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Elaina Sinclair Date

Association of safety and security, privacy, and health with sanitation-related withholding and suppression among women in urban Uganda and India

By

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Master of Science in Public Health

Global Epidemiology

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2019

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Abstract

Association of safety and security, privacy, and health with sanitation-related withholding and suppression among women in urban Uganda and India

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Despite proximity to sanitation facilities, women may still face sanitation insecurity if the physical and sociocultural context prevents toilet access when needed. To cope with sanitation barriers, women may resort to withholding food and water or suppressing of the urge to urinate or defecate. Many qualitative studies have described the concerns of women regarding sanitation-related privacy, safety and security, and health; however, the quantitative association is lacking. This study is a secondary analysis of data collected in Kampala, Uganda, and Tiruchirappalli (Trichy), India. Withholding was found among 38% of women in Kampala and 16% of women in Trichy, and suppression was reported in more than 93% of women in both populations. To quantitatively capture privacy, safety and security, and health as exposures, the Agency, Resources, Institutional Structures for Empowerment (ARISE) Scales and factors were used to derive exposure scores. In addition to traditional demographic measures, several additional covariates were identified including the need to collect water, toilet type, facility sharing and numerous facility characteristics such as lockability and lighting. The privacy, safety and security, and health scores were all significantly associated with the odds of withholding among women in both Kampala and Trichy. Fewer significant results were found between privacy, safety and security and health scores and suppression, suggesting additional unaccounted variables at play. Nonetheless, the prevalence of withholding and suppression suggests concerning numbers of urban women who feel the need to avoid their sanitation facilities. In addition, this study successfully identifies several privacy, safety and security and health factors which programs may target to improve women's sanitation situation and quality of life.

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Introduction

Substantial progress has been made in recent years to expand safe water, sanitation and hygiene (WaSH) access around the world [1]. However, as of 2020 more than 1.7 billion households are estimated to lack access to basic or safely managed sanitation facilities, which are unshared and designed to separate excreta from human contact [1]. Sustainable Development Goal (SDG) 6 aims to 'Ensure availability and sustainable management of water and sanitation for all' [2]. SDG 6.2 specifically targets adequate and safe sanitation for women and girls, but no indicators currently exist for assessing the impacts of gender on sanitation [3]. Proximity to a functional latrine is insufficient to capture all the nuances of the gendered experience of sanitation which depends on the sociocultural context and social and physical environments [4, 5]. If social and physical environments limit access to nearby toilets, sanitation insecurity can persist. Given the complexity of sanitation insecurity, there is a need to further understand sanitation-related experiences and outcomes specific to women, including if and how women change their sanitation-related behaviors in the face of unsupportive sanitation conditions.

Sanitation facilities themselves can influence women's ability to meet their needs. In the physical environment, inadequate sanitation is linked to women's and girls' vulnerability to gender-based violence, and fear of violence can keep women from using sanitation facilities, [6-8]. Privacy, essential for psychosocial wellbeing, is often compromised by inadequate sanitation and women report concerns regarding facilities with broken doors or locks, and the ability to be seen or heard while using the facility, especially by men [9-12]. The association between inadequate water, sanitation and hygiene (WaSH) and poor health outcomes is well established [13-17]. Women and girls have many sanitation-related health concerns including dirty public

toilets, unhygienic defecation practices, insufficient waste management, and open defecation [1, 18, 19].

Societal norms and family rules can influence women's ability to address their sanitation-related needs. Such norms and obligations, such as suppressing urination or defecation to attend to family needs or only addressing needs when accompanied by others, can restrict women's movement and their ability to address sanitation needs and induce sanitation-related shame [5, 11, 20, 21]. Considering it a matter of honor and shame, many women are especially concerned about the potential for men to see their bodies when going for sanitation [4, 10, 11, 22].

When women feel unsafe, are concerned for their health, or lack privacy, they may develop coping strategies: the withholding of food or water and the suppression of urination and defection [5, 20, 23]. Fear of injury or violence from men is a commonly reported stressor leading to sanitation-related withholding or suppression [5]. When sanitation-related sexual assault occurs, women are often blamed and stigmatized [20].In response to inadequate privacy, women limit their need for sanitation by withholding their food and water intake and suppressing urination and defection [19, 22]. To avoid the shame of asking employers for sanitation access, some women restrict their food and water intake while working [24]. Women who withheld food and water, or suppressed urination and defecation due to unsanitary or unsafe facilities reported frequent urinary tract infections, headaches, stomach aches, constipation, diarrhea, and other illnesses [5, 20, 25].

Qualitative studies have linked inadequate sanitation facilities and experiences with withholding and suppression coping strategies. [26, 27]. However, there is a lack of quantitative data identifying the drivers of these coping strategies. Further, the prevalence of withholding and suppression behaviors is currently unknown. Addiitonally, there is a need to identify

causal factors associated with withholding and suppression in order to identify strategies for ameliorating the conditions that drive these behaviors. The aim of this research is to describe the prevalence of withholding and suppression among urban women in Kampala and Trichy, and to identify the safety, privacy, and health factors associated with sanitation-related withholding and suppression [28].

Methods

Study Design

This study is a secondary data analysis of data generated as part of the Measuring Urban Sanitation and women's Empowerment (MUSE) project, which aims to develop and validate quantitative survey instruments to measure women's empowerment in relation to sanitation in urban areas of low-and middle-income countries [28]. The survey was designed using a women's empowerment framework centered around resources, agency, and institutional structures collected data from three domains, resources, agency, and institutional structures, each with multiple sub-domains [29]. From the survey data, the Agency, Resources, Institutional Structures for Empowerment (ARISE) scales were created and validated. [28]

Data are cross sectional and were collected in two locations: Kampala, Uganda, and Tiruchirappalli (Trichy), India in 2019. To be eligible for participation in the MUSE survey, a woman needed to be 18 or older, speak Luganda (in Uganda) or Tamil (in India) or English, be mentally competent as demonstrated by an ability to understand the survey and consent, and have no speech or hearing impediments (to avoid comprehension difficulties). Neighborhoods were purposively selected for low to moderate wealth strata and partner priorities, such as presence of public toilets and lack of underground drainage. Participant selection involved that random-walk sampling method. Female enumerators walked in pairs through selected

neighborhoods on opposite sides of the streets and knocked on every third door. If the selected household had an eligible woman who consented to participate, the enumerator administered the survey. A total of 2,173 women participated in the MUSE survey: 1,094 in Kampala and 1,080 in Trichy.

Primary Outcomes

Primary outcomes of interest are withholding food and water and suppression of the urge to urinate or defecation, both during the 30 days prior to the survey. For this secondary data analysis, data was stratified by population and primary outcome, and included only those women who answered primary outcome and all relevant covariate items. There were substantial data completeness issues, and many women had missing values for the covariates of interest. Specifically, many women did not answer one of the three suppression items necessary to calculate a suppression score and were therefore excluded from the analysis. The analysis sample included 697 women in the withholding dataset and 440 women in suppression dataset from Kampala, and 475 women in the withholding dataset and 270 women in the suppression dataset from Trichy. Suppression datasets are subsets of the withholding datasets.

To assess withholding, four survey items regarding withholding were used to create a dichotomous variable of whether a woman ever practiced withholding in the previous 30 days. Withholding items asked whether a woman: 1) withheld water at home, 2) withheld water when she knew she would be away from home, 3) withheld food at home, and 4) withheld food when she knew she would be away from home. Response options for all withholding items were "Never" (coded value of 1), "Sometimes" (2), "Often" (3) or "Always" (4). Few women reported withholding (Supplemental Figure 1), and those that did reported doing so rarely, which necessitated the creation of a dichotomized withholding variable. The variable captures

whether a woman reported never withholding or reported any level of withholding—for example sometimes, often or always—across the four relevant items (Supplemental Figure 2).

To assess suppression, three items regarding suppression were used to create a mean score reflecting the frequency of suppression in the previous 30 days. Suppression items asked whether women suppressed the urge to urinate or defecate 1) during the daytime at home, 2) when away from home, and 3) at night when at home. Response options for all suppression items were the same as for withholding. Nearly all women reported some level of suppression, which enabled creation of the suppression score by taking the mean reported frequency of suppression across all suppression items. The mean suppression score represents the average frequency with which a woman suppressed, with numbers corresponding with the item response options (never (1) to always (4)) (Supplemental Figure 3).

Primary Exposures

Safety and security, privacy, and health, each of which are sub-domains of empowerment, were selected as the primary exposures of interest. They were selected given existing literature suggesting the importance of these three domains on women's sanitation experiences and coping behaviors [5, 7, 19, 20]. For each sub-domain, the MUSE team has drafted sanitation-specific definitions and created and validated scales for assessment [28].

Specifically, safety and security has been defined as '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. [28]' The safety and security scale includes five factors: 1) 'perceptions of women's risk of harm when going for sanitation', 2) 'perceptions of women's risk of harm when going to sanitation-related meetings', 3) 'perceptions of women's risk of domestic violence related to

sanitation', 4) 'perceptions of own risk of harm when going for sanitation', and 5) 'perceptions of general personal safety related to sanitation'. Each safety factor is composed of three or four items. Response options for all safety items were "Never" (coded value of 1), "Sometimes" (2), "Often" (3) or "Always" (4).

