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Sanitation Insecurity:
Definition, Measurement, and Associations with Women's Mental Health in Rural Orissa, India

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Doctor of Philosophy

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Abstract

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By Bethany A. Caruso

Water, sanitation, and hygiene (WASH) are critical for human health. Research on WASH and health to date has predominantly focused on infectious agents and resultant diseases, leaving other facets of health—such as mental health—underexplored. Qualitative investigations suggest that women experience assaults to their mental health due to poor sanitation conditions and the gendered sanitation behaviors they are expected to perform. No research has aimed to determine the association between women's sanitation-related experiences and their mental-health outcomes. The primary aims of this research were to (1) understand women's lived experiences of sanitation beyond access to a sanitation facility—their *sanitation insecurity,* (2) create a measure of *sanitation insecurity,* and (3) determine the association between *sanitation insecurity* and mental health among women at different life stages in rural Orissa, India. This mixed-methods investigation found that women have a myriad of concerns related to their urination, defecation, and menstrual management behaviors that vary by life stage; women face challenges performing sanitation-related behaviors despite access to a sanitation facility; and associations between women's *sanitation insecurity* and well-being, anxiety, depression, and distress exist.

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## Table of Contents

## List of Figures

## List of Tables

## List of Tables (Continued)

# CHAPTER 1:

# Introduction

## Dissertation Summary

Water, sanitation, and hygiene (WASH) are critical for human health. While research on WASH and health predominantly focuses on infectious disease, other facets of health—such as physical, mental, and social well-being — remain under-explored. Research has revealed that women have faced obstacles to their physical, mental, social well-being in the presence of poor WASH conditions, which is further challenged by their lack of access to and control of WASH resources and the gendered WASH behaviors they are obliged to perform. There is a need for research that specifically explores women's experiences of sanitation and the health outcomes associated with those experiences. Informed by culturally-grounded studies of food and water insecurity that have sought to understand the lived experiences of individuals beyond their access to food and water, the primary goal of this research was to understand women's lived experience of sanitation beyond their access to a sanitation facility, and to determine if there existed an association between those experiences and their well-being. I pursued the following research aims to achieve this goal:

*Aim 1: To develop a culturally grounded definition of what 'sanitation insecurity' means to women in rural Orissa, India based on their voiced concerns related to urination, defecation, and menstruation;*

*Aim 2: To create a culturally-grounded measure of 'sanitation insecurity';*

*Aim 3: To evaluate the relationships between Sanitation Insecurity and mental health outcomes, including well-being, anxiety, depression, and distress.*

This research utilized an exploratory, sequential mixed methods design recommended for novel instrument development. Data was collected in Orissa, India from March 2014 to February 2015 in communities previously engaged in a cluster randomized controlled trial investigating the health impacts of a sanitation intervention.

Findings demonstrate that women have a myriad of concerns and negative experiences when addressing their urination, defecation, and menstruation needs. The gendered context within which they operate, the physical environment, the social environment and their own personal constraints contribute to these concerns and negative experiences, and therefore to their Sanitation Insecurity. The Sanitation Insecurity measure developed was comprised of seven factors that had mixed impacts on the mental health outcomes investigated.

This work contributes to the WASH field by providing insight into how sanitation experiences contribute to poor health; developing a novel measure to assess those sanitation experiences; investigating health outcomes beyond infectious disease; and by specifically engaging women who are under-represented in WASH research.

## Literature Review

Water, sanitation, and hygiene (WASH) are critical for human health and livelihood. Eliminating exposure to human feces via improved water and sanitation reduces risk of infectious diseases like diarrhea, trachoma, soil-transmitted helminthes, which can result in stunting, cognitive impairment, tropical enteropathy, or death, particularly among children under age five [1-8]. Despite the known benefits, global coverage of improved water and sanitation remains a challenge. It is estimated that 663 million people still lack access to an improved drinking water source (which protects water from contamination), and 2.4 billion people lack access to improved sanitation (defined as a facility that separates human excreta from human contact[9]). One billion people continue to practice open defecation globally[9].

Research on WASH and human health has predominantly focused on infectious disease, leaving other facets of health, such as well-being, under explored. Women may be at particular risk of poor physical, mental, and social health outcomes in the presence of poor WASH conditions. In many low-income settings, households have access to water because women facilitate that access by fetching it; in a woman's expected role as wife or mother[10] she is likely responsible for meeting household water needs[11]. Experiences and responsibilities may vary depending on context and the specific roles women are expected to embody may also vary over the life course. Depending on the circumstances, the expectations placed on women regarding water, sanitation, and hygiene may not be feasible to consistently perform or uphold. In order to more fully understand how WASH

impacts women and what gaps in research need to be explored, both a broader health framework and a gendered framework are warranted.

In this literature review, I first present frameworks for both health and gender that can be applied to understand existing WASH research with women and to identify research gaps.

Second, I utilize the frameworks presented to discuss the existing research on WASH, gender, and health. Specifically I discuss how hegemonic gender constructions negatively impact women's physical, mental, and social well-being by a) preventing or making it difficult for women to access the WASH resources or practice the WASH behaviors needed or required of them; b) making women disproportionately responsible for household WASH burdens; c) ignoring the WASH needs that are specific to women's biology; and d) denying women the ability to voice concerns, make decisions, remove barriers, or enact changes to their WASH environment.

Finally, in light of the research presented, I highlight important women-focused WASH research gaps that require further investigation. Specifically, I discuss how research on women's experiences of sanitation is lacking compared to what is known about women's experiences with water and conclude that there is a need to consider how sanitation experience may influence women's health beyond disease.

## 1. Health & Gender Frameworks for Understanding WASH impacts on Women

*Toward a broader understanding of health.* WASH research has focused primarily on infectious disease outcomes, which may be because the classification systems proposed to explain the relationship between WASH and health only include infectious diseases[12-16]. The application of these classification systems may have confined the scope of research on WASH and health by encouraging investigations that focus on a narrow set of physical exposures (such as the presence or absence of feces, pathogens, or WASH structures) and on a narrow set of outcomes (such as disease or death). As a result, the other facets of health defined in the Preamble of the Constitution of the World Health Organization (WHO)—physical, mental, and social well-being—remain under investigated[17]. To understand more comprehensively how WASH impacts health, the definition of health from the WHO should be applied.

*Considering gender.* Deniz Kandiyoti (1988) and Mimi Schippers (2007) provide applicable frameworks for considering women's experiences, behaviors and related health outcomes in relation to WASH [18, 19]. Kandiyoti argues that women operate within a gendered context and that this gendered context has 'concrete constraints' that effect or dictate what strategies women have available to optimize their life choices[19]. Schippers argues that femininities and masculinities are complementary and hierarchical relationships that "guarantee the dominant position of men and the subordination of women" (p.94) [18]. She also notes that men's social dominance over women relies on men having certain characteristics that are denied of women, like strength and authority.

Approaching health and WASH with a gendered lens may elucidate why women have different experiences, access to and control of resources, and health outcomes than men. These frameworks can help to identify why women may perform the WASH behaviors they perform, what behaviors are considered to be in the domain of women alone, how expectations of women are contributing to maintaining the dominance of men over women, and how deviations in WASH behaviors and expectations may not be feasible—even in light of scarce resources or interventions designed to help women—as they may serve to contaminate the gender structure that assures men to be dominant over women.

The influence of gender remains underexplored in the WASH sector [20, 21]. As noted by members of the Expert Group Meeting on Gender-disaggregated Data on Water and Sanitation (2008), "global commitment made in the areas of water and sanitation, including the MDGs [millennium development goals], do not specifically address the equitable division of power, work, access to and control of resources between women and men" (p.8)[22]. Water and sanitation are not "'gender-neutral and common resources'" (p.19)[22], but are very gender-specific. A recent correspondence in The Lancet called on researchers and practitioners to understand and tackle the underlying causes of gender inequity that contribute to women's WASH-related health burden, with attention to how women's water and sanitation experiences impact health. A full accounting of the research on WASH, health and women, with attention to gendered experiences, is warranted in order to identify research gaps in current knowledge and to pursue areas warranting further investigation to inform policy and programming that ameliorates the full array of health risks women may disproportionately face.

## 2. WASH, Gender, and Health

The following sections illuminate how gender structures inform expectations around WASH behaviors, which may contribute to women's health risks.

### *2a. Women face barriers to WASH resources and behaviors*

Hegemonic gender constructions negatively impact women's physical, mental, and social well-being by preventing or making it difficult for them to access the WASH resources or practice the WASH behaviors needed.

*Barriers to sanitation access.* Women face risks to their health and dignity when they do not have access to sanitation and barriers to sanitation make it difficult for women to perform the gender roles they are expected to play. The authors of a multi-country study investigating urban sanitation report that "good women" are those who carry out their household tasks as expected and practice sanitation behaviors in private. Without sanitation, women attend to their needs in the open and breach gendered boundaries that require them to stay in the home; they are burdened with the need to hide the body from view despite not having a place to do so[23].

Women have expressed fear, anger, disgust, anxiety, shame and helplessness in regard to their sanitation environment[24-27]. Women in India and elsewhere have reported being afraid of sexual assault when using public toilets, defecating in the open, or simply being in public spaces[24, 28, 29]. Women discussed threats, name-calling, having stones thrown at them, boys hiding in toilets at night to assault them, and men exposing

themselves[24, 28]. In Uganda, women expressed concern for their safety when accessing latrines at night because they were at risk for rape[25].

The design, number and condition of facilities available to women have created barriers to use. Women have noted that facilities lack disposal for menstrual hygiene materials, making them unsuitable for attending to menstruation-related needs[25]. In their research in the urban slums of India, Bapat and Agarwal (2003) note that one area had only 42 toilets for a settlement of 80,000, so women resorted to alternative, though less safe, locations[26]. Women also reported filth, overuse and smell of facilities to be barriers of use, causing disgust and anxiety[24-26]. Open defecation or defecating in the home was reported to be an alternative to using public facilities (if they existed) so that long lines, far walks, and filth could be avoided[25, 26]. Women reported defecating on railroad tracks, alongside highways, by the riverside, up hillsides or by the sea and accidents and injuries were reported in some of these locations[26].

Fees, going at certain times so as to not interfere with expected household obligations or to coordinate with others, and weather challenges all create barriers to attending to urination, defecation and menstruation needs[25-27].

*Barriers to water access.* Women and girls often need more water than men and boys because they are responsible for numerous household tasks and obligations. Moreover, they often need to get water early in the day in order to complete expected household tasks by an expected time, like cooking a morning meal or washing clothes[27, 30].

However, men may make it difficult for women to access water. In Zimbabwe, women reported tension when men would skip women in water lines, exploit the water for commercial gain, or make sexual advances toward the women trying to get water[27]. Women in rural northern Kenya also reported stress because women and men had to compete for the same water sources—women for domestic use and men for livestock—and water access was determined by male-led management institutions[31].

Difficulty accessing water makes it difficult for women to perform the WASH behaviors that they are expected to practice as wives and mothers. In Zimbabwe, women described reducing meals and not cleaning utensils or diapers immediately[27]. In Mexico, women lacked water for basic needs, including drinking, preparing food, bathing, and washing dirty clothes, dishes and toilets, and they expressed frustration, anguish, bother, worry and anger if they perceived inequity in how water was distributed in the community[32]. 28.3% of women surveyed in Ethiopia indicated that they needed to reduce water for washing clothes, 24.3% for cleaning the house, 23.6% for washing utensils, 21.1% for cooking, and 20.8% for household drinking in the previous 30 days [33].

Difficulty accessing water also makes it difficult for women to practice their own personal WASH needs, and women often sacrificed their own personal needs so that the needs of family members could be met. Water scarcity made it difficult for women in Zimbabwe to practice personal hygiene, which some believed could negatively impact the health of their breastfeeding children[27]. Women in northeastern Brazil indicated that they would hold back on their personal food intake and water-related needs to be

able to meet the water needs of the family[34]. In Ethiopia, 27.8% of women reported reducing the amount of water they used for bathing, 12.7% went to bed thirsty, and 3.7% went an entire day without drinking water in the previous 30 days[33].

An inability to leave the home interferes with women's hygiene. Married women in India—especially the recently married— discussed how men can bathe anywhere at any time, but women are confined to specific places and times, and must rely on their husbands for goods[23, 28, 29]. Women also described challenges related to accessing water and privately bathing after defecation or at menstrual onset due to restricted mobility and access[28, 29]. Women in Dhaka reported taking jobs that paid less because they provided access to private spaces for bathing and defecation[23].

***2b. Women are WASH Duty-Bearers***

Hegemonic gender constructions negatively impact women's physical, mental, and social well-being by making women and girls disproportionately responsible for household WASH burdens.

*The burden of water collection.* The task of providing water to the household is decidedly a female one[20]. Pooled data from 25 sub-Saharan countries and found that 62% of women and 9% of girls bore the responsibility for water collection, compared to 23% of men and 6% of boys[35]. Pooled data from a more globally representative sample of 44 countries, including Central and Eastern Europe, South Asia, East Asia and the Pacific, Eastern, Southern, Western and Central Africa, the Middle East and North Africa, and

Latin America and the Caribbean found women (58.6%) and children (30.4%) to be more common water carriers than men (9.1%)[36].

Fetching water requires a greater time commitment from women compared to men, resulting in disproportionate opportunity costs among women[36]. Time not spent fetching water could be used for income generating activities or for leisure, which is important for quality of life[37, 38].

Water fetching requires significant caloric expenditure, which reduces women's energy for other domestic obligations[39] and exhausts them before attending to other work, particularly when distances are long, walks are steep and loads are heavy[27, 36, 40]. Women may become susceptible to anemia and malnutrition during dry seasons when food is more scarce and water collection points are farther[40]. Water fetching can cause pain to the head, neck, back, shoulders, or hips, depending on how it is carried[27, 36, 39, 40]. The strain of carrying water is further complicated if women are carrying babies on their backs[27], are pregnant, or recently gave birth[40].

Water fetching has resulted in road casualties, and exposes women to risk of assault or attack, hair loss from carrying water on the head, dangerous and uneven terrain or social conflict due to disagreements about waiting times and places in a water point line[27, 31, 36, 41]. Women may be at increased risk of exposure to intestinal worms that burrow through bare feet[36] or malaria, filariasis, or schistosomiasis depending on the environments they pass through[40]. Water fetching disproportionately affects girls'

education if they are obliged to help with water collection that interferes with the school day[27, 42, 43].

*Increased burden in times of scarcity.* In times of water scarcity, women face greater challenges performing their expected roles; they spend more time collecting water during times of scarcity than during normal times, further straining their ability to engage in other activities, like household obligations or sleep[27, 30, 33] Women have had to increase their work hours during periods of drought in order to meet household water needs, specifically because of their 'reproductive work' responsibilities: cooking, fetching water, and caring for children and older family members[44].

*Mental health impacts of shouldering household WASH responsibilities.* Research has linked harsh water conditions with psychosocial distress and anxiety among women in Brazil, Bolivia, and Ethiopia. Coelho et al (2004) found significantly higher levels of anxiety and emotional distress among participants in a drought prone area compared to those in a drought free area in Brazil and they found women to be more emotionally distressed and anxious than men[34]. The authors argue that socially prescribed gender expectations and roles generally induce more stress among women than men. Wutich and Ragsdale (2008) reported that 72% of households in their study in Bolivia used less than the minimum amount of water recommended per day (50l) and did not have enough water for personal hygiene (58%) or cleaning their homes (62%)[45]. The authors found water insecurity to be associated with emotional distress and that women experienced more emotional distress related to water than did men. The authors conclude that distress

related to water develops not from the actual quantity of water accessible as much as from the social and economic negotiations that people (mostly women) need to navigate in order to access it. In Ethiopia, Stevenson et al (2012) found water insecurity (evaluated using their created measure) to be significantly associated with distress[33]. The authors highlight the valuable contribution of assessing the lived experience of water insecurity from local perspectives.

***2c. Women lack WASH Decision-Making Power***

Hegemonic gender constructions negatively impact women's physical, mental, and social well-being by denying women the ability to voice concerns, make decisions, remove barriers, or enact changes to their WASH environment.

*Lack of power to change sanitation environs.* Overall, there is little information on women's engagement in their sanitation environment, suggesting that more research and women-focused programs are needed. In a slum area of Mumbai, one woman discussed how she lived in a location where sanitation was not accessible; she and other ostracized women erected an enclosure for privacy over a drain they were openly using for defecation, but the railway authority tore it down[26].

*Lack of power to change water access and control.* The exclusion of women in management has led to the failure of many community water projects[46]. While some advocates argue that the inclusion of women in WASH is important for women's self-confidence, control of resources and status[47], others have indicated that women are

valuable for the sake of developing the resource or because of their role in the family as water bearers. In either case, that women are under-represented in managing water projects as a whole[20]. In Northern Kenya, Yerian et al (2014) found that women's exclusion from water management and decision making not only made it difficult for women to access the water they needed, it impacted their social health by exposing them to conflict with men who insisted on priority use[41].

