., and N. Saikia. 2024. "Disparity by Caste and Tribe: Understanding Women's Empowerment and Health Outcomes in India." *Social Science and Medicine* 354: 117074. https://doi.org/10.1016/j.socscimed.2024.117074.

Marcus, R. 2021. "Gender, Social Norms, and Women's Economic Empowerment." In *Women's Economic Empowerment*. Routledge.

Mudege, N. N., T. Nyekanyeka, E. Kapalasa, T. Chevo, and P. Demo. 2015. "Understanding Collective Action and Women's Empowerment in Potato Farmer Groups in Ntcheu and Dedza in Malawi." *Journal of Rural Studies* 42: 91–101. https://doi.org/10.1016/j.jrurstud.2015.09.002.

Nasrin, S., and J. Bunker. 2021. "Analyzing Significant Variables for Choosing Different Modes by Female Travelers." *Transport Policy* 114: 12–329. https://doi.org/10.1016/j.tranpol.2021.10.017.

Nyambe, S., L. Agestika, and T. Yamauchi. 2020. "The Improved and the Unimproved: Factors Influencing Sanitation and Diarrhoea in a Peri-Urban Settlement of Lusaka, Zambia." *PLoS One* 15, no. 5: 232–263. https://doi.org/10.1371/journal.pone.0232763.

Okolimong, C., R. Ndejjo, R. K. Mugambe, and A. A. Halage. 2020. "Effect of a Community-Led Total Sanitation Intervention on Sanitation and Hygiene in Pallisa District, Uganda." *American Journal of Tropical Medicine and Hygiene* 103, no. 4: 1735–1741. https://doi.org/10.4269/ajtmh.19-0911.

Oxfam. 2020. "Achieving Sustainable Development Goals 5 and 6. The Case for Gender-Transformative Water Programmes." https://doi.org/10.21201/2020.5884.

Pandolfelli, L., R. Meinzen-Dick, and S. Dohrn. 2007. "Gender and Collective Action: A Conceptual Framework for Analysis. CAPRi Working Papers 64, International Food Policy Research Institute (IFPRI)." https://doi.org/10.2499/CAPRiWP64.

Patel, A., N. Koizumi, and A. Crooks. 2014. "Measuring Slum Severity in Mumbai and Kolkata: A Household-Based Approach." *Habitat*

International 41: 300–306. https://doi.org/10.1016/j.habitatint.2013.09.002.

Prasad, S., S. Acharya, and S. Basu. 2015. "Leadership and Participation: Role of Gender." In *Gender Issues in Water and Sanitation Programmes: Lessons From India*, 190–208. SAGE Publications.

Routray, P., W.-P. Schmidt, S. Boisson, T. Clasen, and M. W. Jenkins. 2015. "Socio-Cultural and Behavioural Factors Constraining Latrine Adoption in Rural Coastal Odisha: An Exploratory Qualitative Study." *BMC Public Health* 15, no. 1: 880. https://doi.org/10.1186/s12889-015-2206-3.

Routray, P., B. Torondel, T. Clasen, and W.-P. Schmidt. 2017. "Women's Role in Sanitation Decision Making in Rural Coastal Odisha, India." *PLoS One* 12, no. 5: e0178042. https://doi.org/10.1371/journal.pone.0178042.

Sachs, J. D., G. Lafortune, and G. Fuller. 2024. *The SDGs and the UN Summit of the Future Sustainable Development Report 2024*. Dublin University Press. https://www.tara.tcd.ie/handle/2262/108572.

Sahoo, K. C., K. R. S. Hulland, B. A. Caruso, et al. 2015. "Sanitation-Related Psychosocial Stress: A Grounded Theory Study of Women Across the Life-Course in Odisha, India." *Social Science & Medicine* 139: 80–89. https://doi.org/10.1016/j.socscimed.2015.06.031.

Sclar, G. D., G. Penakalapati, B. A. Caruso, et al. 2018. "Exploring the Relationship Between Sanitation and Mental and Social Well-Being: A Systematic Review and Qualitative Synthesis." *Social Science and Medicine* 217: 121–134. https://doi.org/10.1016/j.socscimed.2018.09.016.

Senarath, U., and N. S. Gunawardena. 2009. "Women's Autonomy in Decision Making for Health Care in South Asia." *Asia-Pacific Journal of Public Health* 21, no. 2: 137–143. https://doi.org/10.1177/1010539509331590.

Seymour, G., and A. Peterman. 2018. "Context and Measurement: An Analysis of the Relationship Between Intrahousehold Decision Making and Autonomy'." *World Development* 111: 97–112. https://doi.org/10.1016/j.worlddev.2018.06.027.

Shammama, O., and S. Brazys. 2024. "Representation Matters? Female Legislators and Women's Health in Bangladesh." *World Development* 182: 106708. https://doi.org/10.1016/j.worlddev.2024.106708.