Privacy has been defined as 'women's ability to maintain desired levels of privacy when accessing and using sanitation locations.' [28] The privacy scale has a single factor which is composed of five items. Response options for all privacy items were "Never" (coded value of 1), "Sometimes" (2), "Often" (3) or "Always" (4).

Health has been defined as 'women's complete physical, mental and social well-being as affected by sanitation options and conditions; not merely the absence of disease or infirmity.' The health scale includes five factors: 1) 'sanitation-related illness', 2) 'illness due to suppression and withholding', 3) 'fear of injury', 4) 'sanitation-related anxiety, embarrassment, and shame', and 5) 'sanitation-related stress and fear'. Each health factor was composed of three or four items. The health scale was not usable to include as a whole due to health factor 2: 'illness due to suppression and withholding', which introduced a circuitous relationship between the exposure and outcome. Scales were validated using all factors, and the need to exclude health factor 2 necessitated analysis of the health domain using scores for each of the factors (except factor two), rather than by the score for the full scale. Response options for all health items were "Never" (coded value of 1), "Sometimes" (2), "Often" (3) or "Always" (4). For a complete list of scales, factors and survey items please see Supplemental Table 4 in the Appendix.

Response options for each item investigated how often a woman experienced, felt, or perceived a negative experience or situation related to the scale domain of factor sub-domain. Scale item responses were reverse coded so that the more frequent a negative experience the higher the value. After recoding, response options were: "Never" (recoded value of 1),

"Sometimes" (2), "Often" (3) or "Always" (4). Scale scores were calculated as mean values of all responses to items included in the scale, and factor scores were calculated as the mean of all response values from items within the factor. Higher scale or factor scores indicate a greater frequency of negative experiences or situations regarding the scale domain or factor subdomain.

Covariates

Sixteen covariates were identified as possible confounders: age, self-reported perceived physical health status, marital status, wealth, hours away from home, water collection duties, toilet type, with whom a facility was shared, whether the facility was in a private location, if a woman could be seen using the facility, if men also used the facility, if the facility was lockable, if there was lighting inside the facility, if there was lighting outside/on the way to the facility, if it was physically challenging to access the facility, and if the facility had malfunctioned in the past 30 days (see Supplemental Figures 4:6 for DAGs). Additionally, qualitative studies in the literature identify the number of household members and number of household children as important covariates and were included as such [5]. Wealth was calculated by constructing an asset index for each country based on the WHO's International Wealth Index (24 items for Uganda and 28 items for India). A full list of items included in the asset indices are available in Supplemental Table 2.

Analysis

Descriptive statistics were produced to understand the prevalence and frequency of withholding and suppression among a representative sample of urban women from Kampala and Trichy. Additionally, descriptive statistics were calculated for the scale and factor

exposures and the covariates previously described to better understand the demographics of the sample and the sanitation context in both settings.

As withholding was treated as a dichotomized outcome, logistic regression models were run to estimate the odds ratio for the privacy and safety scales, and all five safety factors and four of the health factors on any level of withholding. Models were adjusted for all 18 covariates previously described.

Linear regression models were run to estimate the effect estimates of the privacy and safety scales, and all five safety factors and four of the health factors on suppression frequency, as indicated by the suppression score. Models were adjusted for all 18 covariates previously described.

Modeling of both withholding and suppression was completed by scale (privacy and safety) and factor (safety and health). Analysis of the safety domain by factors in addition to scale allowed for a better understanding of which factors were driving the associations of the scale variable. In a sensitivity analysis, all safety factor scores were included in a single model (logistic for withholding and linear for suppression), and the resulting estimates were compared to that produced by the single-exposure safety scale score model.

Ethics

All participants provide oral or written consent to enumerators in their local language using a standardized script. Study activities were reviewed and approved by Institutional Review Boards at Azim Premji University (India; reference number 2019/SOD/Faculty/5.1) and Makerere University (Uganda; reference number 2019–038).

Results

Among respondents in Kampala, 38.0% reported some level of withholding, compared to 16.2% of respondents in Trichy (Table 1). In both populations, some level of suppression was nearly universal, 94.32% in Kampala, 93.22% in Trichy, and mean suppression scores were near 2, indicating a mean suppression frequency of "Sometimes" (Kampala 1.97, SD = 0.47; Trichy 1.90, SD = 0.39).

The two populations differed on many demographic and sanitation characteristics. In general, the sample population in Kampala was younger than in Trichy in, but this difference was smaller between suppression datasets (mean age, Kampala – 30.29, Trichy – 32.39) than withholding datasets (mean age, Kampala – 32.18, Trichy – 41.21) (Table 2). In Kampala, most women used basic sanitation facilities (83.21%) shared with known households (75.61%), compared to Trichy where most women (75.58%) had private sanitation facilities that varied in improvement level (Improved – 55.79%, Basic - 44.21%). Most women in Kampala (91.68%) had to collect water for their household, compared to 32.84% of women in Trichy.

Safety and Security and privacy scale scores were similar across both populations and slightly higher in the withholding datasets than the suppression datasets (Table 1). Both scale scores were slightly higher in Trichy than Kampala, indicating that women in Trichy had more negative experiences and perceptions regarding sanitation-related safety and security, and privacy. Greater variation in scale scores between women, as indicated by larger standard deviations, were found among women in Kampala. Higher health factor scores and variances were found among women in Kampala.

Table 1. *Descriptive statistics of outcomes and primary exposures for participants in Kampala and Trichy.*

	Withholding Dataset		***Suppression Dataset***	
mean (SD)	Kampala n = 697	Trichy n = 475	Kampala n = 458	Trichy n = 422
Withholding (% Any*)	38.02 (265)	16.21 (77)	NA	NA
Suppression (% Any*)	NA	NA	94.32 (432)	93.33 (404)
Suppression Score	NA	NA	1.97 (0.47)	1.90 (0.39)
Privacy Scale	1.19 (0.51)	0.89 (0.30)	1.22 (0.53)	0.92 (0.34)
Safety Scale	1.86 (0.54)	1.63 (0.43)	1.88 (0.55)	1.66 (0.46)
Safety Factor 1: Perceptions of women's risk of harm when going for sanitation	1.93 (0.73)	1.67 (0.69)	1.94 (0.76)	1.69 (0.73)
Safety Factor 2: Perceptions of women's risk of harm when going to sanitation-related meetings	1.81 (0.68)	1.68 (0.71)	1.79 (0.70)	1.69 (0.73)
Safety Factor 3: Perceptions of women's risk of domestic violence related to sanitation	2.01 (0.73)	1.95 (0.75)	2.02 (0.74)	1.96 (0.74)
Safety Factor 4: Perceptions of own risk of harm when going for sanitation	1.53 (0.66)	1.15 (0.45)	1.56 (0.66)	1.22 (0.56)
Safety Factor 5: Perceptions of general personal safety related to sanitation	1.66 (0.74)	1.36 (0.63)	1.71 (0.74)	1.40 (0.64)
Health Factor 1: Sanitation-related illness	1.62 (0.65)	1.05 (0.20)	1.66 (0.66)	1.06 (0.22)
Health Factor 3: Fear of injury	1.26 (0.55)	1.07 (0.27)	1.26 (0.56)	1.09 (0.31)
Health Factor 4: Sanitation-related anxiety, embarrassment, and shame	1.25 (0.53)	1.06 (0.27)	1.26 (0.53)	1.08 (0.34)
Health Factor 5: Sanitation-related stress and fear	1.75 (0.78)	1.18 (0.42)	1.81 (0.79)	1.22 (0.47)

Response options for suppression score, scale and factor items:
"Never" - 1, "Sometimes" - 2, "Often" - 3 and "Always" – 4
*Any indicates withholding, or suppression was reported sometimes, often or always for one or more relevant items.