### *2d. Women -Specific WASH Needs Remain Underexplored*

Hegemonic gender constructions negatively impact women and girl's physical, mental, and social well-being by de-emphasizing the WASH needs that are specific to women's biology.

*Women's pregnancy related WASH needs.* There are currently no studies that explicitly discuss women's water, sanitation and hygiene needs or experiences during pregnancy in low-income settings. Prospective cohort studies in the US revealed that pregnancy is associated with an increase in urinary incontinence and fecal incontinence [48, 49]. Urinary and fecal incontinence and over-active bladder have been shown to have negative impacts on women's quality of life.[50, 51] We can assume that women in low-income settings also experience over-active bladder and fecal and urinary incontinence during pregnancy, however, it is unclear how many women suffer from these conditions during pregnancy globally or in low-income settings specifically. Moreover, the extent of these challenges impacting quality of life in these settings is also unknown. Women in low-income settings may not have safe and private access to sanitation when an urge comes or

to water and soap for personal hygiene if urinary or fecal leaks occur and personal and clothes/linen washing is needed. These issues have yet to be assessed in low-income settings. There is not only a need to acknowledge that WASH is not a 'gender neutral' issue, but to be explicit about recognizing the specific, biological needs that are exclusive to women at certain stages of her life.

*Women's and girls' menstruation-related WASH needs.* Women's WASH needs during menstruation have received increasing attention over the last decade. In March 2013, the Water Supply and Sanitation Collaborative Council (WSSCC) brought together a range of stakeholders across sectors to "break the silence" around menstruation and issues related to menstrual hygiene management (MHM)[52]. I served as an invited speaker to discuss a research initiative to understand girls' challenges managing menstruation at school in four countries (Bolivia, Philippines, Rwanda and Sierra Leone) in partnership with UNICEF. One of the recommendations we collectively agreed upon at the meeting was a need for more research to understand what women and girls in low-income settings are going through and what they need to manage menstruation effectively and with dignity. More recently, the JMP published a series of technical documents outlining the proposed targets and indicators for WASH post-2015 and menstruation is featured prominently, specifically the need to ensure that menstrual hygiene facilities are available in schools and health centers (I served as an invited reviewer for the initial draft) [53, 54]. Through the process of creating these targets and indicators, the hygiene working group also developed working definitions of menstrual hygiene management and menstrual hygiene facilities that can guide future programs, monitoring, and research [53, 55].

While these efforts are encouraging, the proposed menstruation-related indicators and targets were not included in the final Sustainable Development Goals.

There is a need to understand what women and girls' experiences during menstruation are and to evaluate if they have what is needed to manage menstruation. There have been anthropological investigations of menstruation that have sought to understand attitudes, taboos and meanings behind practices and beliefs[56-58]. Yet, limited research has been carried out among women and girls to understand management behaviors, strategies, needs and the health implications of current practices[59].

**Research Gaps**

Unlike research on water, there has not been any rigorous research to understand and evaluate the lived experience of sanitation from the perspective of women. Important qualitative studies have demonstrated that women experience an array of challenges related to sanitation that are specific to their role and needs as women, including fear, shame, disgust, and helplessness. Further work is warranted that fully investigates women's sanitation experiences but does so with attention to women's life course as well. Quantitative studies have found that harsh water conditions impact women's anxiety and psychosocial distress. While the literature review has revealed that women have qualitatively expressed distress related to their sanitation experience, a quantitative evaluation of women's distress related to sanitation experience has yet to be evaluated.

There has been a recent call for more mental health research that takes a life-course approach and seeks to understand the relationship between environmental exposures and mental health[60]. Research on gender and global health has found that women experience more depression than men and this is related to exposure to life stressors[61]. It is therefore important to quantitatively assess and determine whether or not sanitation experience may be a life stressor. It has also been found that gender-based factors, including heavy workload, humiliating events that devalue a core role, entrapping life experiences related to marital relationship, low decision making power, and experience of sexual violence, and low family support also contribute to stress[61-63]. In terms of sanitation, women have expressed shame and humiliation if their menstrual status is known, if they are seen defecating in the open, or if they are perceived as dirty. This shame is largely linked to their inability to be, as Joshi notes, a "good woman"[23]. In addition, the literature review demonstrated that many women have little control over their sanitation environments, express fear of sexual assault when accessing sanitation locations, and may need to rely on family support if a sanitation need arises at night. The aims of this dissertation were designed to fill these research gaps.

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# Chapter 2:

## Understanding and Defining Sanitation Insecurity: Women's Gendered Experiences of Urination, Defecation, and Menstrual Hygiene Management in Rural Odisha, India

### Introduction

Globally, an estimated 2.4 billion people lack access to improved sanitation— a facility that hygienically separates human excreta from human contact. Of these, 946 million people lack access to any form of sanitation and practice open defecation[1] . Poor or non-existent sanitation facilitates exposure to fecal pathogens and has been linked to multiple infectious diseases, including diarrhea, soil-transmitted helminth infection, trachoma and schistosomiasis, which cumulatively can result in cognitive impairment, stunting, and tropical enteropathy [2, 3].

India represents a particular sanitation challenge, with 44% of the population lacking access to sanitation, including six in ten rural dwellers[1]. Considerable progress has been made under a succession of government programs that emphasize building latrines in rural areas. Despite these efforts, however, two rigorous evaluations found limited increases in latrine coverage and no detectable health impacts[4-6].

Lack of impact on infectious disease-related outcomes may be related to sub-optimal toilet use; open defecation remains common in India even among those with access to an

improved household toilet[7, 8]. There is limited research that seeks to understand why people choose to use or not use toilets when available.

Understanding the drivers of latrine use and non-use, however, requires an understanding of the experience of sanitation, which may vary based on cultural norms, gender, life stage, and personal needs regardless of facility access, or how the experience of sanitation may pose health risks beyond fecal pathogen exposure. Studies have explored the experience of "water insecurity" and have found that assessing the lived experience of water contributes greatly to understanding of behavior and health.[9, 10]

Research suggests that the lived experience of sanitation may contribute to poor physical, mental, and social health outcomes, particularly among women. Women have expressed anger, disgust, anxiety, shame, fear, and helplessness about their sanitation experience and have reported that sanitation facilities are unavailable or filthy, overused, fetid, and full [11-16] This research suggests that the lived experience of sanitation is complex and, just as people experience water insecurity, women may be experiencing sanitation insecurity when they contend with inhospitable environments that may be unsafe, inaccessible, dirty or ignite fear and stress when managing their urination, defecation, and menstruation needs. There is a need to understand and define a corresponding "sanitation insecurity" construct—indeed a call for research to understand the lived experience of sanitation and resultant health impacts has been made[17].

The primary goal of this research is to develop a culturally grounded definition of what sanitation insecurity means to women in rural Orissa, India. To arrive at this definition, this work aims to understand women's experiences of sanitation by documenting their urination, defecation and menstruation related concerns and developing a conceptual model to explain the factors that contribute to their positive and negative experiences. Defining and coming to understand if and how women experience sanitation insecurity will provide insight into why women choose to use or not to use toilets and help ensure that the next generation of interventions and programs better suit women's needs.

Glass and McAtee's framework (2006), which considers how individuals and their biological needs are nested within hierarchies of the socio-ecological context, guides this research. This framework considers changes that individuals and contexts may undergo over time and how opportunities or constraints may vary temporally and within different contexts[18]. Using this framework, we sought to explore temporal variations in sanitation experiences across life stages, seasons, and times of day while also noting the socio-ecological context within which sanitation-related biological behaviors are addressed. To gain insight into the gendered context within which women operate, this research also is informed by Kandiyoti (1988), whose scholarship describes how women operate within a set of 'concrete constraints' that influence the strategies they have available to optimize their life choices[19]. Through analysis, we specifically identify the sanitation concerns that are specific to their gendered status and the strategies they use to adapt.

## Methods

### Setting

This research was conducted in March –April 2014 within a sub-sample of villages previously engaged in a cluster randomized trial in Orissa, India evaluating the impact of a rural sanitation intervention within the context of the Total Sanitation Campaign[20]. Details about the setting and the intervention have been published elsewhere[21]. Toilets provided as part of the intervention remained in the households.

### Qualitative Methods

Following standard approaches in cultural domain analysis, which assumes that a fixed knowledge base or set of cultural beliefs specific to a social group exist, Free-List Interviews (FLIs) and Focus Group Discussions (FGDs) were used to understand women's voiced concerns and to build an understanding of sanitation insecurity [22, 23].

#### *Free List Interviews*

Free-listing is an elicitation technique used to understand common perceptions shared across a homogeneous group of individuals around a specific concept or topic[24]. FLIs were used to learn about women's concerns about urination, defecation, and menstruation and to determine how common concerns were among participants.

Eight communities (3 intervention and 5 control) were selected purposively by members of the trial research team to represent diversity (i.e. toilet coverage, access to water, flooding in monsoons).

We identified four life stages from which to sample participants: (1) Unmarried women (UMW) living with their parents; (2) women who had recently married (RMW; married in the previous 3 years); (3) women married (MW) over 3 years; and (4) women older (OW) than 49 of any marital status. UMW living in their parents' home tend to have more control over resources and thus their personal hygiene than RMW; the latter depend on husbands and have limited mobility outside the home[25]. MW typically have greater freedom of movement and social status than RMW[26]. OW are at greater risk of incontinence[27], have unique needs because of aging, are not represented in demographic and health surveys, and infrequently feature in sanitation studies.

Free-lists are recommended from at least 30 randomly selected participants, with more needed if variability among participants is sought[24]. Because we sought variation in the sample by intervention status (control vs. intervention), toilet ownership, and life stage, we aimed to interview 64 women (2 per strata per village). We initially recruited women through randomly selected households. This method identified few women in the target strata, so we engaged community members to identify eligible women through non-random methods.

FLIs were carried out one-on-one by two Research Assistants (RAs), fluent in both English and Oriya, who participated in a multi-day training and piloting prior to data collection. Women were asked to create three lists indicating concerns when they (1) urinate, (2) defecate, and (3) menstruate. Questions were asked of all participants in the

same manner[24]. Each question included a series of 'probes' to learn if women had unique concerns (1) at night, (2) during the monsoon, (3) when pregnant (as applicable), and (4) about dependents in the household. Women were asked to generate lists based on "women in this community" so they could answer with candor[9]. Interviewers noted that women voluntarily shared personal concerns without reservation.

***Focus Group Discussions***

FGDs aimed to gain detail about the concerns noted in FLIs. They were held in four different communities (two intervention and two control) once FLIs were complete. Two were held per community, one with unmarried women and one with women married for any time period as we could not get enough participants to hold one per life stage.

RAs called contacts in communities to recruit potential participants, met women at a private community location, and gathered demographic information one-on-one from participants prior to commencing the FGD collectively. During the FGDs, women were asked to discuss concerns related to urination, defecation and menstruation; were probed about night, monsoon, pregnancy, and dependents; and were asked to discuss noted concerns in detail as a group. We specifically asked about concerns that were mentioned in the FLIs if not mentioned organically during the FGDs. The RAs conducted FGDs in Oriya, one facilitating and the other taking notes.

## Analysis

FLIs and FGDs were digitally recorded and translated directly into English. RAs listed out all concerns noted during the FLI and then listened to full recordings to verify initial lists. The list items were collated by the primary author (BC) and used as a preliminary codebook. BC then read all transcripts, applied those list-based codes and created others as needed using MAXQDA analytic software. BC then independently created lists for each participant and compared them to originals created by the RAs for consistency. Frequencies of concerns by participant strata and toilet ownership were then generated.

We applied thematic analysis to understand concerns expressed by participants in FLIs and FGDs. It uses a range of tools to examine themes, present the voiced experiences of participants, and build conceptual models[28]. For each concern, we aggregated coded text into summative tables to review collectively and memo. Tables were then sorted by participant type to identify variation by strata and further memos were created to inform results reported[28].

## Ethics

Protocols were approved by the Emory University Institutional Review board (Atlanta GA) and KIIT University (Bhubaneswar, India). Oral consent was obtained from each participant before the initiation of any interviews.

## Results

### Participant Demographics

Sixty-nine women participated in the FLIs: 16 UMW, 12 RMW, 22 MW and 19 OW (Table 2.1). We were unable to get 2 women per category per village as planned because there were not enough RMW in each village who were able to participate. Participants ranged in age from 18 to 75 (mean 36.6). All women interviewed were Hindu, 85% had a card indicating they lived below the poverty line (BPL), 66% were General Caste (who, along with Brahmins, are not eligible for caste-related government benefits), 62% had children, 69% continued to experience menstruation, and 63% had water and 54% had toilets within their household compound.

Forty-six women participated in FGDs: 23 unmarried and 23 married women. Participants ranged in age from 18 to 70 (mean 30.7), 98% were Hindu, 67% had a BPL card, 65% were General Caste, 80% continued to experience menstruation, 70% had water and 59% had a toilet within their household compound (Table 2.2).

### Urination and Defecation Concerns

In FLIs, 63 (91%) participants indicated concerns about urination (29 total concerns), and 65 (94%) indicated concerns about defecation (39 total concerns), revealing that the majority of women had concerns about these behaviors and that a significant range of concerns existed (22.3 summarizes concerns noted and definitions). Concerns fell into four domains, three that align with the socio-ecological levels noted in the Glass and

McAtee framework: physical environment, social environment, and personal constraints. The fourth domain, gender, features concerns related to women's status and noted adaptation strategies, as informed by Kandiyoti. Concerns were similar for urination and defecation and are presented together.

### *Urination and Defecation Concerns Related to the Physical Environment*

Many concerns are inter-related and are italicized in the text as explained.

#### *'Place' and related concerns*

The top concern for all women was the *place* where they urinated or defecated (Tables 2.4 and 2.5), specifically lack of privacy, dirtiness, and distance. Several other concerns resulted from their worry about *place*. For urination, women in all strata worried most about needing to urinate in an open place, such as their backyard, which lacked privacy. For defecation, women across all strata worried equally about open and dirty *places*. Many described how they would maneuver carefully through "defecation fields" (locations in the community used for defecation) to avoid feces or wait if fields were occupied by others, particularly men. For example, one older woman clarified, "The field is dirty…I will go to the middle of the field and defecate then. There will be defecation over defecation, how to sit above it? (403005_FLI_OW_NoToilet _313)

Having a toilet at home influenced *place* concerns for defecation, but not urination. Concern about *place* was expressed more frequently for defecation among participants who did not have a toilet at home than among those who did, as was the concern that they

had *no proper facility* (toilet). For urination, concern about *place* and having *no proper facility* was similar among women with and without toilets.

Having a toilet had scant impact on where women urinated: among those with toilets, only 14% of FLI and 41% of FGD participants reported ever using toilets to urinate, whereas 95% of FLI and 100% of FGD participants reported ever using toilets to defecate. Women generally did not urinate in toilets because they were considered dirty and they needed to change clothing to enter, which took time.

When women who defecated in the open found places to be dirty with feces, urine or mud, or lacking privacy, they adapted by waiting for people to leave or by walking farther away. Women typically bathed after defecating, and also had to wait if men or boys where in a bathing area. Waiting and walking to seek clean areas or privacy led women to worry about how much *time* these activities took and the household *obligations* they were not able to attend to as a result. *Time* and *obligations* were of particular concern to UMW and MW because they typically shouldered greater household burdens than RMW or OW, who expressed these concerns less frequently or not at all.

> We'll sit [to defecate] if there is no one. At times we face trouble… If a boy is coming to the river after defecation for bathing, that's it. Then we have to wait until he finishes and goes. So, however much work we have, can we just come back [without bathing]. (607078_FLI_UMW_Toilet_263).

Through analysis of the interview text, we found that OW were specifically concerned about defecation *places* being too far away and they were more worried than other women about *walking* (nearly 50% compared to <25% for other women), which caused fatigue, overexposure to rain or hot sun, and pain. Women also noted that *walking* to defecation and urination places was particularly challenging during pregnancy because of the exertion required, added weight, and, in later stages, unsteadiness on uneven terrain.

> Interviewer: So if you have a toilet now, would that be comfortable for you or not?
>
> Participant: Of course.
>
> I: But you said that open defecation was comfortable for you.
>
> P: Not anymore at this age. I can't walk. (402104_OW_NoToilet; 180)

Women worried about their *general health* when *places* were dirty, particularly when defecating. Concerns for *health* were more common among women without toilets. UMW most commonly expressed concern for their health during defecation. Only UMW and OW expressed concern during defecation: "In the field, all defecate, the stool dried up and is everywhere. If you sit to defecate on it, you get many types of diseases. That fear is there." (501012_FLI_UMW_NoToilet).