Shankar, A., S. Sundar, and G. Smith. 2019. "Agency-Based Empowerment Interventions: Efforts to Enhance Decision-Making and Action in Health and Development." *Journal of Behavioral Health Services and Research* 46, no. 1: 164–176. https://doi.org/10.1007/s11414-018-9592-0.

Shiras, T., O. Cumming, J. Brown, B. Muneme, R. Nala, and R. Dreibelbis. 2018. "Shared Latrines in Maputo, Mozambique: Exploring Emotional Well-Being and Psychosocial Stress." *BMC International Health and Human Rights* 18, no. 1: 30. https://doi.org/10.1186/s12914-018-0169-z.

Sinharoy, S. S., A. Conrad, M. Patrick, S. McManus, and B. A. Caruso. 2022. "Protocol for Development and Validation of Instruments to Measure Women's Empowerment in Urban Sanitation Across Countries in South Asia and Sub-Saharan Africa: The Agency, Resources and Institutional Structures for Sanitation-Related Empowerment (ARISE) Scales." *BMJ Open* 12, no. 2: e053104. https://doi.org/10.1136/bmjopen-2021-053104.

Sinharoy, S. S., S. McManus, A. Conrad, M. Patrick, and B. A. Caruso. 2023. "The Agency, Resources, and Institutional Structures for Sanitation-Related Empowerment (ARISE) Scales: Development and Validation of Measures of Women's Empowerment in Urban Sanitation for Low- and Middle-Income Countries." *World Development* 164: 106–183. https://doi.org/10.1016/j.worlddev.2023.106183.

Sinharoy, S. S., D. Xia, M. P. Patrick, et al. 2024. "The Agency, Resources, and Institutional Structures for Sanitation-Related Empowerment (ARISE) Scales: Psychometric Evaluation Across Asia and Africa." https://doi.org/10.21203/rs.3.rs-4571408/v1.

Sommer, M., S. Chandraratna, S. Cavill, T. Mahon, and P. Phillips-Howard. 2016. "Managing Menstruation in the Workplace: An Overlooked Issue in Low- and Middle-Income Countries." *International Journal for Equity in Health* 15, no. 1: 86. https://doi.org/10.1186/s12939-016-0379-8.

Song, J., and C.-H. Jang. 2023. "Unpacking the Sustainable Development Goals (SDGs) Interlinkages: A Semantic Network Analysis of the SDGs Targets." *Sustainable Development* 31, no. 4: 2784–2796. https://doi.org/10.1002/sd.2547.

Starr, M., R. Harding, R. Ataide, et al. 2024. "Epidemiology of Menstrual-Related Absenteeism in 44 Low and Middle-Income Countries." https://doi.org/10.1101/2024.05.07.24307016.

United Nations. 2022. "Women's Representation in the Parliaments of Least Developed Countries: From Istanbul (2011) to Doha (2022)." https://www.un.org/ldc5/sites/www.un.org.ldc5/files/women_in_ldc_parliaments_e.pdf.

Upadhyay, U. D., J. D. Gipson, M. Withers, et al. 2014. "Women's Empowerment and Fertility: A Review of the Literature." *Social Science and Medicine* 115: 111–120. https://doi.org/10.1016/j.socscimed.2014.06.014.

Van Eerdewijk, A., F. Wong, C. Vaast, J. Newton, M. Tyszler, and A. Pennington. 2017. "A Conceptual Model of Women and Girls' Empowerment." Royal Tropical Institute, Amsterdam (KIT). https://www.kit.nl/institute/publication/white-paper-conceptual-model-of-women-and-girls-empowerment/.

Vaz, A., P. Pratley, and S. Alkire. 2016. "Measuring Women's Autonomy in Chad Using the Relative Autonomy Index." *Feminist Economics* 22, no. 1: 264–294. https://doi.org/10.1080/13545701.2015.1108991.

von Medeazza, G., M. Jain, A. Tiwari, J. P. Shukla, and N. Kumar. 2015. "Women-Led Total Sanitation: Saving Lives and Dignity." In *Gender Issues in Water and Sanitation Programmes: Lessons From India*, edited by A. A. Cronin, P. K. Mehta, and A. Prakash. SAGE Publications Pvt. Ltd.

Wachs, T. D., M. M. Black, and P. L. Engle. 2009. "Maternal Depression: A Global Threat to Children's Health, Development, and Behavior and to Human Rights." *Child Development Perspectives* 3, no. 1: 51–59. https://doi.org/10.1111/j.1750-8606.2008.00077.x.

WHO. 1946. "Constitution of the World Health Organization." https://apps.who.int/gb/bd/PDF/bd47/EN/constitution-en.pdf.

WHO/UNICEF Joint Monitoring Programme. 2023. "Progress on Household Drinking Water, Sanitation and Hygiene 2000–2022: Special Focus on Gender." https://www.who.int/publications/m/item/progress-on-household-drinking-water--sanitation-and-hygiene-2000-2022---special-focus-on-gender.