Table 2. *Descriptive statistics for covariates sampled women in Kampala and Trichy.*

	Withholding		*Suppression*	
	Kampala n = 697	Trichy n = 475	Kampala n = 440	Trichy n = 270
Age, mean (SD)	32.18 (10.66)	41.21 (14.79)	30.29 (7.99)	32.39 (8.24)
Wealth Index*, mean (SD)	2.81 (1.38)	2.98 (1.43)	2.72 (1.34)	3.03 (1.44)
Number of Household Members, mean (SD)	4.38 (2.20)	4.27 (2.55)	4.31 (2.07)	4.61 (2.90)
Number of Household Children, mean (SD)	0.79 (0.40)	0.59 (0.49)	0.78 (0.42)	0.74 (0.44)
Hours Away from Home, mean (SD)	4.70 (4.41)	3.01 (3.46)	4.89 (4.60)	3.09 (3.34)
Physical Health, % (n)				
Excellent	6.88 (48)	10.32 (49)	7.27 (32)	13.33 (36)
Very Good	21.23 (148)	10.95 (52)	22.50 (99)	12.22 (33)
Good	48.35 (337)	36.21 (172)	49.09 (216)	41.85 (113)
Fair	15.06 (105)	36.42 (173)	13.64 (60)	29.63 (80)
Poor	8.46 (59)	6.11 (29)	7.50 (33)	2.96 (8)
Marital Status, % (n)				
Never Married	16.8 (117)	10.5 (50)	22.3 (98)	16.7 (45)
Married	47.5 (331)	75.2 (357)	43.4 (191)	80.7 (218)
Separated/Divorced/Widowed	35.7 (249)	14.3 (68)	34.5 (151)	2.6 (7)
Toilet Type, % (n)				
Improved	16.50 (115)	55.79 (265)	16.59 (73)	54.44 (147)
Basic	83.21 (580)	44.21 (210)	82.95 (365)	45.56 (123)
Unimproved	0.29 (2)	0 (0)	0.45 (2)	0 (0)
Share Facility, % (n)				
Private/not shared	13.20 (92)	75.58 (359)	10.91 (48)	72.96 (197)
Known households	75.61 (527)	6.53 (31)	77.95 (343)	8.89 (24)
General public	11.19 (78)	17.89 (85)	11.14 (49)	18.15 (49)
Private Location, % (n)	83.64 (583)	33.47 (159)	82.95 (365)	31.11 (84)
Could Be Seen Using, % (n)	16.93 (118)	4.42 (21)	17.27 (76)	4.07 (11)
Men Also Use the Facility, % (n)	96.84 (675)	79.58 (378)	96.36 (424)	81.85 (221)
Lockable Facility, % (n)	82.78 (577)	93.05 (442)	81.14 (357)	94.81 (256)
Lighting Inside Facility, % (n)	64.42 (449)	96.00 (456)	67.05 (295)	95.93 (259)
Lighting Outside/On the Way, % (n)	79.34 (553)	97.68 (464)	70.32 (349)	97.78 (264)
Physically Challenging to Access, % (n)	13.63 (95)	8.84 (42)	14.32 (63)	6.30 (17)
Facility Malfunction, % (n)	17.93 (125)	8.84 (42)	17.95 (79)	10.00 (27)
Collect Water for Household, % (n)	91.68 (639)	32.84 (156)	92.05 (405)	36.30 (98)

*Wealth Index values were calculated by country using the WHO's International Wealth Index

Safety and security, privacy and health factors associated with withholding

In both Kampala and Trichy, women who reported less sanitation-related privacy, as indicated by higher privacy scores, had greater odds of withholding (Table 3, Figure 1). For each one-unit increase in the privacy scale score, the odds of withholding were 4.85 times greater among women in Kampala (CI: 3.25, 7.23) and 2.86 times greater among women in Trichy (CI: 1.31, 6.35).

Women in Kampala and Trichy who were more afraid for their safety and the safety of other women, as indicated by greater safety and security scores, had greater odds of withholding (Table 3, Figure 1). For each one-unit increase in the safety and security scale score, the odds of withholding were 4.22 times greater among women in Kampala (CI: 2.95, 5.04) and 2.83 times greater among women in Trichy (CI: 1.52, 5.27). All five safety factors were statistically significant for the Kampala population, compared with only safety factors 1, 2, and 5 for the Trichy population (Table 3, Figure 2). Among women in both Kampala and Trichy, the strongest association was found for safety and security factor 4: 'perceptions of own risk of harm when going for sanitation'; For each one-unit increase in safety and security factor 4: the odds of withholding increased 3.44 times among women in Kampala (CI: 2.55, 4.64) and 2.87 times among women in Trichy (CI:1.69, 4.88). Overall, the odds ratio estimates are larger in Kampala for both the safety and security scale score and the safety and security factors.

Across both populations, women who reported more negative experiences regarding sanitation-related health, as indicated by greater health factor scores, had greater odds of withholding (Table 3, Figure 2). Health factor odds ratio estimates were comparable across both locations. All four health factors were statistically significant for the Kampala population, compared with only health factors 1, 3, and 5 for the Trichy population (Table 3, Figure 2). Among women in both Kampala and Trichy, the strongest association was found for health

factor 3: 'fear of injury'. For each one-unit increase in health factor 3, the odds of withholding were 3.11 times greater among women in Kampala (CI: 2.13, 4.55) and 2.49 times greater among women in Trichy (CI: 1.07, 5.79). Notably, the odds ratio for health factor 3 in Trichy had a much larger confidence interval than any of the other factors in either population, indicating estimate instability.

To contextualize the odds ratio estimates, a one-unit increase in any scale or factor score is a substantial change, equivalent to a 25% increase in frequency of negative experiences. A one-unit increase in each scale or factor score represents the change in the mean response option across relevant items from "Never" to "Sometimes", "Sometimes" to "Often", or "Often" to "Always". The model was fit better to the Trichy data compared to the Kampala data, as indicated by lower Akaike information criterion (AIC) values.

Table 3. *Logistic regression estimates of the effect of a one-unit increase in scale/factor values on the odds that a woman ever withholds food or water.*

	Kampala			Trichy		
Scale/Factor Score	**Odds Ratio**	**95% CI**	**AIC**	**Odds Ratio**	**95% CI**	**AIC**
Privacy Scale	4.85***	3.25, 7.23	852	2.86**	1.31, 6.35	416
Safety and Security Scale	4.22***	2.95, 5.04	853	2.83**	1.52, 5.27	411
Safety and Security Factor 1	1.76***	1.39, 2.23	901	1.71**	1.20, 2.44	414
Safety and Security Factor 2	1.97***	1.53, 2.53	894	1.58**	1.12, 2.24	416
Safety and Security Factor 3	2.03***	1.61, 2.58	887	1.28	0.89, 1.85	421
Safety and Security Factor 4	3.44***	2.55, 4.64	845	2.87***	1.69, 4.88	405
Safety and Security Factor 5	1.54***	1.22, 1.94	910	1.04	0.68, 1.61	422
Health Factor 1	2.28**	1.72, 3.01	888	5.74**	1.87, 17.58	413
Health Factor 3	3.11***	2.13, 4.55	882	2.49*	1.07, 5.79	418
Health Factor 4	3.01***	1.98, 4.56	892	2.17	0.85, 5.51	419
Health Factor 5	2.12***	1.68, 2.67	881	3.09***	1.74, 5.47	407

*p < 0.05; **p < 0.01; ***p<0.001

Models adjusted for all 18 covariates listed in Table 1.

Safety Factor 1: Perceptions of women's risk of harm when going for sanitation
Safety Factor 2: Perceptions of women's risk of harm when going to sanitation-related meetings
Safety Factor 3: Perceptions of women's risk of domestic violence related to sanitation
Safety Factor 4: Perceptions of own risk of harm when going for sanitation
Safety Factor 5: Perceptions of general personal safety related to sanitation
Health Factor 1: Sanitation-related illness
Health Factor 3: Fear of injury
Health Factor 4: Sanitation-related anxiety, embarrassment, and shame
Health Factor 5: Sanitation-related stress and fear

Figure 1. *Predicted odds ratios and 95% confidence intervals for the effect of a one-unit increase for the safety and security and privacy scale scores on the odds of withholding.*