Women expressed a specific concern about getting a *'urine infection'* from urinating in a place where someone had already urinated. This was most common among UMW (40%), RMW (36%), and MW (29%) who worried that this could impair their health, future fertility, and the health of unborn children. Many women noted that having a bathroom

would be beneficial because it could limit their exposure to urine: “People have fear of urine infection... Say if a diabetic is sitting to urinate, we will go and urinate on it… Or if anyone has any other disease…If we go and urinate there, that disease will come to our body…” (105_FGD_UMW_P2_79-83).

While pregnant, one RMW stopped using the toilet for defecation due to perceived risk to her unborn child, indicating that toilets were not assumed to be better.: “When I was pregnant with my son, I mostly did not go to the latrine…I used to go out in the open…because I would not have seen who had urinated there and whether they washed or not...if their diseases infect us then our child would be affected” (403046_2_C_L; 549).

More women with toilets (36%) worried about access to *water* for defecation than those without (19%). Women had to bring water from outside to flush feces and clean themselves because toilets did not have direct water access inside. Women without a toilet typically defecated near water sources to facilitate cleaning. The need to fetch water for defecation was a deterrent to toilet use, particularly among OW, infirm, or pregnant women.

> P5: We have become old. To fetch a bucket of water is difficult.
>
> P3: If there was water in the toilet, the way I have become handicapped, I would defecate there. (FGD 626_MW_1140).

Some women worried their toilets were unusable due to broken doors or roofs or had dirty *conditions* for defecation, like visible feces or odor. RMW were most concerned about *unusability* or their *conditions*. These worries were likely related to a concern held almost exclusively by RMW: that they were forced to use the toilet (27%). Household toilets were often built for RMW prior to marriage and they were expected to use them. RMW were often the only household members using toilets and lacked agency to influence conditions. They missed roaming outside and selecting where to go.

*Concerns specific to seasonal variation*

When probed about the monsoon season, women in all strata discussed how the rains exacerbated their concerns about the places where they urinated and defecated. Heavy rains made environments – defecation fields, backyard urination spots, paths to toilets – muddy and water logged. Women in all strata worried about *getting dirty* and *getting wet* when urinating or defecating; they described how they had to wade through mud and water to find somewhat cleaner or drier locations, often settling for areas that were simply less bad than others. Women also were concerned about how much extra *work* they would have, such as washing themselves and clothes. Some women were able to urinate under roofed sheds or use umbrellas to get to toilets or fields, but their legs and feet were still muddied. Some places – toilets included – became unusable and women needed to find alternative locations.

> We have to walk in water, which is up to the chest level… The toilet will be filled with water, so we cannot use it…Our father-in-law ties a huge piece of wood in between two

> coconut trees for we daughter-in-laws to defecate…We will go in the evening together so that we will not be scared. (607004_FLI_MW_Toilet _320-325).

Muddy and slippery monsoon conditions caused women to be concerned about *falling*, particularly when pregnant or old: "The difficulty is, it will be muddy everywhere, where will we sit to defecate? ...I slipped near the pond and fell with my face down. I was seven months pregnant then. I hurt my waist and got scratches in the hands." (206007_RMW_L_322-318)

Women across all strata worried more about *general health* during monsoon due to harms from overexposure to mud, rain, and cold. One older woman noted: "We would be getting wet in the monsoons [when defecating], rinsing and drying the clothes, fever, cold and so on. Will have wounds and sores on the hands and legs." (501009_FLI_OW_NoToilet_686).

Women with functional, roofed toilets indicated that they typically used their toilets for defecation during the monsoons, even if they preferred to go outside during other times of the year. As one unmarried woman noted, "In the rainy season we don't go outside…it is very dirty outside. We have to walk on the mud and slush, hold an umbrella and go and still get wet. So I don't go out, [I] use the latrine instead" (607093_FLI_UMW_Toilet _178).

Women without toilets described how having toilets would be of particular use during the monsoon, when going out in the rains, high wind, and storms were so challenging: "In

rains and storms, when you need to go for defecation immediately, how can you just go out then in that weather? ...if you have a latrine you could just defecate there… Aren't you bound to do it in the house… we risk our lives going out to the open" (206054_FLI_MW_NoLattine_327-337).

Women pointed out that summer conditions were also difficult and toilets without roofs were also problematic then: "The problem is this is summer… there is no roof… it will be very hot and sunny, will urinate fast but defecation takes time…I will sit for a minimum of 10 minutes or not. So if the sun directly effects your head, it becomes hot." (628_FGD_MW_P3_1073)

*Concerns specific to night*

Women expressed *fear* about urinating and defecating at night because they felt places were unsafe, whether going in toilets or in the open. Some women were afraid of the dark, while others specifically worried about animals, ghosts, thieves, witches, drunkards, and men who may cause *harm*. UMW and RMW were most fearful and concerned about harm, perhaps because they are perceived to be at greater risk of rape or assault from men compared to Married and Older women.

> Here in our neighboring village… Three or four had come. They lifted the girl and raped her, they have opened the pant and the shirt, so evil…she was lying almost dead... So where will the girls go? Be it daughter-in-law or daughters, where will they go? We have no fear. We are 60, 65, 70, we think who will rape us? (626_FGD_MW_P5_189).

Night conditions were even more challenging during the monsoon, which made muddy and slippery grounds harder to navigate. Advanced age, illness, or pregnancy further complicated this difficult time.

> The concern is about going out for defecation in a pregnant state during monsoons at night or after dark… There's always a fear of slipping and falling down, hurting yourself. The child may be harmed or I may be harmed in some way… (206098_3_OD; 390)

***Urination and Defecation Concerns Related to the Social Environment***

Women, most often UMW, were concerned about *people* seeing them urinate or defecate, and were also most worried about *shame*, whether someone would actively insults them or would talk about them to others. UMW talked often about their reputation and their future marriage prospects; their specific worry about *people* and *shame* may be related.

> I would have gone to urinate, there would be people from another village, what will they think? They will say… she has no regard and she sat to urinate in front of us. So feel a little bad about it. (402072_FLI_UMW_NoToilet_352).

Women with toilets also worried about *people*. Even if toilets had doors, women worried about being seen coming in or out.

> Interviewer: Why do you not use the latrine at day time?

> Participant: It is near the house, people pass by. So feel a little shy going in. (403046_FLI_RMW_Toilet_598-601)

Women were concerned that privacy, if they had it, may be fleeting. If people suddenly appeared, women, particularly UMW, worried about having to *stand* immediately while urinating or defecating. UMW more often worried that they would *urinate on themselves* than others, likely because of the shame it could bring them. These concerns were among the reasons that many women said a bathroom, an enclosed space for urinating and personal bathing, would be useful. Concern for *defecating on the self* was expressed more often in FGDs than FLIs, particularly among older women who may have less control. Both incidents resulted in women having more *work*, like cleaning the body and clothes.

> When we defecate outside and suddenly any male comes over, we stand up. We either hold the feces at that moment or if it was already out as we stood up then we get it all over our legs. That's one trouble. (406_FGD_MW_ P2_397)

Women also *helped*, and in some ways depended on, one another by providing each other company to the defecation field or to toilets or outside at night. However, providing *help* meant providing time that was not always convenient: "If her cooking is not over, we will wait for her. If another person's child is crying will have to wait for her. Is it not inconvenient?" (105_3; P7; 546).

Women with no or few female family members who could provide help were particularly strained by dependents, obligations, and helping others: "If we would be cooking…will

have to look for someone to watch…have a fear that the sooner I finish defecating…I have the dish on the stove. Will have to rush." (403001_FLI_MW_NoToilet_407).

Women were very concerned about *needing support* or company to urinate or defecate, regardless of toilet status, and some felt that there were *barriers to support,* factors impacting their ability to access support when needed. UMW were most concerned about not finding support for urination and defecation, though many other women reflected on the specific need for support during pregnancy. RMW and OW reported the least amount of concern, likely because it was common practice for RMW to be well accompanied and OW were most independent. One older woman reflected: "Pregnancy is quite troublesome. You need somebody to go along with you at this time. Sometimes you get company and sometimes you don't." (607037_FLI_OW_Toilet _286)."

At night, the *need for support* and worries about *barriers to support* were greatest since many women were *fearful* then and concerned about *harm*. Without support, they used suboptimal locations, suppressed or went alone, risking a scolding.

> [My husband] must be thinking that he is working all day and my wife is disturbing me and saying come let's go defecate. So once I thought I will not wake him up today and go alone…I was sitting there to defecate, it must be 2am at night, someone clapped thrice. I was scared… He said 'You did not call me! How did you go alone!' (206098_MW_Toilet_299).

### *Urination and Defecation Concerns Related to Gender*

Many of the concerns women described were unique to their biology as women and to their gender-normative position in the community. Women's biology and their gender-normative position determine how they must perform their urination and defecation needs. Women in FGDs discussed how it is harder for them to urinate because they must squat and expose themselves publically and to germs while men can just stand.

> We are women we can urinate only when we open our clothes. (105_FGD_MW).

> If we get pressure to urinate will have to sit and urinate somewhere…males go and urinate on the roadside and girls will hide and urinate. We do not know what is the condition of the place we sit to urinate, whether there would be germs. (626_FGD_UW).

In terms of their gendered role, women, most often RMWs, were concerned about leaving *dependents* behind, whether small children or adults who required care like the infirm, elderly or disabled and about neglecting household obligations when taking *time* to defecate. Neglecting their gendered roles for their personal needs resulted in fear and anxiety about the consequences.

> Once I had gone out to urinate leaving my kids at home. I told my daughter to watch her baby brother until I returned. My mother-in-law was angry as how I could leave behind

> two small kids and go. So there is always a fear if we leave behind kids alone at home. (403046_FLI_RMW_ Toilet _590).

Women were responsible for – and thus had concerns about – helping others with their needs too. While some women thought having a toilet would help them support family members, others felt it could create additional work, like fetching water or cleaning. Women also acknowledged that providing *help* was particularly difficult when pregnant, but expectations still existed.

> Yes our mother-in-law, now the old woman cannot see. When she is going to urinate … we are forced to take... If we do not go, she will urinate on the bed. If she gets pressure to defecate at night, old woman, what will she do? When she gets pressure she will ask us to go with her to the field and if we do not accompany, she defecates on the bed. That is very inconvenient. (628_FGD_MW_3_P1_314)

Concerns like fear, harm from men, and the need to attend to obligations in the household or care for others were specific to women and their roles in the community. Yet women had limited ability to make strategic decisions about sanitation and had to function within a set of gendered constraints that limited how they made choices about their urination and defecation needs. Women could not, for example, influence change in their physical and social environments, like initiating the construction of facilities, or decide on cooking at a later time. Instead, women necessarily put their responsibilities to others before their own needs. Women had limited control over their urination and defecation and exercised control over concerns, like fear or obligations, by controlling their own bodies.

Specifically, women *suppressed* urination and defecation urges and limited food and water intake. Women worried about the potential harm these actions caused their bodies.

> Say it is time for children to go to school. No matter what, will have to make them ready by 9:30. Make them bathe and then give them food to eat quickly, dress them up, fill their water bottle, arrange their books and in the meantime, if you have the pressure to urinate or defecate, you have to suppress. (628_FGD_MW_P5_1434).

> I do not eat at night out of the fear that I will have the pressure to defecate… Recently I had been admitted in the hospital as I reduced eating. The doctor was angry… he said that if you do not eat at night you will die. The condition you are in you will die. (626_FGD_UMW_P3_386)

***Urination and Defecation Concerns Related to Personal Constraints***

Women reported urination and defecation concerns that were specific to their personal physical constraints.

*Squatting* was particularly challenging for OW during urination and for both MW and OW during defecation. RMW, MW, and OW reflected that squatting was particularly problematic during pregnancy: "In that pregnant condition, sitting down to defecate will be a pain or not? It feels uneasy to squeeze and sit." (402077_MW_Toilet; 716)

Women were concerned about *difficulty or pain*, most commonly MW and OW during defecation, like constipation and pain during menstruation. A few women reported

urinary and fecal *incontinence*, making their ability to control urges for even a moment impossible.

> When I had my delivery… it was really painful…they had to tear the uterus, waste bowel and everything with a blade. After tearing, they haven't stitched properly… Whenever I want to defecate urgently, then my hand and legs get soiled with it. (208066_FLI_MW_Toilet_429).

### *No Concerns Related to Urination and Defecation*

Four FLI participants did not have urination concerns (1 MW, 3 OW), two did not have defecation concerns (1 UMW, 1 MW), and two did not have problems related to either (1 UMW, 1 RMW). Women with no urination concerns discussed having drains in their courtyards for use at night or areas that enabled privacy for use during the day, like a bathroom, a shed, or secluded backyard; two indicated that they had lights so they felt safe at night; and two comfortably used umbrellas during rains. Of those with no concerns about defecation, all had roofed toilets that were usable during monsoon season.

## Menstruation Concerns

Sixty-seven FLI participants discussed worries about menstruation and noted 32 unique concerns (Table 2.6). Women who were no longer experiencing menstruation provided responses based on memory.

***Menstruation Concerns Related to the Physical Environment***

*Bathing* was among the top concerns for UMW, MW, and RMW, which is required at menstrual onset when women are considered untouchable. They cannot touch anything or perform certain tasks until they bathe. Women indicated that bathing at night during the monsoon or winter seasons was most difficult due to harsh rain or cold: "It is very inconvenient in winters. It feels so chilly to bathe at night. Also during monsoons, if it is raining then we have problems bathing" (607049_FLI_UMW_Toilet_349).

If women began menstruating late at night they waited to bathe until morning and separated themselves from their beds due to their untouchable status. Women across all strata reflected that *forced separation* was challenging since they had difficulty sleeping and endured physical discomfort through the night. One unmarried woman commented: "If it starts at midnight, will be forced to stay separately and will not touch anyone. Feel very awkward…it is a dirty thing. So feel bad. Feel damp" (501012_FLI_UMW_NoToilet_1141-1145).

Women, most commonly RMW, MW, and OW worried about the *work* they would have to do cleaning if their period started while already in bed: "At night I am scared that if it starts, will have to wash the whole house, the bed. If we would know beforehand that it will start at this time, on this date, then I would sleep separately" (403046_FLI_RMW_Toilet_816).

*Washing* menstrual cloths was another major concern among women in all strata, either because privacy was hard to find or locations for this purpose were inconvenient. Women, most commonly RMW, worried about accessing *water* for washing cloths. Given their restricted movement, RMW had to depend on others for access to water or seek sources that were nearby but not always preferred. Women had variable access to water sources for cleaning, like tube wells or ponds, and not all were clean, close, or private. Several women preferred to use disposable pads because washing cloth was difficult or made them *feel dirty* and because many experienced *leaks* or *wounds* on their inner thighs or waist in the humid summer months from rubbing cloth. However UMW and RMW, the women who most wanted pads, reported that *accessing materials* was very hard because markets were difficult to reach or were inaccessible unless they had someone to get them.

> When we have menstruation…. we go to the pond and wash. Those who have tube well, they fetch water from the tube well and wash [the cloth] in the backyard and those who do not have tube wells, what will they do? Will the germs go inside the body or not?...I have hatred because it is difficult to wash the cloth. We are not able to use sanitary pads. As the market is a little far away, we will get them only when we go ourselves … Will we ask men and boys to get it for us? …So getting that is a little difficult and so we have to use cloth and feel dirty to wash. (502038_FLI_UMW_Toilet_131-489).

Women typically felt toilets to be unsuitable locations for cleaning cloth, because cleaning could make the toilet dirty or harm health or toilets lacked water access: “If we

wash it in the toilet where we go to defecate and urinate, we will have disease" (403046_FLI_RMW_Toilet_838).

*Drying cloth* was also a primary concern since finding a discrete place where no one could see the cloth was challenging. *Drying* was particularly problematic during the monsoon season, as cloths do not dry fully and can be blown to the ground by wind. Women sometimes had to put cloth on that was still wet because they had no others.

> There is no facility to dry the cloth… elder and younger brother-in-laws, father-in-laws may be around. Will I not feel shy? Where will I take it to a secluded place to dry it? So we face a lot of problems. (607004_FLI_MW_Toilet_399)

Finding places to *change* was difficult only for UMW and RMW because they worried about maintaining privacy: "Changing at home is difficult…I close the door and change. There would be someone asking me to open the door" (208025_FLI_UMW_Toilet_1065).

Where to *dispose* materials was primarily a concern for RMW, who most often used commercial pads, had more restricted mobility, and were less familiar with their newer household surroundings. Women worried about discretion and some felt that it would be easiest if they had a toilet for disposal.