Winter, S. C., R. Dreibelbis, M. N. Dzombo, and F. Barchi. 2019. "A Mixed-Methods Study of Women's Sanitation Utilization in Informal Settlements in Kenya." *PLoS One* 14: e0214114. https://doi.org/10.1371/journal.pone.0214114.

Witter, S., V. Govender, T. K. S. Ravindran, and R. Yates. 2017. "Minding the Gaps: Health Financing, Universal Health Coverage and Gender." *Health Policy and Planning* 32: v4–v12. https://doi.org/10.1093/heapol/czx063.

Wolf, J., R. B. Johnston, A. Ambelu, et al. 2023. "Burden of Disease Attributable to Unsafe Drinking Water, Sanitation, and Hygiene in Domestic Settings: A Global Analysis for Selected Adverse Health Outcomes." *Lancet* 401, no. 10393: 2060–2071. https://doi.org/10.1016/S0140-6736(23)00458-0.

Yount, K. M., S. Dijkerman, S. Zureick-Brown, and K. E. VanderEnde. 2014. "Women's Empowerment and Generalized Anxiety in Minya, Egypt." *Social Science and Medicine* 106: 185–193. https://doi.org/10.1016/j.socscimed.2014.01.022.

Zimmerman, M. A. 2000. "Empowerment Theory: Psychological, Organizational, and Community Levels of Analysis." In *Handbook of Community Psychology*, edited by J. Rappaport and E. Seidman, 43–63. Kluwer Academic Publishers. https://doi.org/10.1007/978-1-4615-4193-6_2.

Appendix A

Sub-Domains of Sanitation-Related Empowerment Measured by the ARISE Scales, With Their Operational Definitions by Domain

Sub-domain	Sanitation-specific definition
Agency	
Decision-making	Women influence and make decisions about sanitation inside and outside the home.
Leadership	Women assume leadership positions, effectively participate, and support women's leadership in informal and formal sanitation initiatives and organizations.
Collective action	Women gain solidarity and take action collectively on sanitation-related issues.
Freedom of movement	Women have the autonomy to move freely to access sanitation facilities, collect water for sanitation-related needs, and/or attend forums on sanitation issues, and women have freedom of movement despite sanitation circumstances.
Resources	
Bodily integrity	Women's control over their bodies and ability to access and use their preferred sanitation location.
Health	Women's complete physical, mental, and social wellbeing as affected by sanitation options and conditions; not merely the absence of disease or infirmity.
Safety and security	Women's freedom from acts or threats of violence (physical or sexual), coercion, harassment, or force when accessing and using sanitation locations or engaging in sanitation-related decision-making processes in the public sphere.
Privacy	Women's ability to maintain desired levels of privacy when accessing and utilizing sanitation locations.
Critical consciousness	Women's ability to identify and question how inequalities in power operate in their lives in relation to sanitation access and decision-making processes and to assert and affirm their self-efficacy inside and outside of the household as it relates to sanitation.
Financial and productive assets	Women's control over economic resources and long-term stocks of value such as land, for the purposes of meeting individual and household sanitation needs.
Time	Women's control over their time and labor spent on sanitation-related tasks and activities.
Social capital	Women's relations and social networks that provide tangible and intangible values and support, including those that enable them to complete sanitation-related tasks and activities.
Knowledge and skills	Women's knowledge and skills related to sanitation (e.g., operation and maintenance of sanitation facilities) and their abilities to apply those knowledge and skills.
Institutional structures	
Norms	Collectively held expectations and beliefs of how women and men should behave and interact inside and outside the household, specifically with regard to (a) the division of labor; (b) decision-making; (c) leadership; (d) collective action; and (e) freedom of movement.
Relations	The interactions and relations—including conflicts, support, hostility, and communication—with key actors that shape women's sanitation-related experiences.

Appendix B

Dependent Variables: Sub-Domain of Agency Indices, Index Items, and Coded Response Options

1. *Household decision-making index*

Response options: Yes = 1, No = 0

I have independently made decisions about how my household cleans and maintains the sanitation environment/facility.

I have independently made decisions about small sanitation-related purchases, like soap, toilet paper, etc., for my household.

I have independently made decisions about household latrine/toilet repairs or enhancements, like new floor tiles, doors, locks, or lights.

I have independently made major decisions about household sanitation, such as construction or large repair projects

I have influenced decisions about how my household cleans and maintains the sanitation environment/facility

I have influenced decisions about latrine/toilet repairs or enhancements in my household, like new floor tiles, doors, locks, or lights.

I have influenced major decisions about sanitation in my household, such as construction or large repair projects

Members of my household have sought my input when making sanitation-related decisions.

Members of my household have listened to my opinions about sanitation issues.

I have spoken up about sanitation-related issues in my household.

I have been present when members of my household have discussed sanitation-related issues.

2. *Freedom of movement index**

Response options: Yes = 1, No = 0

In the past 30 days, have you chosen not to go for a social gathering like church, funeral, or wedding because you may not have access to a sanitation location?

In the past 30 days, have you chosen not to go for work or do business because you may not have access to a sanitation location?