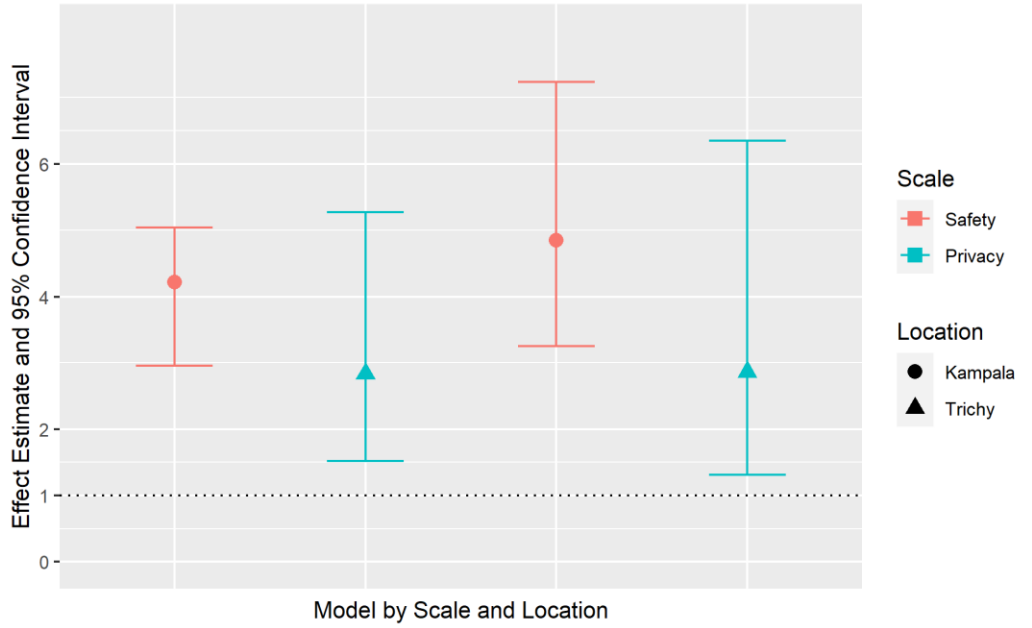
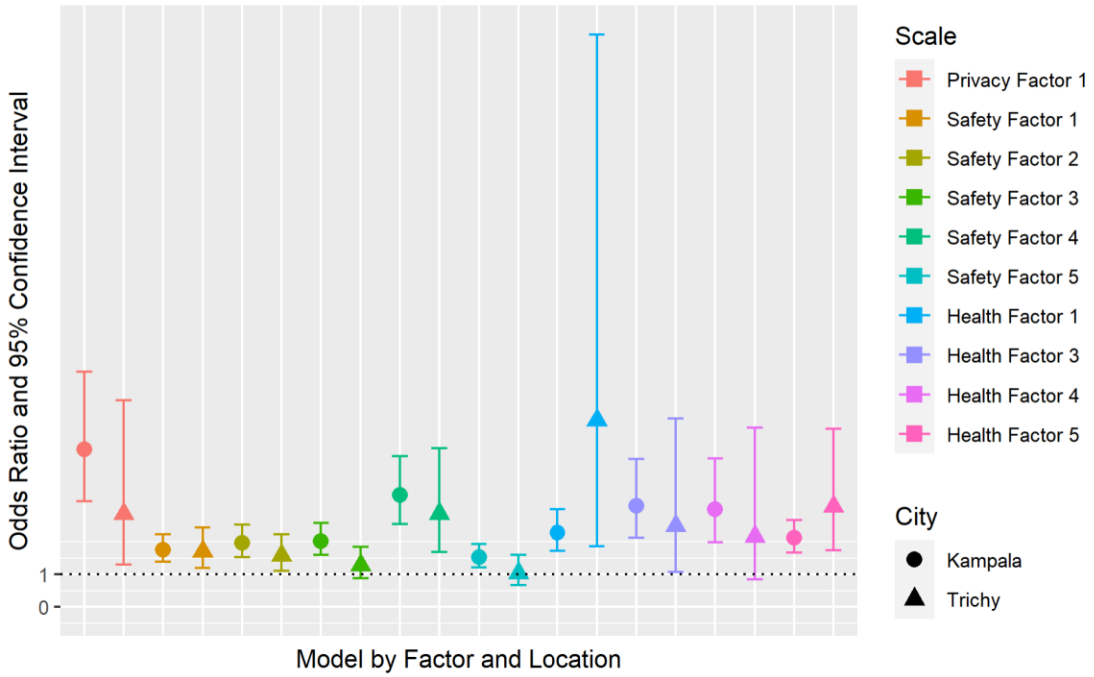


Figure 2. *Predicted odds ratios and 95% confidence intervals for the effect of a one-unit increase for a given factor score on the odds of withholding. The privacy scale has only one factor and is shown again here.*



Safety and security, privacy and health factors associated with suppression

Only one of the models for suppression by scale score was significant: among women in Trichy (Table 4), a woman's suppression score is estimated to increase by 0.21 (CI: 0.08, 0.34) for every one unit increase in the privacy scale score. By safety factor scores, only one model for suppression score was significant: among women in Trichy, a woman's suppression score is estimated to increase by 0.12 (CI: 0.04, 0.19) for every one unit increase in safety factor 4: 'perceptions of own risk of harm when going for sanitation'. Only one model for suppression by health factor was significant: among women in Trichy, a woman's suppression score is estimated to increase by 0.17 (CI: 0.02, 0.33) for every one unit increase in health factor 3: 'fear of injury'. An increase of 0.21 (privacy scale score, Trichy) or 0.17 (health factor 3, Trichy) in the suppression score is the equivalent of increasing a little more than 1/5th from one level of suppression frequency to the next highest frequency, or increasing about 1/20th of the entire frequency scale. An increase of 0.12 (safety factor 3, Trichy) in the suppression score is the equivalent of increasing slightly more than 1/10th from one level of suppression frequency to the next highest frequency, or increasing about 1/40th of the entire frequency scale. All other suppression models did not produce statistically significant effect estimates.

Table 4. *Linear regression estimates of the effect of a one-unit increase in scale/factor values on the effect estimate of the frequency of suppression.*

	Kampala			*Trichy*		
Scale/Factor Score	**Effect Estimate**	**95% CI**	**AIC**	**Effect Estimate**	**95% CI**	**AIC**
Safety Scale	0.02	-0.07, 0.11	598	0.03	-0.07, 0.13	228
Privacy Scale	0.03	-0.07, 0.012	598	0.21**	0.08, 0.34	218
Safety Factor 1	-0.06	-0.12, 0.00	594	0.02	-0.04, 0.08	228
Safety Factor 2	0.03	-0.04, 0.09	597	0.00	-0.06, 0.06	228
Safety Factor 3	0.03	-0.03, 0.09	597	-0.03	-0.09, 0.03	227
Safety Factor 4	0.02	-0.05, 0.09	598	0.12**	0.04, 0.19	219
Safety Factor 5	-0.01	-0.07, 0.05	598	-0.03	-0.10, 0.04	227
Health Factor 1	0.05	-0.02, 0.12	596	0.12	-0.09, 0.33	227
Health Factor 3	0.03	-0.06, 0.12	598	0.17*	0.02, 0.33	223
Health Factor 4	-0.06	-0.16, 0.04	596	0.08	-0.06, 0.22	227
Health Factor 5	0.01	-0.05, 0.07	598	0.08	-0.01, 0.18	225

*p < 0.05; **p < 0.01; ***p<0.001

Models adjusted for all 18 covariates listed in Table 1.

Safety Factor 1: Perceptions of women's risk of harm when going for sanitation
Safety Factor 2: Perceptions of women's risk of harm when going to sanitation-related meetings
Safety Factor 3: Perceptions of women's risk of domestic violence related to sanitation
Safety Factor 4: Perceptions of own risk of harm when going for sanitation
Safety Factor 5: Perceptions of general personal safety related to sanitation
Health Factor 1: Sanitation-related illness
Health Factor 3: Fear of injury
Health Factor 4: Sanitation-related anxiety, embarrassment, and shame
Health Factor 5: Sanitation-related stress and fear

Sensitivity analysis – safety and security

Among women in Kampala, all single-exposure models were statistically significant; however, when the model was run with all five safety and security factors as co-exposures (Table 5), only two factors remained statistically significant: safety and security factor 3: 'perceptions of women's risk of domestic violence related to sanitation' and safety and security factor 4: 'perceptions of own risk of harm when going for sanitation'. Among women in Trichy, safety and security factors 1, 2, and 4 were significant as single-factor models and when the model was run with all five safety and security factors as co-exposures, only safety and security

factor 4, 'perceptions of own risk of harm when going for sanitation', remained significant. The reduction in significant associations between withholding and factors is likely due to multicollinearity: safety and security factors 1 and 2 were highly correlated (Kampala: 0.74, Trichy 0.78) and safety factor 3 was moderately correlated with safety factor 1 (Kampala 0.55, Trichy 0.46) and safety factor 2 (Kampala 0.55, Trichy 0.54). Notably, the five factor co-exposure model was a better fit to the Trichy data (AIC: 447) compared to the data from Kampala (AIC: 848).

Unlike withholding, modeling of suppression by safety factor was robust to sensitivity analysis. Among women in Kampala, no single-exposure models were statistically significant; however, when the model was run with all five safety factors as co-exposures (Table 6), safety and security factor 1: 'perceptions of women's risk of harm when going for sanitation' and safety and security factor 2: 'perceptions of women's risk of harm when going to sanitation-related meetings', became significant. Among women in Trichy, safety and security factor 4: 'perceptions of own risk of harm when going for sanitation', was statistically significant in a single-exposure model and the five-factor co-exposure model. The five-factor co-exposure model was a better fit to the Trichy data (AIC: 233) compared to the data from Kampala (AIC: 590). All withholding, suppression and sensitivity analysis models can be found in Supplemental Text 1 in the Appendix.