> Here, no one uses napkins; I only use…If I throw it [outside], they will know it is mine. I will feel bad. If there was a toilet, would have put it there and flushed and it would have

> gone down. Here there is nothing like that…I throw in the jungle. (501023_MW_NoToilet_1046)

While not mentioned in FLIs, women in FGDs discussed how they were even more concerned about where they urinated and defecated during menstruation as they felt they were at greater risk of infection: "Then the bleeding that we have is direct so it has direct connection with the body… so feel scared. There is more worry for infection" (105_UMW_2_987).

***Menstruation Concerns Related to the Social Environment***

During bathing, washing, drying and changing cloth, women, mostly UMW, were concerned about *people* seeing and *shaming* them. They also worried about others knowing they were menstruating when urinating and defecating.

> If we wash at day time, there would be people moving around… people will look at us and will say that girl has no brains… we need a place where if we wash the cloth no one can see. (402072_FLI_UMW_NoToilet_659).

Toilets may be assumed to be private spaces for washing clothes or bathing, yet only one toilet owner mentioned occasionally bathing inside and only three mentioned ever washing their cloths inside; most felt this practice to be dirty: "Nobody gets to see. I close the door from that side. They would think 'daughter has gone to defecate.' Meanwhile, I wash the cloth." (607078_FLI_UMW_Toilet_439).

***Menstruation Concerns Related to Gender***

Menstruation is biologically unique to women, and like urination and defecation, can interfere with women's gendered roles. Women voiced concerns about socially imposed behavioral *restrictions* and a resulting inability to perform regular household *obligations*. For example, when menstruating, women cannot attend religious festivals, perform daily blessings, enter a temple, or, until they have bathed, touch water, a fresh set of clothes or even their children. These restrictions cause women to experience an anxiety and embarrassment unique to their biology.

> [Menstruation] may start on some religious occasion then I can't perform any rituals. I don't understand why this disgusting thing happens… Boys don't have this problem. They roam around so freely and relaxed and we are the ones who suffer. When it happens on or during the religious occasions and we can't participate, there is chance of huge public embarrassment if someone asks, 'why don't you come to the deity?' (502038_FLI_UM_Toilet).

The intensity of these *restrictions* and constraints on women's *obligations* may be related to their ability to access *water* for bathing at menstrual onset. Restrictions were a greater concern for UMW, who were frustrated about these relatively newer changes to their lives.

> I go to the pond, bring a bucket of water and come back…But until then I don't do any other works. Even if the child cries, I won't pacify him. This is the problem at that time. (208079_FLI_OW_NoToilet).

Due to these restrictions, women, predominantly UMW and MW, were concerned that they *needed support* at menstrual onset and some were concerned that they would have a *barrier to support.* RMW were typically well accompanied by mothers or sisters-in-law for menstruation-related needs.

> Tension is- who will I call to go along with me? I can't touch the clothes I have to change into. Suppose it starts at midnight. People are already sleeping deeply. Will they wake up when I call them? … You will surely feel guilty or not? (502009_FLI_MW_ Toilet).

***Menstruation Concerns Related to Personal Constraints***

Women's ability to manage their personal hygiene was made more challenging if they had personal experiences of menstruation that were severe, particularly when coupled with unsupportive physical and social environments. Specifically, UMW expressed concern over *general discomfort* and *pain* most often, presumably because they were still unaccustomed to menstruation. RMW most commonly expressed tension regarding *irregularity*, which made preparing for menstruation more challenging and led some women to worry about their overall *health* including the ability to have and plan for children.

> I'm getting my period once in 15 days…I don't understand why this is happening… I have delivered kids and don't want any more children. …if I conceive accidentally sometime, is that a concern or not? (502087_MW_Toilet_347)

**Sanitation Insecurity**

Urination, defecation and menstrual hygiene concerns fell into four domains: physical environment, social environment, gendered context and personal constraints. Temporal influences, like seasonal variation, the onset of nightfall, and life stage events (pregnancy, old age), emerged as important. We found domains to be interrelated, and present this conceptualization in Figure 1.1. From this analysis, we propose a definition for sanitation insecurity to be:

> Insufficient and uncertain access to adequate facilities and resources for independently, comfortably, safely, hygienically, and privately urinating, defecating, and managing menses in a culturally acceptable manner at any time of day or year as needs arise.

This definition integrates the physical environment (insufficient and uncertain access, adequate facilities, comfort, cleanliness), the social environment (safety, privacy, independence, cultural acceptability), the gendered context (as needs arise), personal needs (urination, defecation, menstruation), and temporal variability (any time of the day or year).

## Discussion

The activities of the sanitation sector and national governments have been motivated largely by the Millennium Development Goal (MDG) target to increase coverage of 'improved sanitation', focusing efforts on the engineering and construction of toilets that separate human excreta from the physical environment. Our findings indicate that women need more than facilities that change their physical environment, but enable urinating, defecating, and managing menstruation independently, comfortably, safely, hygienically, privately, and as needed.

We found that toilets alone do not address all of the needs and concerns women have when urinating, defecating and managing menstruation, which may help to explain suboptimal use for defecation in Orissa and elsewhere[4, 7, 8]. Many women with toilets indicated that they were of little benefit over open defecation fields: they lacked water access within for necessary post-defecation cleaning and flushing, many did not have roofs or doors to shelter from elements or provide privacy, they were too dark for use at night, and were not always cleaner or more comfortable than outdoor spaces. Those with doors and roofs were of use to women, particularly during monsoon rains or when they had competing obligations and little time. Still, women did not use them all of the time—rather, they enabled women to have access to another option that they could consider. They enabled a choice, not a solution.

Participants in research from other states of India report open defecation to be pleasurable, convenient, comfortable and just as healthy as latrine use [7]. Routray et al

(2015), who investigated drivers of open defecation among toilet owners in Orissa, found that open defecation enabled socialization among women, which was not always possible without the excuse of needing company for open defecation [29]. These and our findings collectively demonstrate that all of women's needs are not currently met by available toilets and underscore the importance of preliminary research and community involvement prior to the implementation of large-scale programming to ensure that facilities cater to the range of needs and wants that women have.

The majority of women in our study do not use toilets for urination or managing menstruation because toilets were deemed too dirty or unsuitable for these needs. Women's menstrual hygiene needs are increasingly gaining attention and recognition as a public health issue,[30] however, to our knowledge, no studies have explored women's experiences of urination and potential risks to health, likely because women's sanitation behaviors are under-investigated and because urination behaviors have not been linked to profound infectious disease risks. Lack of private places and adequate resources for menstrual management and urination activities, however, are prominent concerns for women in our population and may contribute to negative impacts to psycho-social health, like stress and assaults to dignity and status due to public exposure, as reported elsewhere[15, 16].

Provision of sanitation has been framed as a human right fundamental for dignity and privacy[31]. To be effective at fulfilling this right, however, facilities must be considered private and dignified from users' perspectives for urination and menstruation in addition

to defecation. Women in our study overwhelmingly requested the construction of bathrooms—simple enclosures—to enable privacy for urinating and managing menses. While creating structures that truly consider the privacy of women for all of their needs may be costly, continuing to invest in sub-optimal facilities at scale is also an expensive endeavor.

One organization, the Orissa-based organization Gram Vikas, incorporates bathing areas into their design and also requires 100% community consensus before supporting households to build facilities, which include a pit-latrine and an enclosed bathing area, each with their own door and piped water supply for flushing, cleaning, or bathing. A piped water source is also provided to the household, but the water is not made accessible until all households have completed construction of sanitation and bathing facilities. This intervention approach has been shown to reduce severe cases of diarrhea by 30%-50%[32], a finding vastly different from previous studies that saw no health impact with construction of toilets alone[4, 5]. We are working with this organization to carry out further research to assess if their facilities also alleviate the sanitation-related concerns noted here.

The WASH sector typically focuses on changing the physical environment to improve sanitation conditions, however women had concerns outside of this dimension. While the WASH sector may be limited in what it can do to change the social environment, gender norms, or women's personal constraints, it can change the physical environment in ways that may mitigate some of these concerns. To address social environment concerns,

women can be queried to help decide where to place toilets to ensure they are in accessible and non-threatening locations; low-cost lights—in use by some women who reported not needing company—can be installed in and around facilities to enable safer independent use; and doors can be made a compulsory part of designs to ensure privacy. To address personal constraints expressed by women, water access can be made available within latrines to eliminate the need to haul water, stone walkways can be constructed to prevent falling during muddy monsoon seasons, and elevated seats or rails can be added for those with difficulty squatting—improvements of particular benefit to the elderly, infirm and pregnant women.

Through a thorough analysis of concerns from women at different life stages, our definition for sanitation insecurity recognizes the broad scope of women's concerns beyond the physical environment and acknowledges the social environment, gendered context and personal constraints that further determine women's ability to perform necessary behaviors. Our definition uses the voiced concerns of women to push current understanding of what attributes are important to acknowledge when considering what facilities, resources, and program software should be considered as part of woman-friendly sanitation programming. The MGD aim of increasing coverage of 'improved sanitation', may not only have been insufficient at meeting women's needs, but also may have limited how policy makers, practitioners, and engineers have conceived of and actualized sanitation programing to date. Sustainable Development Goal Target 6.2 aims to "achieve adequate and equitable sanitation and hygiene for all…paying special attention to the needs of women and girls" by 2030 and may improve how women's and

girls' needs are incorporated in the future. Unlike the MDG target, the accompanying definition specifically prioritizes addressing urination, defecation and menstruation needs; women's and girls' dignity; and understanding gendered inequity within the household. Ideally, this new target will encourage practitioners to critically assess if their sanitation programs are gender aware, and encourage research to determine if and how women's concerns are addressed, if their experience of sanitation is improved and they are less sanitation insecure, and if women-specific health impacts, like psycho-social distress[33], infection[34], and pre-term birth outcomes[35] are ameliorated.

**Strengths and Limitations**

A key strength of this work is the specific focus on women. This research is among a limited number of sanitation studies about women, and is the first to engage older women. Further research is warranted that investigates how applicable our definition of sanitation insecurity is to men and children.

An additional strength of this work is the inclusion of various techniques to enhance the validity of findings, such as triangulation, respondent validation, comparison and quantification[36]. Employing FLIs and FGDs allowed triangulation of findings to determine if noted concerns were similar across methods; following FLIs with FGDs enabled respondent validation of initial conclusions from the FLI data; including women of different life stages and with varied latrine access, enabled comparison and identification of counterfactuals and exceptional cases (those with no concerns); and

using free listing exercises permitted quantification of concerns collected via open-ended questions, increasing the validity of our generalizations about the population sampled.

Full transcriptions of each FLI and FGD in the original language were not possible. To ensure accuracy of translated text, a trained member of the research team directly transcribed 10% of each FLI or FGD in the original language. That section, unknown to the translator, was then translated by another research team member and compared to the full translation. The full translations matched the transcribed and translated sections well, instilling confidence in the direct translations.

**Conclusion**

This research has revealed that women in rural Orissa, India have several concerns related to urination, defecation and menstrual management that are not addressed. To measure how well sanitation programs are suiting the needs of those who receive them, the experience of sanitation should be assessed. Given their voiced concerns, this research demonstrates that here is a need for a measure of sanitation insecurity that is specific to women to enable future programs to evaluate their sanitation-related experiences. With such a measure, researchers can then evaluate how programs impact experience and how experience, in turn, may influence other outcomes, like mental distress and well being.

**Table 2.1: Demographic information for women who participated in free-list interviews (N=69)**

| | All | | 1. Unmarried (UM) | | 2. Recently Married (<3 years) (RM) | | 3. Married (>3 years) (M) | | 4. Over 49 (OW) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Participants** | 69 | | 16 | 23% | 12 | 17% | 22 | 32% | 19 | 28% |
| **Village Status** | | | | | | | | | | |
| Intervention | 28 | 41% | 5 | 31% | 4 | 33% | 9 | 41% | 10 | 53% |
| Control | 41 | 59% | 11 | 69% | 8 | 67% | 13 | 59% | 9 | 47% |
| **Age**[1] | 36.6 | (18-75) | 20.7 | (18-28) | 23.2 | (20-27) | 34.0 | (24-47) | 61.3 | (50-75) |
| **Education** | | | | | | | | | | |
| None | 16 | 23% | 0 | 0% | 0 | 0% | 4 | 18% | 12 | 63% |
| Some Primary | 12 | 17% | 0 | 0% | 0 | 0% | 5 | 23% | 7 | 37% |
| Primary Complete | 6 | 9% | 1 | 6% | 3 | 25% | 2 | 9% | 0 | 0% |
| Some Secondary | 26 | 38% | 10 | 63% | 9 | 75% | 7 | 32% | 0 | 0% |
| Secondary Complete | 2 | 3% | 0 | 0% | 0 | 0% | 2 | 9% | 0 | 0% |
| Some Tertiary | 4 | 6% | 3 | 19% | 0 | 0% | 1 | 5% | 0 | 0% |
| Tertiary/ University Complete | 3 | 4% | 2 | 13% | 0 | 0% | 1 | 5% | 0 | 0% |
| **Below Poverty Line (BPL) Card**[2] | 55 | 85% | 14 | 88% | 11 | 100% | 15 | 75% | 15 | 83% |
| **Hindu** | 69 | 100% | 16 | 100% | 12 | 100% | 22 | 100% | 19 | 100% |
| **Caste**[3] | | | | | | | | | | |
| Brahmin | 4 | 6% | 1 | 7% | 0 | 0% | 2 | 9% | 1 | 5% |
| Forward / General Caste | 44 | 66% | 12 | 80% | 8 | 73% | 12 | 55% | 12 | 63% |
| Scheduled Caste (SC) | 5 | 7% | 0 | 0% | 0 | 0% | 3 | 14% | 2 | 11% |
| Other Backward Caste (OBC) | 12 | 18% | 2 | 13% | 3 | 27% | 4 | 18% | 3 | 16% |
| Scheduled Tribe (ST) | 2 | 3% | 0 | 0% | 0 | 0% | 1 | 5% | 1 | 5% |
| **Has Children** | 43 | 62% | 0 | 0% | 4 | 33% | 20 | 91% | 19 | 100% |
| **Pregnant**[4] | 5 | 8% | 0 | 0% | 4 | 33% | 1 | 5% | 0 | 0% |
| **Age at first period** | 14.2 | (12-19) | 14.4 | (12-17) | 14.2 | (12-18) | 14.0 | (12-19) | 14.2 | (12-17) |
| **Continues to menstruate**[5] | 47 | 69% | 16 | 100% | 12 | 100% | 19 | 86% | 0 | 0% |
| **Menstrual Management Material**[6] | | | | | | | | | | |
| Cloth | 37 | 54% | 4 | 25% | 1 | 8% | 15 | 68% | 17 | 94% |
| Pad | 9 | 13% | 2 | 13% | 3 | 25% | 3 | 14% | 1 | 6% |
| Both | 22 | 32% | 10 | 62% | 8 | 67% | 4 | 18% | 0 | 0% |
| **Water Source within Compound** | 43 | 63% | 12 | 75% | 7 | 58% | 13 | 59% | 11 | 61% |
| **Latrine within Compound** | 37 | 54% | 10 | 63% | 9 | 75% | 9 | 41% | 9 | 47% |
| Use the Latrine for Urination | 4 | 11% | 1 | 10% | 1 | 11% | 1 | 11% | 1 | 11% |
| Use the Latrine for Defecation | 35 | 95% | 10 | 100% | 9 | 100% | 9 | 100% | 7 | 78% |

*Values are number and percent or mean and range.*

1 Not all women know their exact age, particularly older women. Those who expressed doubt provided a best guess.
2 Missing data for 4 women who participated in the interview: 1 from Category 2 (RM), 2 from 3 (M), 1 from Category 4 (OW).
3 Missing data for 2 women who participated in the interview: 1 from category 1 (UM), 1 from category 2 (RM).
4 Missing data for 4 women who participated in the interview: 3 from category 3 (M), 1 from category 4 (OW).
5 Missing data for 1 woman who participated in the interview: Category 4 (OW).
6 Asked of all participants regardless of whether or not still menstruating. Missing data for 1 woman who participated in the interview: Category 4 (OW).