In the past 30 days, have you chosen not to visit a friend or a relative because you may not have access to a sanitation location?

In the past 30 days, have you chosen not to travel outside of the city because you may not have access to a sanitation location?

In the past 30 days, have you chosen not to go somewhere outside of your neighborhood because you may not have access to a sanitation location?

In the past 30 days, have you chosen not to leave the house because you may not have access to a sanitation location?

* Denotes that all index items are reverse-coded.

3. *Community decision-making index*

Response options: Yes = 1, No = 0

I have made decisions about sanitation for my community.

I have influenced decisions about sanitation for my community. By influencing a decision, we mean that your voice and opinion are considered and affect the final decision that is taken.

Local leaders, NGOs, or government officials have sought my input when making sanitation-related decisions.

I have been listened to in a community meeting about sanitation issues.

I have spoken up in a community meeting about sanitation issues.

I have attended a community meeting about sanitation issues.

4. *Collective action index*

Response options: Yes = 1, No = 0

In the past year, have you gathered with members of your community to discuss sanitation-related problems and possible solutions?

In the past year, have you gathered with neighbors or others in your plot or compound to discuss sanitation-related problems and possible solutions?

In the past year, have you organized with members of your community to demand, construct, fund, or acquire land for latrines?

In the past year, have you organized with neighbors or others in your plot or compound to demand, construct, fund, or acquire land for latrines?

In the past year, have you joined with members of your community to make improvements to a sanitation location, such as toilets and latrines?

In the past year, have you joined with neighbors or others in your plot or compound to make improvements to a sanitation location, such as toilets and latrines?

In the past year, have you joined with members of your community to conduct trainings or awareness sessions related to sanitation?

In the past year, have you joined with members of your community to petition local leaders to make sanitation improvements?

In the past year, have you joined with members of your community to influence media to bring awareness and attention to sanitation problems in the community?

In the past year, have you joined with members of your community to participate in a protest/movement about sanitation issues?

In the past year, have you joined with members of your community to make sanitation locations more female friendly, such as installing rubbish bins for menstrual materials?

Appendix C

Independent Variable and Control Variables: Scales, Scale Items, and Coded Response Options

Independent variable: Health scale

Response options: Always = 1, Often = 2, Sometimes = 3, Never = 4

In the past 30 days, I used a sanitation location that I believed might make me ill.

In the past 30 days, I have gotten sick as a result of using my sanitation location.

In the past 30 days, I have gotten sick as a result of cleaning my sanitation location.

In the past 30 days, I became ill because I had to suppress the urge to urinate or defecate.

In the past 30 days, withholding water to avoid urination made me feel unwell.

In the past 30 days, withholding food to avoid defecation made me feel unwell.

In the past 30 days, I have feared being injured by animals or insects when accessing my sanitation location.

In the past 30 days, I have feared being injured because of the physical conditions—such as slippery conditions, rocks or thorns, uneven pathways, obstacles, sharp doors or floors, etc.—when accessing my sanitation location.

In the past 30 days, I have felt anxiety, stress, or tension when I needed to access a sanitation location.

In the past 30 days, I have experienced embarrassment or shame when accessing a sanitation location during the day

In the past 30 days, I have experienced embarrassment or shame when accessing a sanitation location at night

In the past 30 days, I have feared being harassed or injured by men, boys, or other people when accessing my sanitation location.

In the past 30 days, I have been too afraid to use a sanitation location because it is dark.

In the past 30 days, I have felt stress or frustration related to the sanitation conditions in my community.

In the past 30 days, I have felt stress or frustration related to the sanitation conditions in my household.

In the past 30 days, I fear for the safety of women or children going to sanitation locations.

Control variables

1. Self-efficacy scale

Response options: Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4

I feel I can change sanitation conditions in my community if I want to

I feel like I can influence sanitation behaviors of others in my community, such as encouraging proper latrine use and maintenance, proper disposal of sanitation napkins, etc.

I feel I can change sanitation conditions in my household or compound if I want to.

I feel like I can influence sanitation behaviors of members of my household.

If I had a problem related to sanitation, I could probably think of a solution.

If I had a problem related to sanitation, I believe I could solve it.

2. Time scale*

Response options: Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4

The sanitation-related needs and responsibilities of my household prevent me from completing other household work

The sanitation-related needs and responsibilities of my household require that I often have to wake up early than I want.

The sanitation-related needs and responsibilities of my household often make me miss out on other activities that I would like to do.

It often takes too much time to access and use my sanitation location.

I often have to rush when I am using my sanitation location.

I often have to wake up earlier than I want to access a sanitation location.

3. Financial and productive assets scale

Response Options: Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4

I have control over money that I could use to contribute to a community sanitation project.

I have control over money that I could use to pay for household latrine/toilet improvements or repairs.

I have control over money that I could use to pay for household latrine/toilet construction.

I could acquire money to build a household latrine/toilet by selling or renting something I own or by earning money through work.