Table 5. *Logistic regression model estimates of the effect of a one-unit increase of a safety factor on the **odds of withholding**, model included all five factors as co-exposures.*

Location	Safety Factor	Odds Ratio	95% CI
Kampala	1	0.87	0.60, 1.26
	2	1.31	0.89, 1.93
	3*	1.42	1.05, 1.92
	4***	2.99	2.10, 4.26
	5	0.90	0.68, 1.20
Trichy	1	1.26	0.71, 2.21
	2	1.31	0.73, 2.32
	3	0.98	0.62, 1.55
	4***	2.88	1.64, 5.07
	5	0.69	0.41, 1.18

Table 6. *Linear regression model estimates of the effect of a one-unit increase of a safety factor on the **suppression score**, model included all five factors as co-exposures.*

Location	Safety Factor	Effect Estimate	95% CI
Kampala	1**	-0.20	-0.30, -0.11
	2*	0.13	0.04, 0.23
	3	0.07	-0.01, 0.14
	4	0.04	-0.04, 0.13
	5	-0.02	0.09, 0.05
Trichy	1	0.01	-0.09, 0.10
	2	0.01	-0.09, 0.11
	3	-0.04	-0.12, 0.03
	4***	0.14	0.06, 0.23
	5	0.07	-0.14, 0.00

*p < 0.05; **p < 0.01; ***p<0.001
Models adjusted for all 18 covariates listed in Table 1.
Safety Factor 1: Perceptions of women's risk of harm when going for sanitation
Safety Factor 2: Perceptions of women's risk of harm when going to sanitation-related meetings
Safety Factor 3: Perceptions of women's risk of domestic violence related to sanitation
Safety Factor 4: Perceptions of own risk of harm when going for sanitation
Safety Factor 5: Perceptions of general personal safety related to sanitation
Health Factor 1: Sanitation-related illness
Health Factor 3: Fear of injury
Health Factor 4: Sanitation-related anxiety, embarrassment, and shame
Health Factor 5: Sanitation-related stress and fear

Discussion

The aim of this study was to describe the prevalence and frequency of sanitation-related withholding and suppression among urban women in Kampala and Trichy, and to identify if privacy, safety and security, and health factors were associated with these often-overlooked sanitation coping behaviors. Withholding was a coping behavior employed by women of both populations, but more so in Kampala (38.02%) than Trichy (16.21%). Suppression was nearly ubiquitous with 94.32% of women in Kampala and 93.33% of women in Trichy reporting some level of suppression. The prevalence of both withholding and suppression is concerning given the long-term clinical consequences of these coping strategies, such as urinary tract infections,

headaches, stomach aches, constipation, and other illnesses [5, 19] . Analysis by both scale and factor found higher scores (indicating more negative experience) of sanitation-related safety, privacy, and health to be significant predictors of withholding. Fewer significant results were attained for suppression, likely due to it being so ubiquitous an outcome. Nonetheless, sanitation-related privacy and the perception of risk of harm when going for sanitation are indicated as important considerations for women in Trichy.

Few studies have looked at withholding and suppression as primary outcomes [23]. The prevalence of withholding and suppression found in this study, despite near universal toilet access (basic or improved toilets: 100% Kampala, 99.55% Trichy), further demonstrates that women's experiences of sanitation are more complicated than can be assumed by simply assessing the physical presence of a toilet. As shown with other studies, we found that toilet access does not mean a woman is able to use it when she needs it [5, 30, 31].

Withholding and suppression are not without biological consequences; women who report withholding food or water, or suppressing urges to urinate or defecate report urinary tract infections, headaches, stomach aches, constipation and other illness[2]es [19, 25]. Additionally, the need for women to withhold food and water and suppress the urge to urinate and defecate as coping strategies can causes stress and adversely effects mental well-being [10, 26, 32, 33]. Few previous studies have quantified the prevalence of withholding and suppression, however the levels of withholding found in this study corroborate those found by Panchang et al. in urban locations of Maharashtra, India (21.5%).

The privacy scale score was significantly associated with both withholding and suppression, supporting existing qualitative literature that being seen or heard when going for sanitation is a major concern for women [5, 9, 10]. Consistent with the existing literature, safety and security

factor 4: 'perceptions of own risk of harm when going for sanitation' was the safety and security factor most strongly associated with both coping mechanisms, quantifying the degree to which fear of harassment, assault and violence, especially by men, causes sanitation-related stress and insecurity [7-9, 12]. Among the health factors, health factor 3: 'fear of injury' was associated with the highest odds of withholding in both populations and was the only significant health factor associated with suppression among women in Trichy. The fear of injury is closely related to the perception of the risk of harm, and the fear of actual or threatened violence negatively impacts women's quality of life. [6, 8-10]. Overall, this study links withholding and suppression with the fear of being seen, heard, or harmed when going for sanitation and supports previous arguments, including those that discuss sanitation insecurity, that women's experiences of sanitation are more complex than can be understood by simply assessing access to a toilet [5, 9, 23].

Associations between both scale scores (safety and security and privacy) and safety and security factor scores were generally higher among women in Kampala than women in Trichy. One possible explanation for this difference in privacy and safety estimates could be the much greater percentage of women in Kampala who used shared sanitation facilities and facilities shared with men. Additionally, more women in Kampala reported being able to be seen while using the facility and were less likely have lockable facilities, facilities with lighting on the way or lighting inside the facility.

Results were more mixed for the association between health factor scores and the odds of withholding with higher associations found in each population depending on the health factor. Health factor 1: 'Sanitation-related illness' was more strongly associated with withholding among women in Trichy, and this may in part be explained by the beliefs of many Indian

women that menstruation makes them particularly vulnerable to infection from sanitation facilities [5, 11, 27]. Conversely, health factor 3: 'fear of injury', more strongly associated with withholding among women in Kampala, may be linked to a greater percentage of women reporting their sanitation facility was physically challenging to access and other covariates perhaps more related to safety, such as shared facilities, lockable facilities, and lighting. Further investigation of the covariates most strongly associated with withholding and suppression is needed.

This study treated withholding and suppression as coping strategies, separated by temporality: withholding prevents, and suppression delays the urge to urinate or defecate. Many more significant results were found for the odds of withholding than the effect estimate for suppression frequency. The difference in modeling success between the two coping strategies indicates unaccounted for variables that influence women's suppression. Further investigation is needed to better understand the causal factors and motivating circumstances under which women suppress.

This study has several limitations. This is a secondary data analysis and data was not collected with this analysis in mind. There were several missing data issues, most notably regarding one of the suppression items which lead to additional data restriction and fewer observations among the suppression datasets. It is not certain if the data is missing completely at random, however both linear and logistic regression were completed using complete cases without data imputation. The exclusion of health factor 2: 'illness due to suppression and withholding' limited the use of the health scale in this analysis. However, this study demonstrated the utility of analysis by health factors rather than by health scale and demonstrated the ability to explore the safety domain by both scale and factor. A key strength

of this analysis were the large samples of urban women in both Kampala and Trichy and the breadth of data collected. Additionally, this is one of the few quantitative studies able to analyze withholding and suppression as primary outcomes.

In conclusion, this study found levels of withholding and suppression that are concerning as indicators of sanitation insecurity and tried to identify associated privacy, safety and security and health factors. Further refinement of the model and exploration of other ARISE scale domains should be pursed to more completely identify other sociocultural and physical factors that may be associated with withholding and suppression. Ideally, the factors identified in this study can inform programmatic decisions and help target sanitation interventions to improve women's quality of life.