**Table 2.2: Demographic information for women who participated in focus group discussions (N=46)**

| | All | | 1. Unmarried (UM) | | 3. Married (M) | | 4. Over 49 (OW) | |
|---|---|---|---|---|---|---|---|---|
| **Number of Participants** | 46 | | 23 | 50% | 16 | 35% | 7 | 15% |
| **Village Status** | | | | | | | | |
| Intervention | 22 | 48% | 10 | 43% | 7 | 44% | 5 | 71% |
| Control | 24 | 52% | 13 | 57% | 9 | 56% | 2 | 29% |
| **Age**[1] | 30.7 | (18-70) | 19.2 | (18-23) | 34.8 | (20-48) | 59.7 | (51-70) |
| **Education** | | | | | | | | |
| None | 1 | 2% | 0 | 0% | 0 | 0% | 1 | 14% |
| Some Primary | 5 | 11% | 0 | 0% | 4 | 25% | 1 | 14% |
| Primary Complete | 8 | 17% | 0 | 0% | 4 | 25% | 4 | 57% |
| Some Secondary | 10 | 22% | 3 | 13% | 6 | 38% | 1 | 14% |
| Secondary Complete | 2 | 4% | 2 | 9% | 0 | 0% | 0 | 0% |
| Some Tertiary | 16 | 35% | 15 | 65% | 1 | 6% | 0 | 0% |
| Tertiary/ University Complete | 4 | 9% | 3 | 13% | 1 | 6% | 0 | 0% |
| **Below Poverty Line (BPL) Card**[2] | 29 | 67% | 16 | 70% | 10 | 71% | 3 | 50% |
| **Hindu** | 45 | 98% | 22 | 96% | 16 | 100% | 7 | 100% |
| **Caste** | | | | | | | | |
| Brahmin | 1 | 2% | 1 | 4% | 0 | 0% | 0 | 0% |
| Forward / General Caste | 30 | 65% | 12 | 52% | 11 | 69% | 7 | 100% |
| Scheduled Caste (SC) | 8 | 17% | 5 | 22% | 3 | 19% | 0 | 0% |
| Other Backward Caste (OBC) | 7 | 15% | 5 | 22% | 2 | 13% | 0 | 0% |
| Scheduled Tribe (ST) | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| **Children** | 23 | 50% | 0 | 0% | 16 | 100% | 7 | 100% |
| **Pregnant** | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| **Age at first period** | 14.0 | (12-18) | 14.0 | (12-17) | 13.3 | (12-16) | 15.6 | (13-18) |
| **Continues to menstruate** | 37 | 80% | 23 | 100% | 14 | 87% | 0 | 0% |
| **Menstrual Management Material**[3] | | | | | | | | |
| Cloth | 23 | 50% | 3 | 13% | 13 | 87% | 7 | 100% |
| Pad | 8 | 17% | 8 | 35% | 0 | 0% | 0 | 0% |
| Both | 14 | 30% | 12 | 52% | 2 | 13% | 0 | 0% |
| **Water Source within Compound** | 32 | 70% | 16 | 70% | 11 | 69% | 5 | 71% |
| **Latrine within Compound** | 27 | 59% | 14 | 61% | 8 | 50% | 5 | 71% |
| Use the Latrine for Urination | 11 | 41% | 7 | 50% | 4 | 50% | 0 | 0% |
| Use the Latrine for Defecation | 27 | 100% | 14 | 100% | 8 | 100% | 5 | 100% |

*Values are number and percent or mean and range.*

1 Not all women know their exact age, particularly older women. Those who expressed doubt provided a best guess.

2 Missing data for 3 women who participated in the FGD: 2 from category 3 (M), 1 from category 4 (OW).

3 Asked of all participants regardless of whether or not still menstruating. Missing data for 1 woman who participated in the FGD: Category 3 (M).

**Table 2.3a: Concerns noted by participants in free list activities and definitions used for coding**

| *Concern* | *Definition* |
|---|---|
| *Themes in all Urination, Defecation and Menstruation Lists* | |
| **Fear** | Fear when going to urinate/ defecate/ manage menses, whether of animals, ghosts, people, or harsh weather. |
| **Feel Dirty** | Concern about feeling or getting dirty when urinating/ defecating/ managing menses. |
| **Health** | Concern that health is compromised when urinating/ defecating or in relation to menstruation. |
| **Need Support** | Concern unable to urinate/ defecate/ manage menses alone because of need for company or support. |
| **People** | Concern of being seen by people when urinating/ defecating/ managing menses or that menstrual materials will be seen. |
| **Shame** | Concern of being publically shamed or feeling ashamed if seen by others when urinating/ defecating/ managing menses. |
| **Support Barrier** | Concern that someone will not provide support / will get upset if asked to accompany to urinate/ defecate/ manage menses. |
| **Water** | Concern getting and carrying water for urinating/ defecating/ managing menses is a great difficulty. |
| **Work** | Concern that workload related to urination/ defecation/ menstrual management activities is high. |
| *Themes in Urination and Defecation Lists* | |
| **Dependents** | Concern for well-being of dependents - child, elderly, infirm- when leaving them to urinate/ defecate. |
| **Difficulty-Pain** | Concern about pain or difficulty related to urination/ defecation, including general body pain, strain, etc. |
| **Fall** | Concern for falling when going to or in the act of urinating/ defecating. |
| **Harm** | Concern about being harmed when urinating/ defecating, whether by an animal, person, or environmental conditions. |
| **Incontinence** | Concern about the inability to hold urination/ defecation due to physical ailment. |
| **Light** | Concern about not having light when urinating/ defecating at night. |
| **Menstruation** | Concern about increased difficulty urinating/ defecating at the time of menstruation. |
| **No Proper Facility** | Concern that there is not a proper facility for urinating/ defecating available. |
| **Place** | Concern the place available and used for urinating/ defecating is problematic, whether dirty, far, hard to access, in the open, etc. |
| **Squat** | Concern about having difficulty sitting, squatting, or getting up and down when urinating/ defecating. |
| **Stand** | Concern for need to stand up in the middle of urination/ defecation if someone suddenly appears. |
| **Support Others** | Concern that there is difficulty providing support to others for their urination/ defecation needs. |
| **Suppress** | Concern about the need to suppress because various factors prevent attention to personal needs. |
| **Urgency** | Concern about experiencing and sudden, strong urge to urinate/ defecate. |
| **Walk** | Concern about walking to the place for urination/ defecation. |
| **Wet** | Concern that she will have to get wet when going to urinate/defecate during the rains. |

**Table 2.3b: Concerns noted by participants in free list activities and definitions used for coding *(Continued)***

| *Concern* | *Definition* |
|---|---|
| *Themes in Urination List Only* | |
| **Infection** | Concern for infection if unintentionally urinating over the urine of others. |
| **Limit Water** | Concern about the need to limit water in order to reduce need for urination. |
| **Urine Contact** | Concern about accidentally touching urine and therefore becoming untouchable or making others untouchable. |
| **Urine On Self** | Concern about getting urine on the body because of inability to suppress. |
| *Themes in Defecation List Only* | |
| **Cleaning Self** | Concern about personal cleaning after defecation. |
| **Concern For Others** | Concerns for others' safety or needs when defecating, typically their concern for daughters or daughters-in-law. |
| **Defecate On Self** | Concern about getting feces on the body because of inability to suppress. |
| **Defecation Time** | Concerns about the amount of time defecation takes to complete because location is far, others around, cleaning extensive, etc. |
| **Fixed Time** | Concern about having to defecate at a fixed time of day. |
| **Forced Latrine Use** | Concern about being forced to use the latrine against will, either all the time or during certain times of day or year. |
| **Future Needs** | Concerns about defecating in the future given deteriorating health, inevitable departure of daughters to marriage, etc. |
| **Latrine Conditions** | Concern that the conditions of the household latrine are poor. |
| **Latrine Unusable** | Concern that the latrine available is unsuitable for defecating. |
| **Limit Food** | Concern about the need to limit food in order to reduce need for defecation. |
| **No Money** | Concern for lacking money to construct or maintain a latrine. |
| **No Gov. Support** | Concern for insufficient support, financial or otherwise, from government to build or maintain a latrine. |
| **Obligations** | Concern regarding the need to attend to household obligations or responsibilities to others before tending to defecation needs. |
| **Scold** | Concern about being scolded due to defecation behavior (i.e. taking time, going to wrong place, improperly caring for others). |

**Table 2.3c: Concerns noted by participants in free list activities and definitions used for coding *(Continued)***

| *Concern* | *Definition* |
|---|---|
| *Themes in Menstruation List Only* | |
| **Access to Materials** | Concern about barriers to getting materials wanted /needed. |
| **Bathing** | Concern about bathing at onset of menstruation, regardless of time of day, night, season. |
| **Changing Cloth** | Concern with changing the cloth or pad, whether finding a place, not having privacy, etc. |
| **Disposal** | Concern about where and how to dispose of menstrual cloths or pads. |
| **Drying Cloth** | Concerns about where/ how to dry cloth after washing. |
| **Falling Cloth** | Concern that cloth will fall from clothing. |
| **Fertility** | Concern about fertility related to menstrual cycle, whether about ability to have children or plan for them due to irregularity. |
| **Forced Separation** | Concern about the need to 'stay separate' at night until bathing possible due to menstrual onset. |
| **General Discomfort** | Concern about generally feeling uncomfortable, bad, weak, or irritated because of menstruation. |
| **Heavy Bleeding** | Concern about heavy menstrual flow. |
| **Household Duties** | Concern about ability to effectively perform household work during menstruation. |
| **Irregularity** | Concern about not having a regular menstrual cycle. |
| **Leaks** | Concern for menstrual leaks on cloths, bed, etc. |
| **Mobility** | Concern about inability to move freely during menstruation, because of cloth, pad, restrictions, discomfort, etc. |
| **Odor** | Concern that body, cloth or clothes is generating a bad odor. |
| **Pain** | Concern about pain, whether in the head, stomach, legs, back or hands. |
| **Restrictions** | Concern for restrictions or requirements that are imposed because menstruation. |
| **Sleep** | Concern about inability to sleep well during menstruation. |
| **Start when Away** | Concern that menstrual cycle will start when away from home. |
| **Storing Cloth** | Concern about storing the reusable menstrual cloth between uses. |
| **Untouchability** | Concern about being untouchable, making things untouchable, or others touching things made untouchable by menstruation. |
| **Urination** | Concern with urinating during menstruation. |
| **Washing Cloth** | Concern with washing cloths used to absorb menstrual blood. |
| **Wounds** | Concern about getting wounds on legs from their menstrual pads or cloths. |

**Table 2.4: Type and frequency of urination-related concerns overall, and by participant type and latrine status**

| Concern | All | | 1. Unmarried (UM) | | 2. Recently Married (RM) | | 3. Married (M) | | 4. Older Woman (OW) | | Latrine At Home | | No Latrine At Home | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N=63 | | n=15 | | n=11 | | n=21 | | n=16 | | n=34 | | n=29 | |
| **Place** | 47 | 74.6% | 11 | 73.3% | 10 | 90.9% | 14 | 66.7% | 12 | 75.0% | 25 | 73.5% | 22 | 75.9% |
| **People** | 42 | 66.7% | 14 | 93.3% | 6 | 54.5% | 12 | 57.1% | 10 | 62.5% | 22 | 64.7% | 20 | 69.0% |
| **Fear** | 40 | 63.5% | 13 | 86.7% | 10 | 90.9% | 10 | 47.6% | 7 | 43.8% | 22 | 64.7% | 17 | 58.6% |
| **Need Support** | 26 | 41.3% | 10 | 66.7% | 5 | 45.5% | 7 | 33.3% | 4 | 25.0% | 14 | 41.2% | 12 | 41.4% |
| **Wet** | 21 | 33.3% | 9 | 60.0% | 3 | 27.3% | 4 | 19.0% | 5 | 31.3% | 9 | 26.5% | 12 | 41.4% |
| **Squat** | 21 | 33.3% | 0 | 0.0% | 3 | 27.3% | 6 | 28.6% | 12 | 75.0% | 13 | 38.2% | 8 | 27.6% |
| **Urine Infection** | 19 | 30.2% | 6 | 40.0% | 4 | 36.4% | 6 | 28.6% | 3 | 18.8% | 10 | 29.4% | 9 | 31.0% |
| **Get Dirty** | 17 | 27.0% | 9 | 60.0% | 3 | 27.3% | 4 | 19.0% | 1 | 6.3% | 8 | 23.5% | 9 | 31.0% |
| **Suppress** | 16 | 25.4% | 5 | 33.3% | 5 | 45.5% | 3 | 14.3% | 3 | 18.8% | 11 | 32.4% | 5 | 17.2% |
| **Work** | 12 | 19.0% | 5 | 33.3% | 1 | 9.1% | 4 | 19.0% | 2 | 12.5% | 4 | 11.8% | 8 | 27.6% |
| **No Proper Facility** | 11 | 17.5% | 4 | 26.7% | 3 | 27.3% | 1 | 4.8% | 3 | 18.8% | 5 | 14.7% | 6 | 20.7% |
| **Shame** | 10 | 15.9% | 6 | 40.0% | 0 | 0.0% | 3 | 14.3% | 1 | 6.3% | 6 | 17.6% | 4 | 13.8% |
| **Support Others** | 9 | 14.3% | 3 | 20.0% | 0 | 0.0% | 3 | 14.3% | 3 | 18.8% | 5 | 14.7% | 4 | 13.8% |
| **Walk** | 9 | 14.3% | 0 | 0.0% | 1 | 9.1% | 3 | 14.3% | 5 | 31.3% | 3 | 8.8% | 6 | 20.7% |
| **Support Barrier** | 8 | 12.7% | 5 | 33.3% | 0 | 0.0% | 3 | 14.3% | 0 | 0.0% | 2 | 5.9% | 6 | 20.7% |
| **Stand** | 8 | 12.7% | 5 | 33.3% | 1 | 9.1% | 1 | 4.8% | 1 | 6.3% | 4 | 11.8% | 4 | 13.8% |
| **Urine On Self** | 8 | 12.7% | 3 | 20.0% | 1 | 9.1% | 2 | 9.5% | 2 | 12.5% | 3 | 8.8% | 5 | 17.2% |
| **Dependents** | 7 | 11.1% | 2 | 13.3% | 2 | 18.2% | 2 | 9.5% | 1 | 6.3% | 4 | 11.8% | 3 | 10.3% |
| **Urine Contact** | 6 | 9.5% | 1 | 6.7% | 0 | 0.0% | 3 | 14.3% | 2 | 12.5% | 1 | 2.9% | 5 | 17.2% |
| **Harm** | 5 | 7.9% | 1 | 6.7% | 0 | 0.0% | 1 | 4.8% | 3 | 18.8% | 1 | 2.9% | 4 | 13.8% |
| **Urgency** | 4 | 6.3% | 0 | 0.0% | 0 | 0.0% | 2 | 9.5% | 2 | 12.5% | 1 | 2.9% | 3 | 10.3% |
| **Incontinence** | 4 | 6.3% | 0 | 0.0% | 0 | 0.0% | 2 | 9.5% | 2 | 12.5% | 2 | 5.9% | 2 | 6.9% |
| **Menstruation** | 4 | 6.3% | 2 | 13.3% | 0 | 0.0% | 1 | 4.8% | 1 | 6.3% | 3 | 8.8% | 1 | 3.4% |
| **Fall** | 4 | 6.3% | 1 | 6.7% | 2 | 18.2% | 0 | 0.0% | 1 | 6.3% | 2 | 5.9% | 2 | 6.9% |
| **Health** | 4 | 6.3% | 2 | 13.3% | 0 | 0.0% | 0 | 0.0% | 2 | 12.5% | 1 | 2.9% | 3 | 10.3% |
| **Difficulty-Pain** | 4 | 6.3% | 0 | 0.0% | 1 | 9.1% | 2 | 9.5% | 1 | 6.3% | 4 | 11.8% | 0 | 0.0% |
| **Water** | 3 | 4.8% | 0 | 0.0% | 2 | 18.2% | 0 | 0.0% | 1 | 6.3% | 2 | 5.9% | 1 | 3.4% |

*Only one respondent mentioned each of the following concerns:* Limit Water (RM); Light (RM).
*Six women did not indicate any concerns related to urination: 1 UM, 1 RM, 1 M, and 3 OW; 3 have latrines and 3 do not.*