I could acquire money to improve or repair a household latrine/toilet by selling or renting something I own or by earning money through work.

I could acquire money to build a household latrine/toilet by accessing credit or participating in a savings group.

I would need to ask permission before spending household money on small sanitation-related expenses, such as toilet paper, soap, or pay-per-use latrines*.

I depend on someone else to pay for small sanitation-related expenses, such as toilet paper, soap, or pay-per-use latrines*.

4. Norms scale

Response options: Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4

In this community, it is women more often than men who are expected to assume most responsibilities related to maintaining the cleanliness of the sanitation location the family uses*.

In this community, it is women more often than men who are expected to accompany or support elderly, sick, or disabled family members who cannot urinate or defecate on their own*.

In this community, it is women more often than men who are expected to accompany or support children in their household when they need to urinate or defecate*.

In this community, it is women more often than men who are expected to clean feces from their home or household compound from children or other family members*.

In this community, it is women more often than men who are expected to who are expected to wash clothes that become dirty as a result of sanitation conditions or accidents*.

In this community, it is women more often than men who are expected to clean their children after defecation if needed*.

Even if women were trained, it would be socially unacceptable for women to do construction, repairs, or upgrades for latrines*.

Technical work, like latrine construction, repairs, or upgrades, should be done by men, not women*.

Emptying latrine pits should be done by men, not women*.

At a sanitation-related meeting where both men and women are present, women should only speak when they are asked to do so*.

At a sanitation-related meeting where both men and women are present, women should only speak after all the men have shared their opinions*.

At a sanitation-related meeting where both men and women are present, women should not speak*.

It is appropriate for women to attend sanitation-related meetings where men are present.

In this community, it is considered appropriate for a woman to express her opinion about sanitation issues at a community meeting when men are present.

It is appropriate for women to discuss sanitation-related issues in front of men.

In this community, it is socially acceptable for women to have leadership roles in sanitation-focused committees or organizations.

In this community, it is acceptable for a woman to bring a complaint about a sanitation-problem to a local leader.

It would be socially acceptable for women to organize an initiative to improve sanitation conditions in the community.

If there was a community initiative to improve sanitation, it would be socially acceptable for women to participate.

In this community, it is acceptable for a woman to express a different opinion than her husband in a household discussion about sanitation issues.

In this community, it is acceptable for a woman to express a different opinion than her husband about sanitation issues in front of people outside the family.

5. Social capital scale

Response options: Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4

I have someone who I can talk to about problems related to my sanitation location.

I have someone who would help with chores, like cooking or providing childcare, so I could tend to my sanitation needs

I have someone who would help me with sanitation-related chores.

I have someone who could get small sanitation-related items if I asked them to, such as if I were too busy.

I know leaders in the community who I can talk to about problems related to my sanitation location.

I know other members of my community who I would feel comfortable asking to help me address a sanitation-related problem in the community.

I have connections to someone with the power to improve sanitation conditions for my household or community.

I know someone who can give me information about better sanitation practices.

* Denotes all scale items are reverse-coded.

Appendix D

Descriptive Statistics by City

	Trichy	Narsapur	Warangal	Saidpur	Meherpur	Dakar	Lusaka	Kampala
Health-related sanitation burden								
Health scale score (mean, SD)	3.84, 0.30	3.84, 0.34	3.72, 0.50	3.97, 0.13	3.85, 0.32	3.86, 0.30	3.65, 0.30	3.70, 0.32
Agency								
Decision-making (mean, SD)	2.86, 0.35	2.60, 0.40	2.50, 0.41	2.60, 0.40	2.72, 0.46	2.60, 0.35	3.13, 0.48	3.10, 0.45
Freedom of movement (mean, SD)	3.95, 0.77	4.30, 0.60	4.34, 0.61	4.40, 0.60	4.36, 0.62	4.20, 0.74	4.30, 0.60	4.51, 0.51
Collective action (mean, SD)	2.54, 0.53	2.43, 0.51	2.40, 0.55	2.30, 0.50	2.37, 0.61	2.80, 0.42	2.82, 0.60	2.90, 0.61
Employment status (percent)								
Engaged in paid work outside home	24.5	33.2	48.2	6.7	8.5	39.7	17.6	34.7
Engaged in paid work inside home	15.2	66.8	51.8	14.1	22.1	11.2	22.1	20.5
Engaged in paid work and outside home	0.7	0.0	0.0	0.5	1.1	2.1	1.7	2.4
Not engaged in paid work	59.6	0.0	0.0	78.6	68.3	47.0	58.5	42.3
Respondent age								
Mean	33.7	33.5	35.23	33.24	35.63	43.84	37.05	33.84
Standard deviation	8.4	8.6	8.7	9.21	10.20	16.0	15.36	12.75
Shared sanitation with non- household members (percent)								
No	76.5	95.8	92.6	91.4	83.1	64.0	29.5	22.6
Yes	23.5	4.2	7.4	8.5	17.0	36.0	70.4	77.3
Education completed (percent)								
Less than primary [pre-school/kindergarten]	3.6	16.3	9.2	11.3	12.1	5.3	6.9	11.3
Primary [up to grade 5]	16.0	30.5	20.0	18.0	16.2	40.1	33.8	26.1
Lower secondary [grade 6 to grade 10]	32.0	19.5	22.6	25.8	36.0	20.4	27.0	38.8
Upper secondary [grade 11 to grade 12]	18.0	13.4	26.8	34.3	25.3	17.7	27.1	8.8
Short-cycle tertiary [vocational training/diploma]	6.3	5.2	3.8	0.4	0.7	4.8	3.3	9.4
Graduate and above	24.2	15.0	17.7	10.0	8.5	11.6	1.9	5.3
Other (unclassified)	0.1	0.2	0.0	0.0	1.0	0.0	0.0	0.1
Religion (percent)								
Christian: Catholic	6.7	4.3	3.3	0.1	0.0	3.4	21.7	35.1
Christian: Protestant	1.5	10.8	5.8	1.5	0.0	0.7	77.3	47.9
Muslim	13.3	0.7	22.7	94.0	89.6	96.0	0.4	16.8
Hindu	78.5	83.7	67.9	4.3	10.4	0.0	0.0	0.0
Buddhist	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
Jewish	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Household size								
Mean	4.0	3.71	3.92	4.60	4.40	10.20	5.53	4.33
Standard deviation	1.30	1.20	2.06	1.85	2.02	6.0	2.40	2.13