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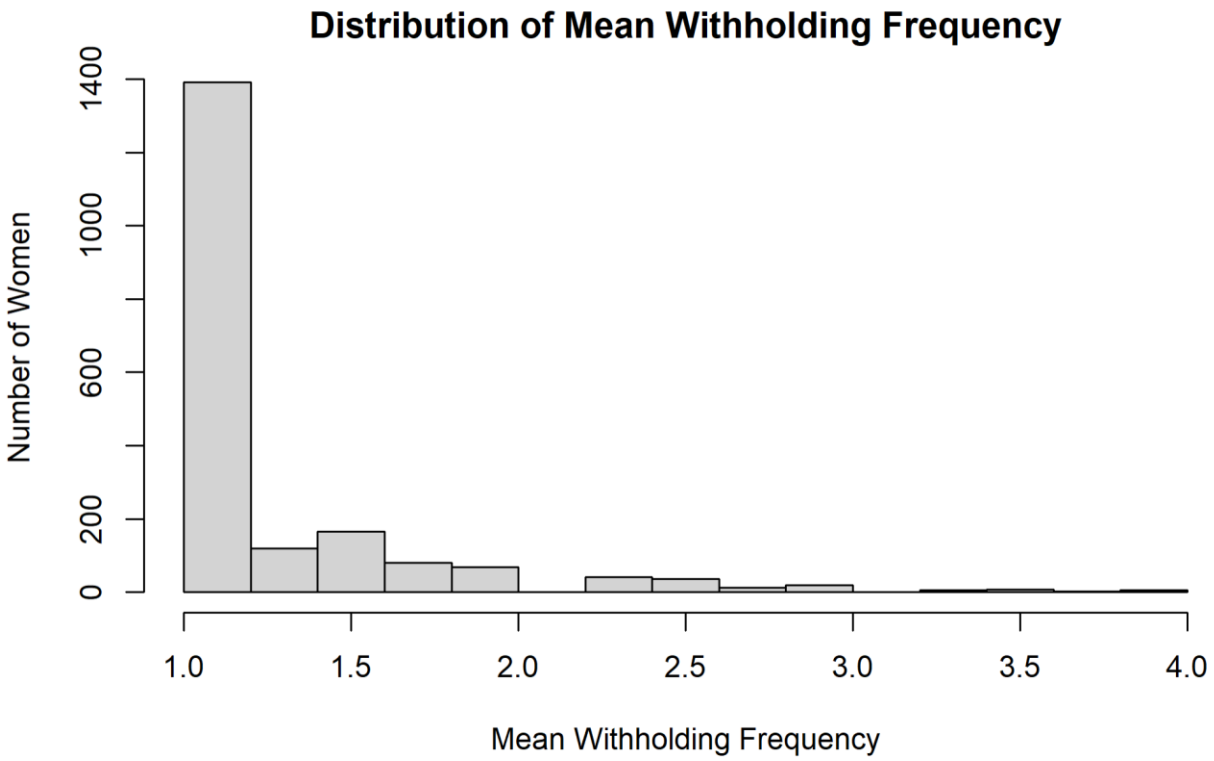
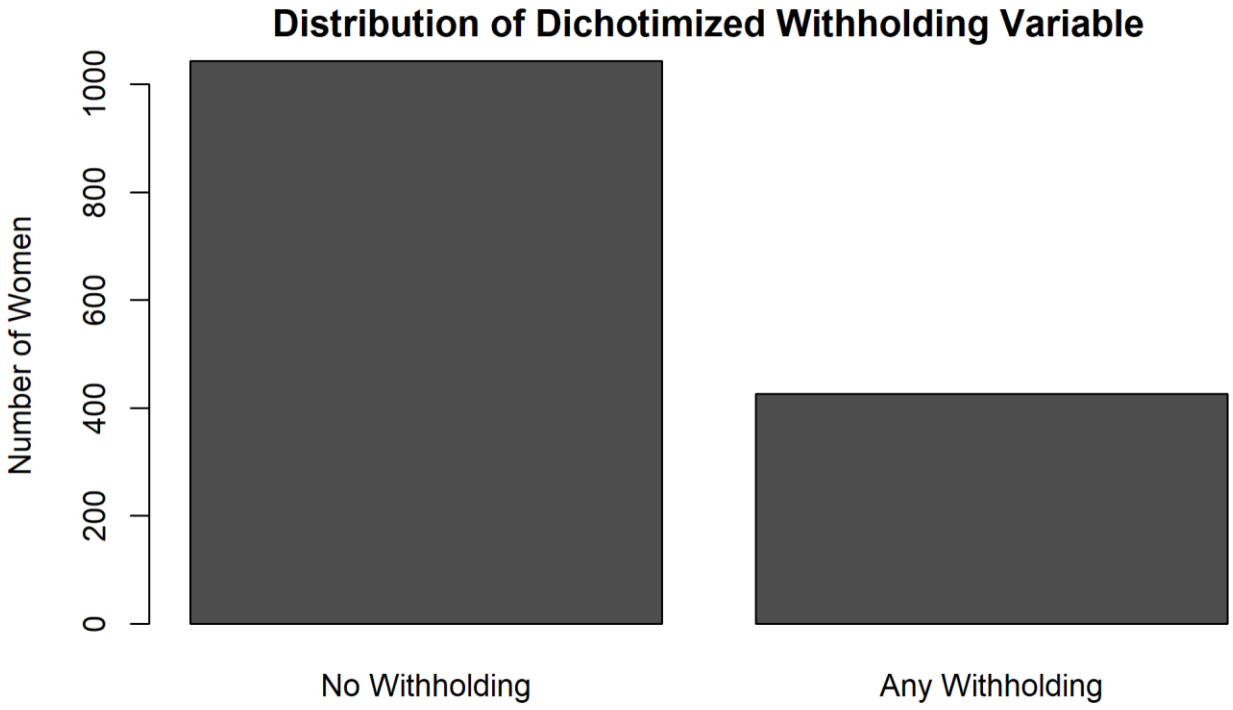
Appendix

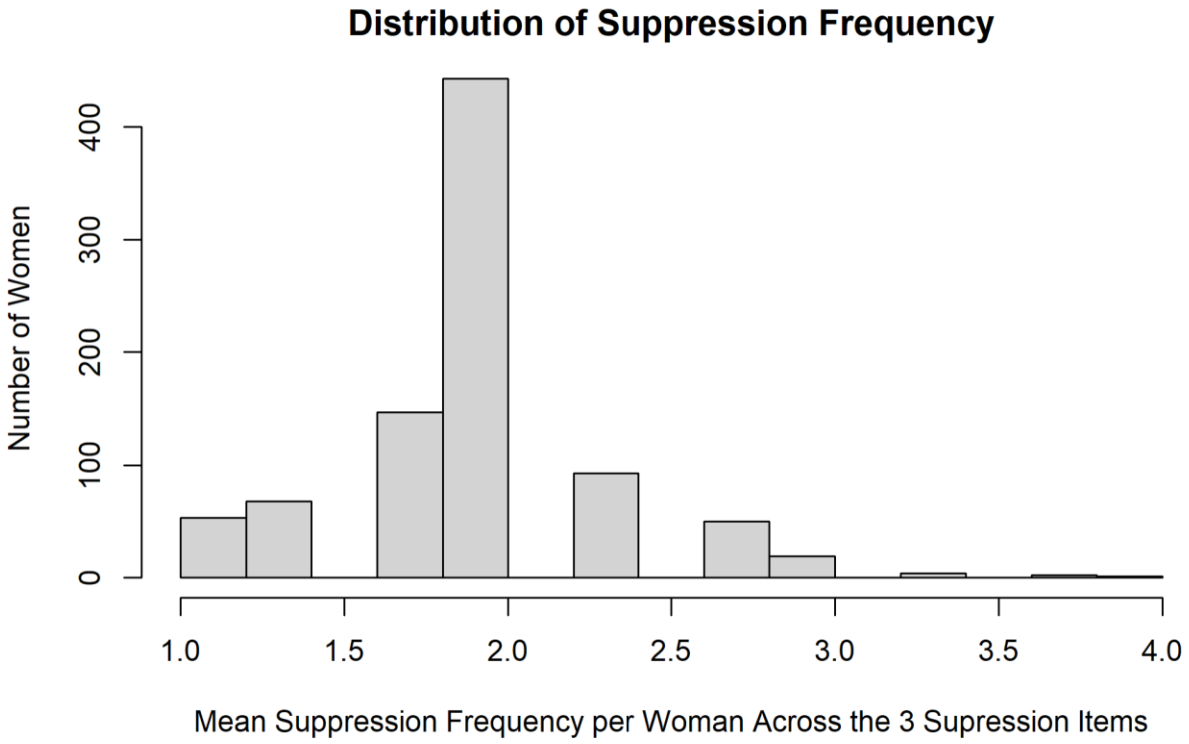
Supplemental Figure 1: *Distribution of mean withholding frequency per woman among women from both Trichy and Kampala. Mean withholding frequency calculated as the mean frequency over all four withholding items.*



Supplemental Figure 2: *Distribution of dichotomized withholding variable among women from both Trichy and Kampala. The withholding variable was dichotomized as no reported withholding and any non-zero level of withholding reported across the four withholding items.*



Supplemental Figure 3: *Distribution of mean suppression frequency among women from both Trichy and Kampala. Response options were 'Never" – 1, "Sometimes" – 2, "Often" – 3 and "Always" – 4.*



Supplemental Table 1. *ARISE Scales and their component factors and survey items. All survey items had the response options of "Never", "Sometimes", "Often" or "Always", coded 1, 2, 3 and 4, respectively.*

Scale	Factor	Survey Item	
Health	Factor 1: Sanitation-related illness	H01	Used a sanitation location that I believed might make me ill
		H02	Got sick as a result of using my sanitation location
		H03	Got sick as a result of cleaning my sanitation location
	*Factor 2: Illness due to suppression and withholding	H04	Became ill because I had to suppress the urge to urinate or defecate
		H05	Withholding water to avoid urination made me feel unwell
		H06	Withholding food to avoid defecation made me feel unwell
	Factor 3: Fear of injury	H08	Feared being harassed or injured by men, boys, or other people when accessing my sanitation location
		H09	Feared being injured by animals or insects when accessing my sanitation location
		H10	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
	Factor 4: Sanitation-related anxiety, embarrassment, and shame	H12	Felt anxiety, stress, or tension when I needed to access a sanitation location during the day when at home
		H15	Experienced embarrassment or shame when accessing a sanitation location during the day
		H16	Experienced embarrassment or shame when accessing a sanitation location at night
	Factor 5: Sanitation-related stress and fear	H17	Been too afraid to use a sanitation location because it is dark