**Table 2.5: Type and frequency of defecation-related concerns overall, and by participant type and latrine status**

| Concern | All | | 1. Unmarried (UM) | | 2. Recently Married (RM) | | 3. Married (M) | | 4. Older Woman (OW) | | Latrine At Home | | No Latrine At Home | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N=65 | | n=14 | | n=11 | | n=21 | | n=19 | | n=33 | | n=31 | |
| **Place** | 47 | 72.3% | 10 | 71.4% | 8 | 72.7% | 15 | 71.4% | 14 | 73.7% | 17 | 51.5% | 30 | 96.8% |
| **Fear** | 36 | 55.4% | 10 | 71.4% | 5 | 45.5% | 12 | 57.1% | 9 | 47.4% | 16 | 48.5% | 20 | 64.5% |
| **Need Support** | 33 | 50.8% | 5 | 35.7% | 6 | 54.5% | 13 | 61.9% | 9 | 47.4% | 16 | 48.5% | 17 | 54.8% |
| **People** | 27 | 41.5% | 9 | 64.3% | 5 | 45.5% | 7 | 33.3% | 6 | 31.6% | 8 | 24.2% | 19 | 61.3% |
| **No Proper Facility** | 23 | 35.4% | 3 | 21.4% | 3 | 27.3% | 10 | 47.6% | 7 | 36.8% | 1 | 3.0% | 22 | 71.0% |
| **Get Dirty** | 21 | 32.3% | 5 | 35.7% | 5 | 45.5% | 6 | 28.6% | 5 | 26.3% | 6 | 18.2% | 15 | 48.4% |
| **Support Others** | 20 | 30.8% | 3 | 21.4% | 3 | 27.3% | 4 | 19.0% | 10 | 52.6% | 9 | 27.3% | 11 | 35.5% |
| **Water** | 18 | 27.7% | 3 | 21.4% | 3 | 27.3% | 7 | 33.3% | 4 | 21.1% | 12 | 36.4% | 6 | 19.4% |
| **Walk** | 17 | 26.2% | 1 | 7.1% | 1 | 9.1% | 5 | 23.8% | 9 | 47.4% | 6 | 18.2% | 11 | 35.5% |
| **Suppress** | 15 | 23.1% | 6 | 42.9% | 2 | 18.2% | 5 | 23.8% | 2 | 10.5% | 6 | 18.2% | 9 | 29.0% |
| **Dependents** | 14 | 21.5% | 2 | 14.3% | 3 | 27.3% | 5 | 23.8% | 4 | 21.1% | 8 | 24.2% | 6 | 19.4% |
| **Health** | 13 | 20.0% | 5 | 35.7% | 1 | 9.1% | 4 | 19.0% | 3 | 15.8% | 5 | 15.2% | 8 | 25.8% |
| **Squat** | 13 | 20.0% | 0 | 0.0% | 2 | 18.2% | 6 | 28.6% | 5 | 26.3% | 8 | 24.2% | 5 | 16.1% |
| **Support Barrier** | 13 | 20.0% | 4 | 28.6% | 2 | 18.2% | 4 | 19.0% | 3 | 15.8% | 6 | 18.2% | 7 | 22.6% |
| **Wet** | 13 | 20.0% | 5 | 35.7% | 2 | 18.2% | 2 | 9.5% | 4 | 21.1% | 6 | 18.2% | 7 | 22.6% |
| **Shame** | 12 | 18.5% | 6 | 42.9% | 1 | 9.1% | 3 | 14.3% | 2 | 10.5% | 4 | 12.1% | 8 | 25.8% |
| **Latrine Conditions** | 11 | 16.9% | 1 | 7.1% | 5 | 45.5% | 3 | 14.3% | 2 | 10.5% | 10 | 30.3% | 1 | 3.2% |
| **Obligations** | 11 | 16.9% | 4 | 28.6% | 0 | 0.0% | 6 | 28.6% | 1 | 5.3% | 5 | 15.2% | 6 | 19.4% |
| **Urgency** | 10 | 15.4% | 3 | 21.4% | 0 | 0.0% | 4 | 19.0% | 3 | 15.8% | 2 | 6.1% | 8 | 25.8% |
| **Latrine Unusable** | 10 | 15.4% | 1 | 7.1% | 3 | 27.3% | 3 | 14.3% | 3 | 15.8% | 10 | 30.3% | 0 | 0.0% |
| **Work** | 9 | 13.8% | 0 | 0.0% | 1 | 9.1% | 5 | 23.8% | 3 | 15.8% | 4 | 12.1% | 5 | 16.1% |
| **Harm** | 8 | 12.3% | 2 | 14.3% | 0 | 0.0% | 5 | 23.8% | 1 | 5.3% | 1 | 3.0% | 7 | 22.6% |
| **Fall** | 7 | 10.8% | 0 | 0.0% | 1 | 9.1% | 2 | 9.5% | 4 | 21.1% | 1 | 3.0% | 6 | 19.4% |
| **Stand** | 7 | 10.8% | 2 | 14.3% | 2 | 18.2% | 0 | 0.0% | 3 | 15.8% | 0 | 0.0% | 7 | 22.6% |
| **Defecation Time** | 6 | 9.2% | 2 | 14.3% | 1 | 9.1% | 3 | 14.3% | 0 | 0.0% | 3 | 9.1% | 3 | 9.7% |
| **Difficulty-Pain** | 6 | 9.2% | 0 | 0.0% | 0 | 0.0% | 3 | 14.3% | 3 | 15.8% | 3 | 9.1% | 3 | 9.7% |
| **No Money** | 5 | 7.7% | 0 | 0.0% | 1 | 9.1% | 3 | 14.3% | 1 | 5.3% | 1 | 3.0% | 4 | 12.9% |
| **Scold** | 5 | 7.7% | 1 | 7.1% | 0 | 0.0% | 3 | 14.3% | 1 | 5.3% | 0 | 0.0% | 5 | 16.1% |
| **Cleaning Self** | 4 | 6.2% | 0 | 0.0% | 0 | 0.0% | 2 | 9.5% | 2 | 10.5% | 2 | 6.1% | 2 | 6.5% |
| **Forced Latrine Use** | 4 | 6.2% | 1 | 7.1% | 3 | 27.3% | 0 | 0.0% | 0 | 0.0% | 4 | 12.1% | 0 | 0.0% |
| **Defecate On Self** | 3 | 4.6% | 1 | 7.1% | 0 | 0.0% | 2 | 9.5% | 0 | 0.0% | 1 | 3.0% | 2 | 6.5% |
| **Limit Food** | 3 | 4.6% | 0 | 0.0% | 0 | 0.0% | 3 | 14.3% | 0 | 0.0% | 0 | 0.0% | 3 | 9.7% |

*Only two respondents mentioned each of the following concerns:* Concern For Others (1 M, 1 OW); Fixed Time (2 RM); Light (2 RM); Future Needs (1 M, 1 OW).
*Only one respondent mentioned each of the following concerns:* No Support (M); Incontinence (M); Menstruation (OW).
*Four women did not indicate any concerns related to defecation 2 UM, 1 RM, and 1 M; All 4 have latrines.*

**Table 2.6: Type and frequency of menstruation-related concerns overall, by participant type, and latrine status**

| Concern | All | | 1. Unmarried (UM) | | 2. Recently Married (RM) | | 3. Married (M) | | 4. Older Woman (OW) | | Latrine At Home | | No Latrine At Home | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N=67 | | n=16 | | n=12 | | n=21 | | n=18 | | n=37 | | n=30 | |
| **Bathing** | 35 | 52.2% | 12 | 75.0% | 7 | 58.3% | 13 | 61.9% | 3 | 16.7% | 19 | 51.4% | 16 | 53.3% |
| **Washing Cloth** | 34 | 50.7% | 8 | 50.0% | 8 | 66.7% | 9 | 42.9% | 9 | 50.0% | 19 | 51.4% | 16 | 53.3% |
| **Drying Cloth** | 31 | 46.3% | 10 | 62.5% | 3 | 25.0% | 11 | 52.4% | 7 | 38.9% | 16 | 43.2% | 15 | 50.0% |
| **General Discomfort** | 29 | 43.3% | 11 | 68.8% | 2 | 16.7% | 7 | 33.3% | 10 | 55.6% | 12 | 32.4% | 17 | 56.7% |
| **People** | 25 | 37.3% | 8 | 50.0% | 4 | 33.3% | 7 | 33.3% | 6 | 33.3% | 13 | 35.1% | 12 | 40.0% |
| **Pain** | 23 | 34.3% | 8 | 50.0% | 4 | 33.3% | 7 | 33.3% | 6 | 33.3% | 13 | 35.1% | 12 | 40.0% |
| **Feel Dirty** | 20 | 29.9% | 8 | 50.0% | 4 | 33.3% | 3 | 14.3% | 5 | 27.8% | 9 | 24.3% | 11 | 36.7% |
| **Restrictions** | 20 | 29.9% | 7 | 43.8% | 3 | 25.0% | 6 | 28.6% | 4 | 22.2% | 13 | 35.1% | 7 | 23.3% |
| **Irregularity** | 18 | 26.9% | 4 | 25.0% | 6 | 50.0% | 6 | 28.6% | 2 | 11.1% | 14 | 37.8% | 4 | 13.3% |
| **Need Support** | 15 | 22.4% | 4 | 25.0% | 2 | 16.7% | 7 | 33.3% | 2 | 11.1% | 10 | 27.0% | 5 | 16.7% |
| **Work** | 13 | 19.4% | 1 | 6.3% | 3 | 25.0% | 5 | 23.8% | 4 | 22.2% | 4 | 10.8% | 9 | 30.0% |
| **Wounds** | 13 | 19.4% | 3 | 18.8% | 2 | 16.7% | 5 | 23.8% | 3 | 16.7% | 6 | 16.2% | 7 | 23.3% |
| **Leaks** | 12 | 17.9% | 3 | 18.8% | 2 | 16.7% | 4 | 19.0% | 3 | 16.7% | 7 | 18.9% | 5 | 16.7% |
| **Obligations** | 12 | 17.9% | 2 | 12.5% | 1 | 8.3% | 4 | 19.0% | 5 | 27.8% | 4 | 10.8% | 8 | 26.7% |
| **Water** | 12 | 17.9% | 4 | 25.0% | 4 | 33.3% | 2 | 9.5% | 2 | 11.1% | 6 | 16.2% | 6 | 20.0% |
| **Forced Separation** | 11 | 16.4% | 2 | 12.5% | 2 | 16.7% | 4 | 19.0% | 3 | 16.7% | 5 | 13.5% | 6 | 20.0% |
| **Access to Materials** | 10 | 14.9% | 5 | 31.3% | 4 | 33.3% | 1 | 4.8% | 0 | 0.0% | 8 | 21.6% | 2 | 6.7% |
| **Shame** | 8 | 11.9% | 2 | 12.5% | 2 | 16.7% | 3 | 14.3% | 1 | 5.6% | 5 | 13.5% | 3 | 10.0% |
| **Constrained Mobility** | 7 | 10.4% | 1 | 6.3% | 4 | 33.3% | 2 | 9.5% | 0 | 0.0% | 4 | 10.8% | 3 | 10.0% |
| **Heavy Bleeding** | 7 | 10.4% | 1 | 6.3% | 0 | 0.0% | 3 | 14.3% | 3 | 16.7% | 2 | 5.4% | 5 | 16.7% |
| **Health** | 6 | 9.0% | 1 | 6.3% | 3 | 25.0% | 1 | 4.8% | 1 | 5.6% | 5 | 13.5% | 1 | 3.3% |
| **Odor** | 6 | 9.0% | 2 | 12.5% | 0 | 0.0% | 2 | 9.5% | 2 | 11.1% | 2 | 5.4% | 4 | 13.3% |
| **Disposal** | 5 | 7.5% | 1 | 6.3% | 3 | 25.0% | 1 | 4.8% | 0 | 0.0% | 4 | 10.8% | 1 | 3.3% |
| **Untouchability** | 5 | 7.5% | 1 | 6.3% | 1 | 8.3% | 2 | 9.5% | 1 | 5.6% | 2 | 5.4% | 3 | 10.0% |
| **Changing Cloth** | 4 | 6.0% | 2 | 12.5% | 2 | 16.7% | 0 | 0.0% | 0 | 0.0% | 3 | 8.1% | 1 | 3.3% |
| **Sleep** | 4 | 6.0% | 0 | 0.0% | 0 | 0.0% | 3 | 14.3% | 1 | 5.6% | 2 | 5.4% | 2 | 6.7% |
| **Support Barrier** | 4 | 6.0% | 2 | 12.5% | 0 | 0.0% | 2 | 9.5% | 0 | 0.0% | 4 | 10.8% | 0 | 0.0% |

*Only three respondents mentioned each of the following concerns:* Fear (2 UM, 1 RM); Fertility (1 RM, 2 M); Storing Cloth (1 UM, 1 RM, 1 OW).
*Only two respondents mentioned each of the following concerns: Falling Cloth (1 UM, 1 RM); Start when Away (1 UM, 1 M); Urination (1 UM, 1 M).*
*Two women did not indicate any concerns related to urination: 1 M and 1 OW; neither 4 have latrines.*

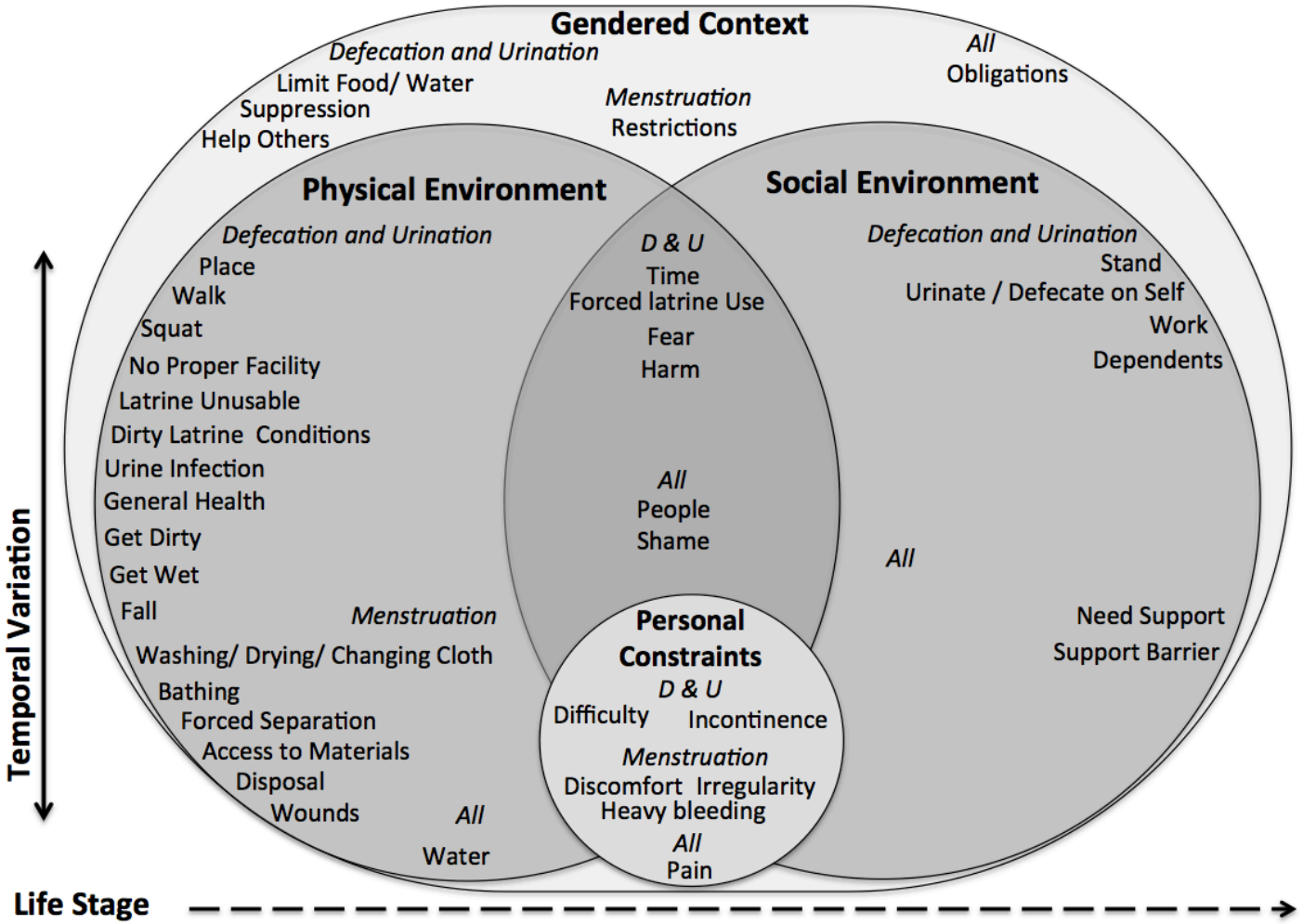


**Figure 2.1:** Conceptual model illustrating how domains of women's concerns related to sanitation influence one another. A dashed, unidirectional arrow representing both changes in life and forward movement in time represents *Life Stage*. *Temporal Variation* is represented by a bidirectional arrow indicating oscillating shifts that influence the domains, like cyclical seasonal changes or changes from day to night.

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# Chapter 3:

## Assessing Women's Experiences of Sanitation Insecurity:

## The Development of a Novel Measure

### Introduction

Research to date on sanitation and health has focused on links between exposure to pathogens and risk of infectious diseases (like diarrhea, soil-transmitted helminthes, and trachoma) or the longer term impacts of these infectious diseases, particularly among children under five (like tropical enteropathy, stunting, and cognitive impairment)[1-9]. Asessing health impacts related to pathogen exposures and their downstream effects alone may not capture the breadth of negative health outcomes that may be associated with compromised water, sanitation, and hygiene environments. Individuals' experiences attending to their sanitation needs may be harmful to health, though there is no current means to quantitatively assess the presence and intensity of negative sanitation experiences. The purpose of this paper is to document the development of a novel measure to assess Sanitation Insecurity, a construct capturing concerns and negative experiences related to sanitation.