	Trichy	Narsapur	Warangal	Saidpur	Meherpur	Dakar	Lusaka	Kampala
Marital status (percent)								
Single/never married	11.0	11.0	5.0	11.0	2.4	18.0	20.5	17.5
Married	86.2	81.3	88.0	85.6	91.0	55.8	56.5	25.4
Unmarried/living with partner	0.0	0.4	2.8	0.0	0.0	0.0	0.3	35.0
Divorced/separated	1.0	1.2	0.3	0.1	2.0	5.0	7.1	15.0
Widowed	2.3	6.3	4.1	3.3	4.7	21.2	15.6	7.2
Providing sanitation-related support at home (percent)								
Children under 5 years	62.3	66.8	68.0	100.0	100.0	70.1	67.4	71.2
Children between 5 and 17 years	42.2	62.4	81.5	100.0	100.0	67.4	50.5	34.5
Adults	4.0	3.2	53.2	100.0	100.0	33.3	25.2	8.0
Time scale score (mean, SD)	3.10, 0.55	2.70, 0.41	2.65, 0.50	3.17, 0.46	3.13, 0.44	2.86, 0.44	3.10, 0.53	3.40, 0.53
Assets scale score (mean, SD)	2.55, 0.36	2.42, 0.35	2.42, 0.41	2.33, 0.51	2.25, 0.51	2.23, 0.40	2.72, 0.71	2.34, 0.71
Self-efficacy scale score (mean, SD)	2.92, 0.40	2.71, 0.43	2.62, 0.48	2.51, 0.47	2.44, 0.53	2.58, 0.51	3.02, 0.58	3.10, 0.57
Social capital scale score (mean, SD)	3.63, 0.46	2.50, 0.41	2.51, 0.46	2.26, 0.40	2.37, 0.36	2.50, 0.42	2.60, 0.50	2.90, 0.53
Norms scale score (mean, SD)	2.60, 0.36	2.50, 0.15	2.55, 0.20	2.40, 0.31	2.50, 0.22	2.47, 0.15	2.66, 0.27	2.63, 0.27
N	**735**	**720**	**703**	**729**	**720**	**709**	**715**	**713**

Appendix E

Regression Results by City

	Household-level agency		Community-level agency	
Variable	**Decision-making**	**Freedom of movement**	**Decision-making**	**Collective action**
Sanitation burden				
Health	0.14***	−0.24***	−0.40***	−0.20***
	(0.03)	(0.04)	(0.06)	(0.04)
City-wise sanitation burden (base: Trichy)				
Kampala	−0.16***	0.19***	0.40***	0.13**
	(0.05)	(0.05)	(0.08)	(0.05)
Lusaka	−0.21***	0.21***	0.40***	0.14***
	(0.04)	(0.04)	(0.07)	(0.05)
Narsapur	0.08	0.23***	0.41***	0.26***
	(0.07)	(0.51)	(0.07)	(0.05)
Warangal	−0.08	0.08	0.30***	−0.11
	(0.06)	(0.05)	(0.08)	(0.07)
Dakar	−0.01	0.24***	0.50***	0.20***
	(0.05)	(0.04)	(0.06)	(0.05)
Meherpur	−0.003	0.19**	0.32***	0.14***
	(0.06)	(0.07)	(0.06)	(0.05)
Saidpur	0.05	0.06	0.40***	0.13**
	(0.08)	(0.17)	(0.07)	(0.06)
Age	0.01***	0.01**	0.01**	0.005***
	(0.002)	(0.003)	(0.002)	(0.001)
Marital status (base: single/never married)				
Married	0.04*	0.01	0.01	−0.01
	(0.02)	(0.02)	(0.02)	(0.01)
Unmarried/living with partner	0.06**	−0.02	−0.07**	−0.03
	(0.03)	(0.02)	(0.03)	(0.03)
Divorced/separated	0.06**	−0.01	0.01	−0.02
	(0.03)	(0.02)	(0.03)	(0.02)
Widowed	0.06*	0.01	0.01	−0.03
	(0.03)	(0.03)	(0.02)	(0.02)
Work status (base: not working for income)				
Earns income outside home	0.03***	−0.03*	0.004	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)
Earns income inside home	0.02	−0.03*	0.01	0.001
	(0.01)	(0.02)	(0.01)	(0.01)
Earns income inside and outside home	0.003	−0.01	0.01	0.04
	(0.03)	(0.05)	(0.06)	(0.04)
Sanitation-related support at home to:				
Children under 5 years old	−0.01	0.03**	−0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)