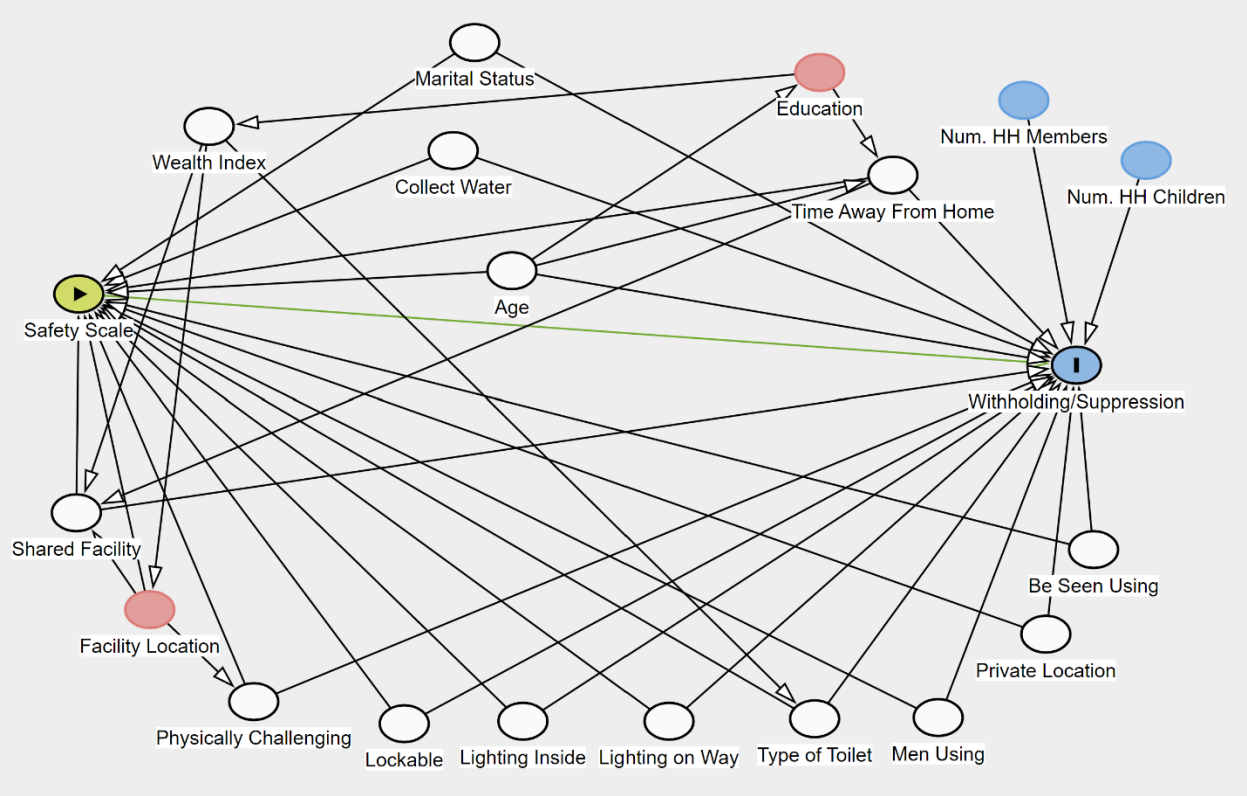
		H18	Felt stress or frustration related to the sanitation conditions in my community
		H19	Felt stress or frustration related to the sanitation conditions in my household
		H20	Feared for the safety of women or children going to sanitation locations
Safety	Factor 1: Perceptions of women's risk of harm when going for sanitation	S01	Women in my community face the risk of being physically harmed by men or boys when going to sanitation locations
		S08	Women in my community face the risk of sexual assault when going to sanitation locations
		S10	Women in my community face the risk of someone making sexual comments or saying obscene things to them when they go to sanitation locations
	Factor 2: Perceptions of women's risk of harm when going to sanitation-related meetings	S11	Women in my community face the risk of someone making sexual comments or saying obscene things to them when they go to a sanitation-related meeting
		S13	Women in my community face the risk of experiencing harassment, such as being called by rude names, yelling, or shaming, if they go to a sanitation-related meeting
		S14	Women in my community face the risk of experiencing harassment, such as being called by rude names, yelling, or shaming, if they speak up in a sanitation-related meeting
	Factor 3: Perceptions of women's risk of domestic violence related to sanitation	S04	Women in my community face the risk of being hit by their husbands or other family members if they go for sanitation without telling someone or stay out too long
		S05	Women in my community face the risk of being hit by their husbands or other family members if they fail to complete sanitation-related chores
		S06	Women in my community face the risk of being hit by their husbands or other family members if they argue with the head of their households/another family member about sanitation issues

		S07	Women in my community face the risk of being hit by their husbands or other family members if they argue with neighbors or other people in the community about sanitation issues
	Factor 4: Perceptions of own risk of harm when going for sanitation	S24	Feared I would be physically harmed by someone when I went to a sanitation location when away from home
		S29	Feared someone would make sexual comments or say obscene things to me when I went to a sanitation location when away from home
		S31	Feared someone would expose himself or spy/peep on me when I went to a sanitation location when away from home
		S33	Felt unsafe when using a sanitation location outside the home that was not for women only
	Factor 5: Perceptions of general personal safety related to sanitation	S21	Felt unsafe in the place where I typically go for sanitation during the day
		S22	Felt unsafe in a place where I have gone for sanitation when away from home
		S23	Felt unsafe in the place where I typically go for sanitation at night
Privacy	Factor 1: Privacy for sanitation	P01	Worried that someone would see me urinating or defecating
		P02	Had to use a sanitation location that was not private enough for me when I was at home
		P03	Had to use a sanitation location that was not private enough for me when I was away from home
		P04	While at home, had to stop urinating or defecating because someone came near me and I no longer had privacy
		P05	While away from home, I had to stop urinating or defecating because someone came near me and I no longer had privacy

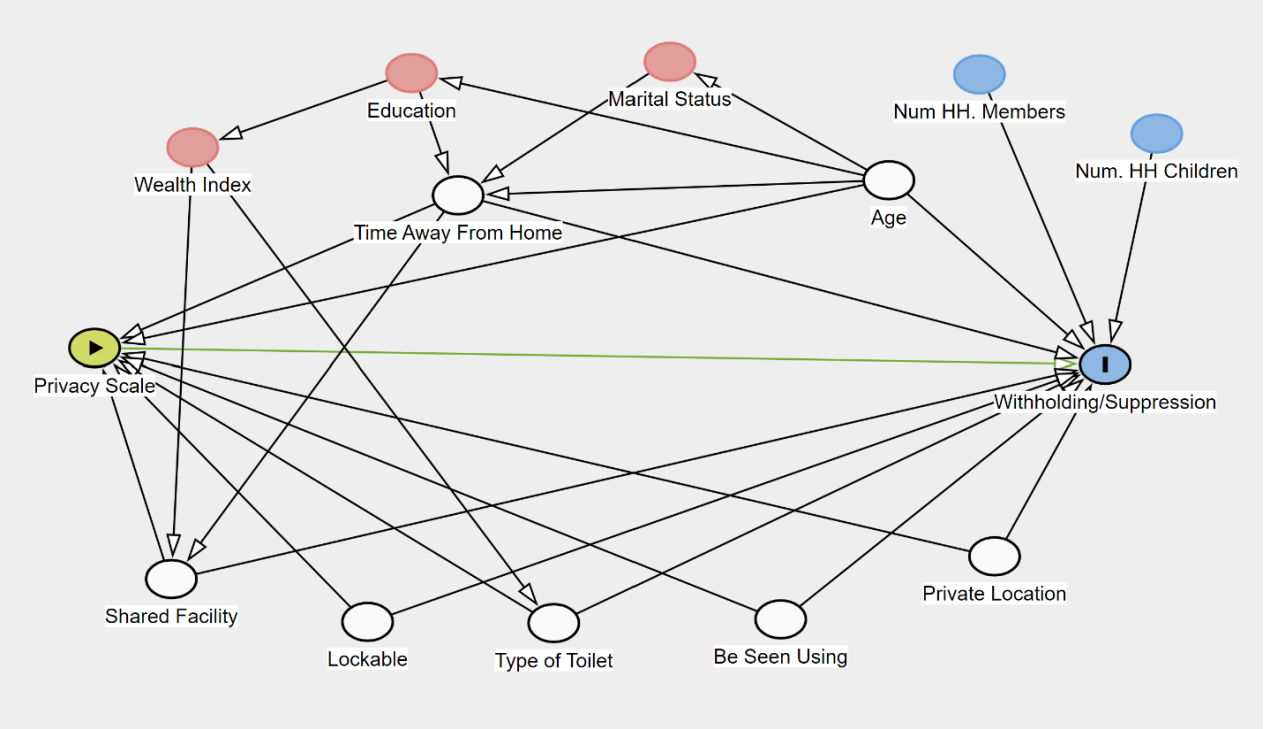
*Health Factor 2 was not used due to the circuitous relationship it introduced between exposure and outcome.