A poor sanitation environment has typically been considered to be one where a toilet is non-existent or is 'unimproved'—that is, incapable of hygienically separating human excreta from human contact. An estimated 2.4 billion people lack access to improved sanitation, with 946 million of those people practicing open defecation because they lack access to any form of sanitation facility whatsoever[10]. While the number of people

without access to facilities is staggering, current estimates of improved sanitation coverage do not consider privacy, cleanliness, safety, comfort, accessibility or acceptability of facilities from the perspective of those who have them, or even use. Even those with latrines may not use them, which is well documented in India. In a cross-sectional study in Orissa, over a third of households with latrines did not have a single household member using it[11]. In another study across six Indian states with 3.235 households representing over 22,00 individuals, Coffey et al (2014) found that 48% of households that had a latrine had at least one family member that did not use it[9]As a result, even those with an 'improved' facility may have a poor sanitation environment that could compromise health outcomes.

Research has revealed that the experience of urinating, defecating, and managing menstruation can pose challenges that may expose individuals, particularly women, to physical, social, and mental health risks. Specifically, poor sanitation conditions, even for people with improved facilities, may pose threats to women's safety and dignity. For example, poor sanitation environs have caused disgust due to filth, interfered with responsibilities because of long lines or distantly-located locations for sanitation needs, failed to accommodate cultural practices or sex-specific needs, and reinforced women's lack of control over their environment [12-16]. A grounded theory study with women in rural India at different stages of the life course found that numerous sanitation-related factors contributed to women's experiences of 'Sanitation-related psycho-social stress.'[17]

Inspired by research that has investigated and created measures for culturally grounded notions of food and water insecurity, the aim of this paper is to document the development of a novel measure for sanitation insecurity'[18-25]. The concept of Sanitation Insecurity has only recently been conceptualized and investigated. Based on qualitative research carried out with women in rural Odisha, India, Sanitation Insecurity is relate to three broad domains, the physical environment, the social environment, and personal constraints, and has been defined as:

> Insufficient and uncertain access to adequate facilities and resources for independently, comfortably, safely, hygienically, and privately urinating, defecating and managing menses (as needed) in a culturally acceptable manner at any time of day or year as needs arise[26].

While some of the experiences women have when trying to address their sanitation-related needs have been documented, no measure of sanitation insecurity exists to quantify the extent to which women have sanitation-related concerns and negative experiences, or how frequently these concerns or experiences occur. A contexualized measure of sanitation insecurity is needed to understand more fully the range of women's experiences relating to sanitation. A measure of Sanitation Insecurity will make it possible to quantify the extent and frequency of sanitation-related concerns and experiences within populations. Moreover, this measure will enable researchers to assess the determinants of this insecurity and its impacts on other health indicators, like stress and quality of life, and determine if and how sanitation interventions effectively ameliorate women's concerns and negative experiences.

## Methods

### Setting

The present research uses the ground-up approaches used in food and water insecurity research to create a measure of sanitation insecurity from the perspective of women in rural Odisha, India. A measure of sanitation insecurity is particularly relevant to the Indian context, where only 44% of the total population has access to a sanitation facility and 61% of rural inhabitants practice open defecation[10].

Data were collected from March 2014- February 2015 in rural communities of Odisha, India that had been engaged in a cluster randomized controlled trial (CRT) assessing the health impacts of a sanitation intervention (toilet provision) as part of the government funded Total Sanitation Campaign (See Boisson et al 2014 for more detailed information about the intervention)[27-29]. Over the course of the trial (May 2010-December 2013), mean sanitation coverage increased from 9% to 63% in intervention communities and from 8% to 12% in control communities; no reduction in diarrhea, soil-transmitted helminth infection, or child malnutrition was detected as a result of the intervention[28].

### Overview of Research Design

To create and evaluate a measure of Sanitation Insecurity, we followed a sequential mixed methods design[30]. During phase one, the qualitative phase, we conducted research to develop a culturally grounded concept of Sanitation Insecurity and to generate items for the scale. During phase two, the quantitative phase, we conducted a census of

eligible communities to create a sampling frame and administered a survey with the scale items to a probability-based sample of women in those communities. During phase three, the measurement finalization phase, we explored the factor structure of the Sanitation Insecurity items using exploratory factor analysis (EFA), used confirmatory factor analysis (CFA) to test the factor structure identified in the EFA, and used multiple indicator multiple causes (MIMIC) models to test for measurement non-invariance, or differential item functioning (DIF), of specific scale items[31]. From these analyses, we recommend a final set of items for the Sanitation Insecurity measure (See Figure 2.1).

Our definition of Sanitation Insecurity includes urination-, defecation-, and menstruation-related behaviors. Because menstruation is not experienced by women who are pregnant, recently gave birth, or of advanced age, we only include urination and defecation-related items in our sanitation insecurity measure to make it applicable for women at all life stages. A menstruation-specific measure will be developed separately.

**Phase 1: Qualitative Research**

The qualitative research phase involved 3 stages: data collection, item identification, and item review and finalization. Complete details about the qualitative research activities and the analysis procedures to arrive at the conceptualization of sanitation insecurity are presented elsewhere[26].

***Phase 1, Stage 1: Data Collection***

First, we conducted Free-listing interviews (FLIs) to identify items for the sanitation insecurity measure (March-April 2014). Free-listing is an activity used to identify commonly shared perceptions about a topic or concept from a homogenous group of participants[32]. Specifically, women were asked to list their concerns related to urination and defecation. For each behavior, we probed about additional concerns they may have at night, during the monsoon season, and about dependents. We interviewed 69 women from eight communities (5 intervention and 3 control), which were purposively selected to represent varied sanitation coverage and geographical diversity. Women were purposively selected within each community to represent unique life stages: (1) unmarried (N=16), (2) married three years or less (N=12), (3) married over three years (N=22), (4) and women over 49 years of age (N=19).

Second, we conducted 8 Focus Group Discusions (FGDs)with 46 women in four different, purposively selected communities (2 intervention and 2 control) to gain more detail about concerns expressed in individual interviews (April-May 2014). As with the FLIs, we asked FGD participants to indicate concerns related to urination and defecation. We also inquired about specific concerns mentioned in FLIs about which we wanted more detail, and probed about the severity of concerns noted. Four FGDs were held with unmarried women (N=23) and four FGDs with married women (N=23).

FLIs and FGDs were facilitated by trained research assistants in Oriya, recorded, transcribed, and translated into English.

### *Phase 1, Stage 2: Item Identification*

To generate potential items for inclusion in the measure, we analyzed the FLIs first to understand the scope and frequency of concerns. Of the 69 women who participated in FLIs, 63 indicated having concerns related to urination and 65 indicated having concerns related to defecation; a total of 29 unique urination concerns and 39 unique defecation concerns were noted (See Chapter 2 for lists of all concerns and corresponding frequencies). FGDs corroborated the concerns noted in FLIs, but provided more detail and context. We created an initial list of items from the FLI and FGD concerns and then omitted all items directly related to the monsoon, as survey administration would not overlap with that season to make those questions relevant.

### *Phase 1, Stage 3: Item Review and Finalization*

During this stage, four rounds of item review took place to assess content validity, face validity, and translation. Items for the survey were then finalized. First, draft items were sent to two peer-reviewers with experience researching women's sanitation in India to assess content validity[33]. The peer-reviewers provided recommendations for revising the wording of items related to experience and concern for harm. Second, to further assess content validity the two research assistants (RAs) who carried out the qualitative data collection then reviewed the items and provided comments, with particular attention to alternative phrasing for existing items to be more specific (for example, they suggested asking about a concern for infection as opposed to a concern about health in general). They also suggested including an item about needing to go back and forth to a defecation

location because of a lack of privacy. The two RAs then translated the items from English to Oriya independently and then compared translations to reconcile any discrepancies and create a single translation.

Third, the RAs reviewed each translated item with the nine Oriya-speaking female data collectors (DCs) hired to administer the survey to assess face validity[33]. The DCs were from the region where the data collection was to take place and had experience with sanitation-related surveys from previous research. They were able to speak both from their own experience of sanitation and their perception of the experiences of their fellow community members. Specifically, we used cognitive interviewing methods to determine if the DCs understood the items as we intended them to be understood, asking them to explain, in their own words, what each item meant [34]. Modifications to the translations were made, as needed.

As an additional check to face validity, the research team (the RAs and the nine female DCs) piloted the items in a community similar to those where the data collection was to take place. During the pilot, the team noted items that were confusing to participants and wording that would be better. The team met after the pilot to discuss feedback and amend the item translations one final time.

The final survey included 68 items, 32 for urination and 36 for defecation, with four possible response options: never, sometimes, often and always. Items covered three hypothesized domains: the physical environment (i.e. had difficulty finding a clean place

to urinate); the social environment (i.e. worried people would talk about me if they saw me); and personal constraints that influence individual behavior (i.e. had difficulty or pain squatting for defecation). Women were asked to indicate how often they had a particular experience within the previous 30 days and could provide one of four responses: never, sometimes, often or always.

**Phase 2: Quantitative Research**

The quantitative research phase involved 3 stages: a census, creation of sampling frames and final sampling lists, and survey administration.

***Phase 2, Stage 1: Household Census***

We administered a census to create sampling frames from which to identify participants eligible for the final survey with the sanitation insecurity items (September-November 2014).

We had a stratified, multistage, cluster sample design where we aimed to survey 1440 total participants from 60 communities, 30 intervention and 30 control. The sample size was powered to detect small effect sizes using multilevel modeling (hierarchical modeling)[35] across two levels: Cluster level (i.e. intervention status), and Individual level (i.e. latrine access, life stage, etc.). This sample size is based on a simulation study that demonstrated power to detect small (d=0.20) direct and cross-level interaction effects for a continuous level-2 predictor to be greater than 96% for 60 clusters of 20 participants[36]. Hence, power was sufficient for both continuous and dichotomous

predictors (base sample size of 1200). Our sample size of 1440 in 60 communities allowed for attrition due to 1) incomplete surveys, 3) error in census data, 3) and accidental double sampling of households.

Former intervention communities were eligible for inclusion in the survey, and therefore the census, if they had greater than 25% latrine coverage, and former control communities were eligible for inclusion if they had less than 20% latrine coverage. To select the eligible intervention communities, coverage data were used from the final trial data collection in December 2014, assuming little change in coverage since that time[28]. To select the eligible control communities, we sought feedback from a non-government organization (NGO) partner actively working to provide sanitation in the control villages. Communities were excluded if they had been included in the qualitative activities that generated the survey items.

For the census, a team of trained DCs asked a single representative from every household in each of the 60 communities to provide basic information about members of the household (sex, age, marital status) and the household itself (water and latrine access).

***Phase 2, Stage 2: Creation of Sampling Frames and Final Sampling Lists***

We used data collected from the census to create sampling frames from which to randomly select participants for the final survey.

As with the FLIs, we aimed to include women over 18 from four life stages: (1) unmarried, (2) married three years or less, (3) married over three years and age 49 or younger, and (4) women over 49 years of age of any marital status. For each community, we used age and marital status data for each individual community member to then assign to a life stage category. Individuals who did not belong to one of the four identified life stage categories were excluded. Four lists were generated per community, one for each life stage category. We randomly selected women to participate from each of these four lists.

***Phase 2, Stage 3: Survey Administration***

Trained DCs (those who assisted in the pilot phase of the items) administered the survey to collect data on Sanitation Insecurity items for measurement creation as well as data on participant demographics, and sanitation behavior and access (December 2014 to February 2015, a year after the intervention ended).

In each community, the data collection team aimed to survey 24 women, 6 from each of the four life stage categories. Data collectors sought women in each life stage category list until the appropriate number of participants was attained, being mindful to not survey someone if another household member had already participated.

***Phase 3: Measurement Finalization***

The measurement finalization phase involved 3 stages: exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and assessment of differential item functioning

(DIF). These three steps enabled us to arrive at a final measure with a reduced number of items and identified sub-domains.

***Phase 3, Stage 1: Exploratory Factor Analysis***

EFA is recommended as the first step of measure development when little or no research to determine the structure of a measure has been conducted[37]. After EFA is used to explore the factor structure of the data; CFA is recommended to test the factor structure identified in the EFA [37]. Because we had a large sample, we split our data into random sub-samples to first carry out EFA (N1 =703) and then CFA (N2 =705). We generated descriptive statistics of the demographic and household information provided by participants sampled and performed chi-square and t-tests to determine if there were any significant differences in demographic and household information between the sub-samples.

We estimated the frequencies of responses for all 68 sanitation insecurity items to determine distributions, both overall and across women in different life-stage groups. We also determined the skewness and kurtosis for each item. EFA does not require or assume that data be normal, however reporting of non-normality, minimal variation, and outliers is recommended[37].

With sub-sample N1 (703), we carried out EFA with all 68 items (MPLUS7 software, Muthén & Muthén) to determine the number of factors and the factor loadings of each item[38]. We hypothesized that the factor structure would reflect the three broad domains

that the Sanitation Insecurity construct reflects (the physical environment, the social environment, and personal constraints). By default, MPLUS performs EFA modeling all available data under the assumption of data missing at random[38]. As part of the EFA process, we first estimated polychoric correlations of the items (i.e. correlations between observed ordinal variables) to assess the relationships between items[39, 40]. We assumed the factors to be correlated and therefore selected an oblique rotation of the data[37]. Due to the categorical responses, the estimator was WLSMV, a weighted least square parameter estimate that uses a diagonal weight matrix with standard errors and mean-and variance-adjusted chi-square test statistic[38]. Seven items showed little variance, resulting in negative correlations. These seven items (U07, U14, U21, U30, D13, D16, and D35) were therefore eliminated. EFA was then re-run and the number of factors, factor loadings, and theoretical and model fit was assessed. We explored all factors with an eigen value greater than one (Kaiser Criteria)[41].

***Phase 3, Stage 2: Confirmatory Factor Analysis***

After EFA, we used the second sub-sample (N2=705) to test the factor structure identified through EFA in MPLUS. The WLSMV estimator was used. Root mean square error of approximation (RMSEA), comparative fit index (CFI) and Tucker-Lewis index (TLI) were used to assess model fit. We decided a priori to drop any item with a factor loading <0.30 or if there were several adequate loaders (>0.50 on each factor)[41].

***Phase 3, Stage 1: Assessment of Differential Item Functioning (DIF)***

After evaluating the CFA model, we assessed DIF to determine if women from the various life stage categories responded to individual items in the measure differently. Differential item functioning (DIF) occurs if sub-groups in the population have a different propensity to report specific responses, despite having the same underlying trait[42]. DIF can be problematic from a validity perspective; if sub-groups perform differently, inferences made from the measure may be biased[43]. In the present study, we were concerned that women at different life stages may respond differently because they may have interpretations or perspectives of an item that are specific to the members of the life stage group to which they belong.

Using the same sub-sample as was used for the CFA (N2=705), we expanded the CFA model to Multiple Indicator Multiple Causes (MIMIC) structural equation models to test for DIF. First, we regressed the latent factors of the CFA model on three life stage covariates (with stage 1 (unmarried women) serving as the reference category. No direct effects of life stage covariates on individual items were included. If there is a significant effect of covariates on latent factors, factor means are different for different covariate levels indicating population heterogeneity. Next, the output modification indices (MIs) (with MIs greater than 3.84), which provide estimates of how much a specific model modification improves model fit, were assessed to determine if allowing direct effects of any of the life stage covariates on individual items should be estimated freely. Direct effects of the covariates on specific items were added sequentially, starting with the direct effect associated with the largest modification index. After each addition, modification

indices were re-assessed and additional direct effects were added until no DIF related MIs were generated. We assessed significance of each direct effect of the covariate on the respective item, which represents DIF. DIF can be addressed in two ways: account for DIF by generating individual scores through modeling approaches or eliminate items to create a DIF-free instrument[31]. We decided we would eliminate items to make results comparable in future studies.

CFA and MIMIC models were evaluated with MPLUS7 (Muthén & Muthén) using a mean- and variance-adjusted weighted least squares (WLSMV) estimator as recommended for categorical data.

### Ethics

Approval for this study was attained by the Institutional Review Board at Emory University (Atlanta, GA) and the Institutional Ethics Committee of KIIT University (Bhubaneswar, India). After being informed of the details concerning the study, participants provided oral consent prior to the interviews.