	Household-level agency		Community-level agency	
Variable	**Decision-making**	**Freedom of movement**	**Decision-making**	**Collective action**
Children aged 5–17 years	−0.04	−0.02**	−0.001	−0.02
	(0.01)***	(0.01)	(0.02)	(0.01)
Adults	0.02	0.04	0.05**	0.03
	(0.03)	(0.03)	(0.02)	(0.02)
Time	−0.04***	−0.04*	−0.04***	−0.03***
	(0.01)	(0.02)	(0.01)	(0.01)
Financial and productive assets	0.06***	−0.03**	0.04***	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)
Norms	0.04**	0.03	−0.02	0.05***
	(0.01)	(0.03)	(0.02)	(0.01)
Self-efficacy	0.01***	0.03**	0.08***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Freedom of movement	—	—	0.03*	0.05***
	—	—	(0.02)	(0.02)
Social capital	0.01	0.01	0.11***	0.10***
	(0.01)	(0.01)	(0.01)	(0.01)
N	**3238**	**3203**	**3198**	**3203**

Note: These models also control for women's religion, education, and rate of growth in age (age-squared).
***, **, and * refer to $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. Standard errors are in parentheses, are robust, and are clustered at the community level. Estimates accommodate hierarchical fixed effects at city and country levels.

Appendix F

Instrumental Validity and Instrumental Variable Regression Results for Endogenous Independent Variables

We chose a binary variable in our survey—type of household sanitation—that asks "whether sanitation facility is shared with non-household members" to instrument the relationship between health-related sanitation burden and women's household-level decision-making and collective action agency outcomes. The tables below display the results of endogeneity test on all outcome variables and validity tests for our chosen instrument where endogeneity is present.

TABLE F1 | Results for tests of instrument validity and endogeneity in the association between sanitation burden (independent variable) and household-level decision-making agency (outcome variable #1).

Underidentification test (Kleibergen–Paap rk LM statistic): Chi-sq(1) *p* value	26.78 0.000	H0: instrument not valid **Result: reject H0. Therefore, instrument (type of sanitation facility) is valid**
Weak identification test (Cragg–Donald Wald *F* statistic): (Kleibergen–Paap rk Wald *F* statistic)	76.71 39.865	**Result: reject H0 (instrument is weak) because *F* statistics are above Stock-Yogo critical thresholds. Therefore, instrument (type of sanitation facility) is not a weak instrument**
Stock–Yogo weak ID test critical values: 10% maximal IV size	16.38	
15% maximal IV size	8.96	
20% maximal IV size	6.66	
25% maximal IV size	5.53	
Source: Stock–Yogo (2005). Reproduced by permission.		
NB: Critical values are for Cragg–Donald *F* statistic and i.i.d. errors.		
Hansen J statistic (overidentification test of all instruments): (equation exactly identified)	0.000	
Endogeneity test of endogenous regressors: Chi-sq(1) *p* value	6.654 0.0099	H0: sanitation burden is exogenous **Result: rejecting H0; sanitation burden is endogenous and IV is appropriate**

Note: Important statistics are in bold.

TABLE F2 | Result for the test of endogeneity in the association between sanitation burden (independent variable) and freedom of movement agency (outcome variable #2).

Underidentification test (Kleibergen–Paap rk LM statistic): Chi-sq(1) *p* value	26.78 0.000	
Weak identification test (Cragg–Donald Wald *F* statistic): (Kleibergen–Paap rk Wald *F* statistic)	76.70 39.86	
Hansen *J* statistic (overidentification test of all instruments): (equation exactly identified)	0.000	
Endogeneity test of endogenous regressors: Chi-sq(1) *p* value	1.010 0.315	H0: sanitastion burden is exogenous **Result: cannot reject H0; sanitation burden is exogenous and IV is not appropriate**

Note: Important statistics are in bold.

TABLE F3 | Result for the test of endogeneity in the association between sanitation burden (independent variable) and community-level decision-making agency (outcome variable #3).