Supplemental Table 2. *Items included in the asset indices for each country according to the WHO International Wealth Index.*	
Does your household have (a/an)….	
Uganda	**India**
Electricity	Electricty
Radio	Radio or transmitter
Black and white television	Television
Color television	Pressure cooker
Non-mobile television	Sewing machine
Computer	Computer
Refrigerator	Refrigerator
Electric fan	Internet
Table	Table
Chair	Chair
Sofa set	Matress
Bed	Cot or bed
Cupboard	An air conditioner or fan
Clock	Washing machine
Watch	Water pump
Mobile Phone	Mobile phone
Cassette/CD/DVD Player	Land line phone
Bicycle	Bicycle
Animal-drawn cart	Animal-drawn cart
Motorcycle or scooter	Motorcycle or scooter
Car/truck	Car
Boat with a motor	Autorickshaw
Boat without a motor	Lorry/truck
Agricultural land	Agricultural land
Farm animals (local cattle, exotic/cross-breed cattle, horses, donkeys, mules, goats, sheep, chickens, other poultry, pigs)	Farm animals (local cattle, exotic/cross-breed cattle, horses, donkeys, mules, goats, sheep, chickens, other poultry, pigs)
	Thresher
	Tractor

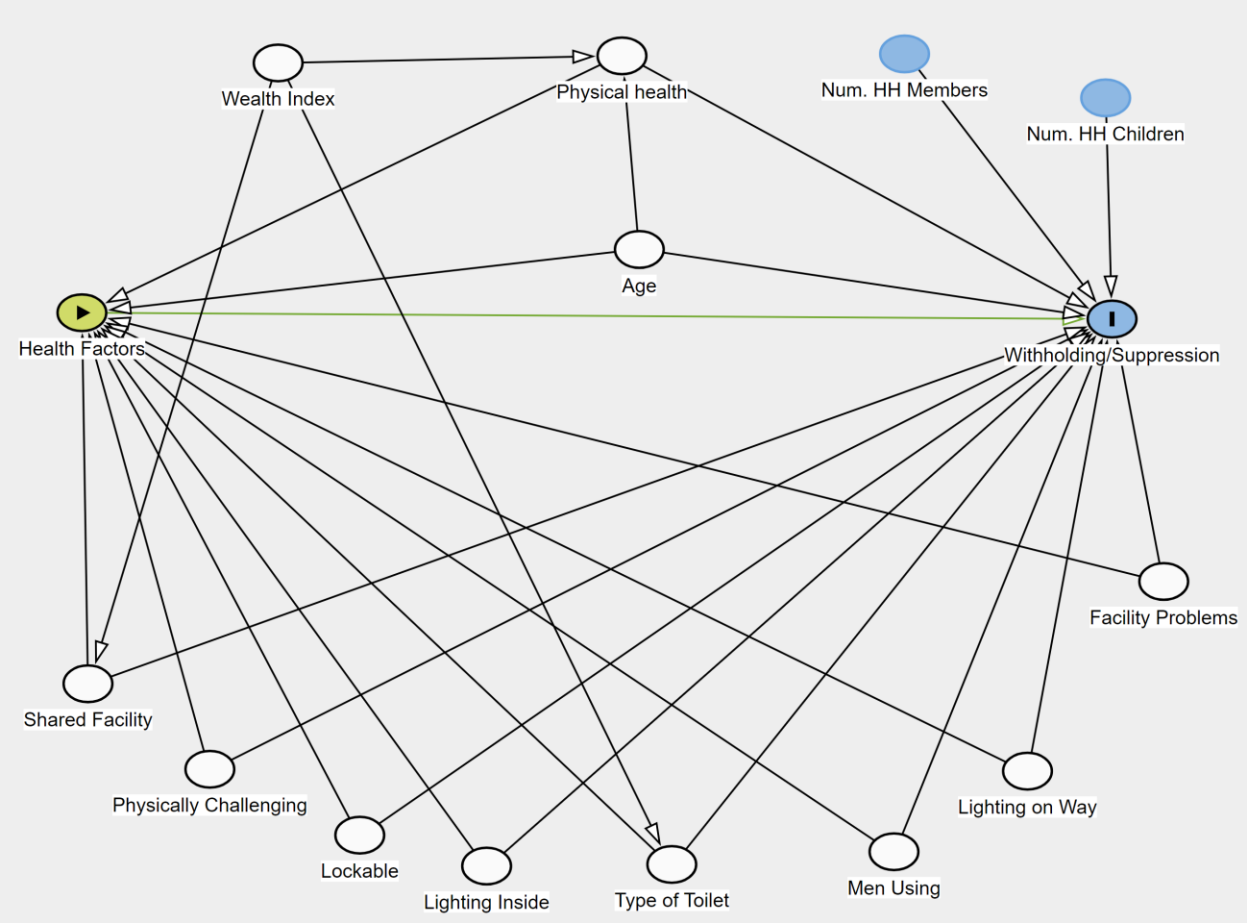
Supplemental Figure 4. *Safety Scale DAG used to inform covariate selection.*



Supplemental Figure 5. *Privacy Scale DAG used to inform covariate selection.*



Supplemental Figure 6. *Health Factors DAG used to inform covariate selection.*



Supplemental Text 1. *Withholding, Suppression and Sensitivity Models.*

- Logistic regression model to estimate the odds ratio of withholding between any two consecutive values for a given scale or factor score.
    - $\text{logit}(\textbf{Withholding}) = \alpha + \beta * \text{Scale or Factor Score} + \gamma_1 * \text{Age} + \gamma_2 * \text{Wealth} + \gamma_3 * \text{Num. Household Members} + \gamma_4 * \text{Num. Household Children} + \gamma_5 * \text{Hours Away From Home} + \gamma_6 * \text{Collect Water} + \gamma_7 * \text{Physical Health} + \gamma_8 * \text{Marital Status} + \gamma_9 * \text{Toilet Type} + \gamma_{10} * \text{Share Facility} + \gamma_{11} * \text{Private Location} + \gamma_{12} * \text{Seen Using} + \gamma_{13} * \text{Men Facility} + \gamma_{14} * \text{Lockable} + \gamma_{15} * \text{Lighting Inside} + \gamma_{16} * \text{Lighting Outside} + \gamma_{17} * \text{Physcially Challenging} + \gamma_{18} * \text{Facility Malfunction}$

- Linear regression model to estimate the effect estimate of a given scale or factor score on suppression frequency (represented by suppression score).
    - $\textbf{Suppression Score} = \alpha + \beta * \text{Scale or Factor Score} + \gamma_1 * \text{Age} + \gamma_2 * \text{Wealth} + \gamma_3 * \text{Num. Household Members} + \gamma_4 * \text{Num. Household Children} + \gamma_5 * \text{Hours Away From Home} + \gamma_6 * \text{Collect Water} + \gamma_7 * \text{Physical Health} + \gamma_8 * \text{Marital Status} + \gamma_9 * \text{Toilet Type} + \gamma_{10} * \text{Share Facility} + \gamma_{11} * \text{Private Location} + \gamma_{12} * \text{Seen Using} + \gamma_{13} * \text{Men Facility} + \gamma_{14} * \text{Lockable} + \gamma_{15} * \text{Lighting Inside} + \gamma_{16} * \text{Lighting Outside} + \gamma_{17} * \text{Physcially Challenging} + \gamma_{18} * \text{Facility Malfunction}$

- Sensitivity analysis for withholding: the logistic regression model used to estimate the odds ratio of withholding between any two consecutive values with all five safety factor scores as co-exposures. Compared to the logistic regression model with the safety scale score as the single exposure.
    - $\text{logit}(\textbf{Withholding}) = \alpha + \beta_1 * \text{Safety Factor 1 Score} + \beta_2 * \text{Safety Factor 2 Score} + \beta_3 * \text{Safety Factor 3 Score} + \beta_4 * \text{Safety Factor 4 Score} + \beta_5 * \text{Safety Factor 5 Score} + \gamma_1 * \text{Age} + \gamma_2 * \text{Wealth} + \gamma_3 * \text{Num. Household Members} + \gamma_4 * \text{Num. Household Children} + \gamma_5 * \text{Hours Away From Home} + \gamma_6 * \text{Collect Water} + \gamma_7 * \text{Physical Health} + \gamma_8 * \text{Marital Status} + \gamma_9 * \text{Toilet Type} + \gamma_{10} * \text{Share Facility} + \gamma_{11} * \text{Private Location} + \gamma_{12} * \text{Seen Using} + \gamma_{13} * \text{Men Facility} + \gamma_{14} * \text{Lockable} + \gamma_{15} * \text{Lighting Inside} + \gamma_{16} * \text{Lighting Outside} + \gamma_{17} * \text{Physcially Challenging} + \gamma_{18} * \text{Facility Malfunction}$

- Sensitivity analysis for suppression: linear regression model to estimate the effect estimate of all five safety factors as co-exposures on suppression frequency (represented by suppression score). Compared to the linear regression model with the safety scale score as the single exposure.
    - $\textbf{Suppression Score} = \alpha + \beta_1 * \text{Safety Factor 1 Score} + \beta_2 * \text{Safety Factor 2 Score} + \beta_3 * \text{Safety Factor 3 Score} + \beta_4 * \text{Safety Factor 4 Score} + \beta_5 * \text{Safety Factor 5 Score} + \gamma_1 * \text{Age} + \gamma_2 * \text{Wealth} + \gamma_3 * \text{Num. Household Members} + \gamma_4 * \text{Num. Household Children} + \gamma_5 * \text{Hours Away From Home} + \gamma_6 * \text{Collect Water} + \gamma_7 * \text{Physical Health} + \gamma_8 * \text{Marital Status} + \gamma_9 * \text{Toilet Type} + \gamma_{10} * \text{Share Facility} + \gamma_{11} * \text{Private Location} + \gamma_{12} * \text{Seen Using} + \gamma_{13} * \text{Men Facility} + \gamma_{14} * \text{Lockable} + \gamma_{15} * \text{Lighting Inside} + \gamma_{16} * \text{Lighting Outside} + \gamma_{17} * \text{Physcially Challenging} + \gamma_{18} * \text{Facility Malfunction}$