Underidentification test (Kleibergen–Paap rk LM statistic): Chi-sq(1) *p* value	26.84 0.000	
Weak identification test (Cragg–Donald Wald *F* statistic): (Kleibergen–Paap rk Wald *F* statistic):	76.96 40.20	
Hansen *J* statistic (overidentification test of all instruments): (equation exactly identified)	0.000	
Endogeneity test of endogenous regressors: Chi-sq(1) *p* value	1.051 0.3054	H0: sanitation burden is exogenous **Result: cannot reject H0; sanitation burden is exogenous and IV is not appropriate**

Note: Important statistics are in bold.

TABLE F4 | Results for tests of instrument validity and endogeneity in the association between sanitation burden (independent variable) and collective action agency (outcome variable #4).

Underidentification test (Kleibergen–Paap rk LM statistic): Chi-sq(1) *p* value	25.53 0.000	H0: instrument not valid **Result: rejecting H0; instrument (type of sanitation facility) is valid**
Weak identification test (Cragg–Donald Wald *F* statistic): (Kleibergen–Paap rk Wald *F* statistic)	72.96 37.94	**Result: rejecting H0 (instrument is weak); instrument (type of sanitation facility) is not a weak instrument**
Stock–Yogo weak ID test critical values: 10% maximal IV size	16.38	
15% maximal IV size	8.96	
20% maximal IV size	6.66	
25% maximal IV size	5.53	
Source: Stock–Yogo (2005). Reproduced by permission.		
NB: Critical values are for Cragg–Donald *F* statistic and i.i.d. errors.		
Hansen *J* statistic (overidentification test of all instruments): (equation exactly identified)	0.000	
Endogeneity test of endogenous regressors: Chi-sq(1) *p* value	6.973 0.0083	H0: sanitation burden is exogenous **Result: rejecting H0; sanitation burden is endogenous and IV is appropriate**

Note: Important statistics are in bold.

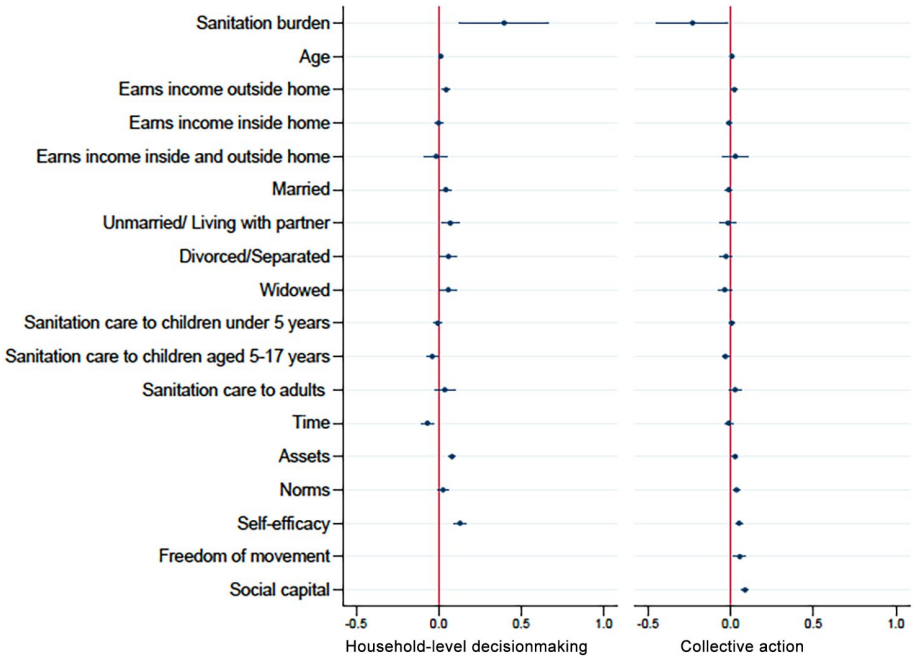

FIGURE F1 | Instrumental variable regression results for household-level decision-making agency and collective action agency.

Appendix G

Pairwise Correlations and Mean Difference Between Outcome Variables

The table below shows the results of pairwise correlations and tests of statistical difference between our outcome/dependent variables—four domains of women's sanitation-specific agency. The estimates are significantly different and weakly correlated with each other, except for the observed correlation between community-level decision-making and collective action. Therefore, domain-specific analyses may be necessary to compare and contrast the effect that women's health-related sanitation burden can have on their capacity to participate in and influence household and community decisions and activities.

Outcome variables: 4 Agency domains	Pearson's correlation	Difference
Household-level decision-making and community-level decision-making	0.210***	0.571***
Household-level decision-making and freedom of movement	0.100***	−0.573***
Household-level decision-making and collective action	0.1445***	0.630***
Freedom of movement and collective action	0.0695***	0.053***
Community-level decision-making and collective action	0.650***	−0.054***
Community-level decision-making and freedom of movement	0.025*	−0.002

***$p < 0.01$; *$p < 0.1$.