## Results

### Participant demographics

In total, 1437 surveys were administered. Detailed demographics information about participants involved in the qualitative phase of the research can be found elsewhere[26]. Twenty-nine women were eventually excluded because they were missing data for all relevant items (1), had another household member already participate (8) or were under

age 18 (20). The final sample size was 1408, including 341 (24%) unmarried women (stage 1), 320 (23%) women married three years or less (stage 2), 395 (28%) women married over three years (stage 3), and 352 (25%) women over age 49 of any marital status (stage 4).

Participants were 36 years old on average, almost all women were Hindu, and the majority had a 'below the poverty line' (BPL) card entitling them to government support, and some schooling. Most participants had access to water outside their household compound and did not have household latrine access (Table 3.1).

**Sanitation Insecurity Items**

The survey included 32 urination and 36 defecation items for potential inclusion in the final sanitation insecurity measure. The urination items participants most commonly responded 'always' to were those related to a lack of facility access, night, and concern for infection: 'Felt concerned I would get an infection if I was urinating in an unsuitable/dirty place' (36%); 'Felt concerned I would get an infection if I urinated on someone else's urine' (34%); 'Worried about not having a proper facility to urinate' (33%); 'Felt scared urinating in the dark at night' (27%); and 'Felt scared of ghosts when I went to urinate at night' (26%). The urination items participants most commonly responded 'Never' to were those related to experience of direct harms from others: 'Had men or boys harm or harass me when going to urinate' (100%)and 'Had people tease me when they saw me urinating ' (99%) (Table 3.2).

The defecation items participants most commonly responded ‘always’ to were those related to having and maintain a toilet: ‘Worried about not having a toilet to defecate in’ (54%) and ‘Worried that I have no money to build or maintain a toilet’ (45%). The defecation items participants most commonly responded ‘never’ to were, like the urination items, those related to experience of direct harms from others: ‘Had men or boys harm or harass me when going to defecate’ (100%) and ‘Had people tease me when they saw me defeating‘ (99%) (Table 3.3).

In an assessment of distributions, 12 urination items and 11 defecation items had skewness outside of the suggested ranges and some differences were noted in the sub-samples for urination and defecation items.

**Exploratory Factor Analysis**

Both sub-samples generated for the EFA and CFA analyses were similar overall and by life stage for all demographic information (no statistically significant differences were detected).

We determined that the 7-factor solution with the PROMAX rotation best suited the data theoretically. The seven factors each produced strong and positive factor loadings and had strong model fit (RMSEA=0.035, should be <0.06[44]; CFI and TLI results not provided for PROMAX rotation in MPLUS7) (Table 3.4). One item (‘Changing and washing clothes used only for defecation increased workload’) was omitted due to

multiple, low cross loadings and poor theoretical fit with the other factors, resulting in a total of 60 total items among the seven factors.

The seven factors broadly corresponded to the three initially hypothesized domains: the physical environment, the social environment, and personal constraints that influence individual behavior.

Specifically, factors 1, 4, and 7 largely concerned the physical environment. For factor 1, labeled 'Potential harms', all 11 items related to concerns or experiences related to potential for harm at urination and defecation locations (i.e. risk of infection, polluting exposure to unclean places) (factor loadings: 0.697-0.910). All 4 items in factor 4, 'Night concerns' dealt with night, like fear of the dark or of ghosts (factor loadings: 0.722-0.870). And the 12 items in Factor 7 related to concerns about 'defecation place', including not having a toilet, needing to go far, dirty conditions, and lack of privacy (factor loadings: 0.683-0.945).

Factors 2 and 5 related to the social environment. Factor 2 was labeled 'Social expectations and repercussions'. All 14 items in this factor dealt with a woman's need to modify behaviors based on presence of others; suppression of urges based on social constraints; concern about others talking about their behaviors if not socially acceptable (factor loadings: 0.533-0.863). Factor 5, 'Social Support' included 6 items about women's concerns providing or getting social support when they have a urination or

defecation need, like finding support to look after work or dependents, or not being able to provide social support when addressing their needs (factor loadings: 0.481-0.933).

Factors 3 and 6 dealt with women's personal constraints. Factor 3, labeled 'Physical exertion or strain', included 9 items about concerns or experiences regarding how women needed to exert or strain their bodies to manage or control their urination and defecation needs, like withholding food and water to control urges, and doing work to wash the self or clothing after addressing needs (factor loadings: 0.431-0.715). Factor 6, 'Physical Agility' included 4 items related to women's personal physical agility when urinating or defecating, like difficulty squatting or concern for falling (factor loadings: 0.713-0.920).

**Confirmatory Factor Analysis**

For the CFA, two items were omitted, one to deal with non-convergence for having a negative residual variance ('Had difficulty walking to defecation place') and the second ('Had frequent pressure to urinate') for having a very low factor loading (<0.150), resulting in a further refined model. Factor loadings for the 58 items remaining were significant and in similar ranges All factors covaried significantly. The model fit was adequate (See Table 3.4).

**Assessment of Differential Item Functioning**

The final MIMIC model accommodated uniform DIF by allowing modifications to the model that allow life stage to have direct effects on specific items along with the indirect effects of the life stage covariates on the factor means. The final model included 10

suggested modifications involving the addition of direct effects on 8 items (Supplement 3). Despite these modifications, the indirect effects of life stage on the factor means did not change greatly. The most notable change was for 'Physical exertion or strain' (F3); women older than age 49 (stage 4) had a significantly lower factor mean (-0.140) than unmarried women (stage 1). All other previously reported significant differences by life stage remained the same with changes only made to the degree of difference.

The inclusion of the 10 suggested direct effects of life stages on specific items had little effect on model fit. Of the 8 items that functioned differently, six pertained to women over 49 and two pertained to recently married women and women married over three years (See Table 3.5).

**Final Measure**

We elected to delete the 8 items that exhibited DIF to make the instrument more parsimonious. We did not feel that item deletion endangered construct validity, given the range of items still remaining that touch upon similar concepts. The final CFA model included 50 items (11 items in F1: 'Potential harms'; 13 items in F2: 'Social expectations and repercussions'; 6 items in F3: 'Physical exertion or strain'; 4 items in F4: 'Night Concerns'; 4 items in F5: 'Social support'; 6 items in F6: 'Physical agility; and 9 items in F7: 'Defecation place') (See Supplement 4 for final items by factor). All items loading on each factor were significant. The model fit was adequate, and slightly improved for CFI and TLI compared to the initial CFA (RMSEA=0.060; CFI= 0.944; TLI=0.941). All factors covaried significantly (Table 3.4).

## Discussion

This study is the first to develop and validate a measure of sanitation insecurity that explicitly aims to capture the existence and frequency of the full range of women's concerns and experiences related to urination and defecation. The mixed methods approach utilized to produce this measure – including qualitative research, a census to identify appropriate respondents, and a survey involving over 1400 participants –was imperative to ensure that the final items included reflected and represented the voiced concerns and experiences of the target population. Further, the use of EFA to hypothesize the factor structure, CFA to evaluate it, and DIF to identify variability in response by life stage all served to strengthen the final measure.

Bradley and Bartram (2013) outlined the need to re-think water security and included sanitation as part of water insecurity. However, the authors focused on the security and sustainability of technologies (water and sanitation systems) and did not consider the relationship between the technologies described and the perspectives of the individuals interacting with them[45]. Our research demonstrates that sanitation security requires more than the sustainability of technologies, but coniseration of users' perspectives, to gain insight of their lived experiences of sanitation, and to assess whether and how those experiences may put users at risk or cause harm. A sanitation facility that is unbreakable, scalable, and technologically perfect is of no value if it is culturally unacceptable, undignified, unsafe, inconvenient and unfit for use. Given the documented challenges women have faced in regard to their sanitation experiences and their gender- and sex-

specific needs, a focus on understanding women's experiences and whether or not sanitation technologies improve those experiences is imperative.

We proposed a measure of sanitation insecurity that reflected women's voiced concerns about their sanitation experiences. The items reflected three broad domains: the physical environment, the social environment, and personal constraints. The seven factors that make up the final measure correspond to these three domains. It is imperative to note that only a few items actually correspond to sanitation technology (U01: worry about not having a proper facility to urinate and D01: worry about not having a toilet to defecate). Several items relate to concern about the physical environment (items in Factors 1, 4, and 7), however the construction of a toilet will not guarantee that these concerns are eliminated or even ameliorated unless engineers and practitioners make an intentional effort to address them. For example, concerns about harm from animals or people, fear at night, and the need to go a far distance (since facilities are typically outside the home) could be addressed by including women in decisions about the placement and design of facilities, but very well may not be.

Issues related to the social environment (factors 2 and 5) pose challenges for a WASH sector that has historically been focused on engineering changes to the physical environment. From qualitative research, we know that women have difficulty addressing their urination and defecation needs if they have social constraints like work they are required to complete, restrictions on what time of day needs can be addressed, or depend on others to watch children. Providing a toilet could ease these social difficulties if efforts

to do so deliberately incorporate women's needs and concerns. If a toilet is situated in an accessible location (from women's perspectives), for example, and contains the resources she needs within or attached to it (like water and a bathing area as appropriate), a woman may no longer need extended time, bodily restraint, or the assistance of others to take care of her own bodily needs.

Personal constraints (Factors 3 and 5), namely those related to physical exertion, strain and agility, need further attention and could be addressed by mindful technology approaches. Women may need to exert tremendous amounts of energy to fetch water or clean themselves and their clothes post-defecation or may risk falling or experience pain squatting, particularly if they have limited mobility. These difficulties may be more pronounced if women have disabilities, are in advanced stages of pregnancy, or are elderly. In short, women may have different needs. Yet toilets are typically designed to accommodate the 'average user', particularly in low-income settings where building facilities at scale is a priority. Researchers, have called for practitioners nad policy makers address the specific needs of users in the design of sanitation facilities for children at school (size of squatting holes, height of door knobs and locks, etc.), including school children with disabilities (ramps for wheelchair access), and for women and girls who menstruate (water and space for washing and disposal units in stalls), yet it is unclear if these calls have had any impact on facilities themselves [46-49]. Similarly, practitioners and policy makers need to consider women's personal abilities to use facilities when they are designed.

**Strengths and Limitations**

The sanitation insecurity measure is the first measure designed to assess the occurrence and frequency of the full range of women's concerns and negative experiences related to sanitation. While it reflects the voiced concerns of women in various life stages in rural Odisha, India, it does not necessarily reflect those of other populations. Further research is needed to learn if this measure would be of use among other populations in India—whether with men and individuals younger than 18 or with women in urban and tribal areas—and beyond. Recent research in Odisha, India involving women in rural, urban and tribal areas found that women in urban areas had higher sanitation related stressors that could be attributed to the environment or sexual coercion than women in other areas[17]. The evaluation of this tool with other populations could enable these populations to be compared and for intervention designs to be targeted based on specific needs.

Further, this tool does not capture seasonal variability, which may influence experiences. Data was collected in the winter months with only a 30 day re-call, and so it was not appropriate to ask women about concerns related to extreme heat or the monsoon even though women described many concerns and challenges during these times. This tool should be used at different times of the year to see if the intensity of sanitation insecurity changes and additional questions could be considered for inclusion.

## Conclusion

This sanitation insecurity measure aims to quantify the existence and frequency of the full range of women's concerns and negative experiences related to sanitation. With this measure, sanitation interventions could be evaluated to determine if they actually improve women's experiences or if they have unintended consequences of making their experiences worse, therefore moving beyond simpler assessments that solely evaluate hardware and ability to contain feces. The measure can also be used to assess women's experiences before a sanitation intervention is initiated in order to include components that actively address women's sanitation concerns when facilities and programs are designed. Finally, scores resulting from this measure could be used to determine if there is a relationship between women's level of sanitation insecurity and their health, with attention to facets of health beyond infectious disease, like anxiety, quality of life and risk of violence.

**Table 3.1: Demographic characteristics of survey participants, overall and by life stage in Rural Orissa, India (N=1408)**

| | All | | 1. Unmarried (UM) | | 2. Recently Married (<3 years) (RM) | | 3. Married (>3 years) (M) | | 4. Over 49 (OW) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Participants** | 1408 | | 341 | | 320 | | 395 | | 352 | |
| **Village Status** | | | | | | | | | | |
| Control | 707 | 50.2% | 175 | 51.3% | 162 | 50.6% | 193 | 48.9% | 177 | 50.3% |
| Intervention | 701 | 49.8% | 166 | 48.7% | 158 | 49.4% | 202 | 51.1% | 175 | 49.7% |
| **Age** | 36.4 | (17.9) | 21.2 | (2.9) | 23.9 | (3.0) | 35.4 | (7.0) | 63.6 | (10.0) |
| **Education** | | | | | | | | | | |
| None | 335 | 23.8% | 3 | 0.9% | 7 | 2.2% | 80 | 20.3% | 245 | 69.6% |
| Some Primary | 410 | 29.1% | 53 | 15.5% | 68 | 21.3% | 190 | 48.1% | 99 | 28.1% |
| Some Secondary | 588 | 41.8% | 235 | 68.9% | 232 | 72.5% | 114 | 28.9% | 8 | 2.3% |
| Higher than Secondary | 75 | 5.3% | 50 | 14.7% | 13 | 4.1% | 12 | 3.0% | 0 | 0.0% |
| **Possession of Government Assistance Card (Below Poverty Line, Antodaya or both)** [1] | | | | | | | | | | |
| Yes | 1033 | 73.4% | 259 | 76.0% | 223 | 69.7% | 286 | 72.6% | 265 | 75.3% |
| **Religion** | | | | | | | | | | |
| Hindu | 1389 | 98.7% | 339 | 99.4% | 315 | 98.4% | 386 | 97.7% | 349 | 99.1% |
| Muslim | 19 | 1.3% | 2 | 0.6% | 5 | 1.6% | 9 | 2.3% | 3 | 0.9% |
| **Caste**[1] | | | | | | | | | | |
| Brahmin | 38 | 2.7% | 10 | 2.9% | 8 | 2.5% | 12 | 3.0% | 8 | 2.3% |
| Forward / General Caste | 672 | 47.8% | 150 | 44.1% | 151 | 47.3% | 171 | 43.3% | 155 | 44.0% |
| Scheduled Caste (SC) | 247 | 17.6% | 51 | 15.0% | 59 | 18.5% | 76 | 19.2% | 61 | 17.3% |
| Other Backward Caste (OBC) | 464 | 33.0% | 124 | 36.5% | 92 | 28.8% | 128 | 32.4% | 120 | 34.1% |
| Scheduled Tribe (ST) | 11 | 0.8% | 2 | 0.6% | 2 | 0.6% | 3 | 0.8% | 4 | 1.1% |
| Don't Know | 19 | 1.4% | 3 | 0.9% | 7 | 2.2% | 5 | 1.3% | 4 | 1.1% |
| **Has children** | 906 | 64.3% | 0 | 0.0% | 180 | 56.3% | 382 | 96.7% | 344 | 97.7% |
| **Number of Children** | 2.6 | (2.2) | 0 | (0.0) | 0.6 | (0.6) | 2.4 | (1.2) | 4.6 | (2.2) |
| **Primary Drinking Water Source Location**[2] | | | | | | | | | | |
| In Dwelling | 131 | 9.8% | 15 | 4.6% | 43 | 14.5% | 33 | 8.8% | 40 | 11.8% |
| In Compound | 273 | 20.5% | 68 | 21.1% | 71 | 23.9% | 70 | 18.7% | 64 | 18.8% |
| Outside Compound | 927 | 69.6% | 240 | 74.3% | 183 | 61.6% | 271 | 72.5% | 233 | 68.5% |
| **Household Latrine Ownership**[2] | | | | | | | | | | |
| Yes | 414 | 29.4% | 71 | 20.8% | 128 | 40.0% | 103 | 26.2% | 112 | 31.8% |
| No | 815 | 58.0% | 226 | 66.3% | 155 | 48.4% | 241 | 61.3% | 193 | 54.8% |
| Under Construction | 177 | 12.6% | 44 | 12.9% | 37 | 11.6% | 49 | 12.5% | 47 | 13.4% |

Data are number and percent or mean and (standard deviation).

1 For *Possession of government Assistance Card: 1 missing (stage 3);* For *Caste: 2 missing* (stage 1 and stage 2) and 19 indicated 'don't know'

2 For *Water source*: data taken from census, 77 participants with missing data; For *Latrine ownership*: data taken from census, 2 participants with missing data

**Table 3.2a: Frequency of participant responses for urination module questions by random split halves and life stage categories.**

***Question: How often have you experienced any of the following in the previous 30 days when going to urinate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **u01 Worried about not having a proper facility to urinate**[1] | | | | | | | | | | | | | | | | | | | | |
| Never | 615 | 43.7% | 309 | 44.0% | 52 | 31.3% | 72 | 44.4% | 84 | 45.4% | 101 | 53.2% | 306 | 43.4% | 65 | 37.1% | 69 | 43.7% | 90 | 42.9% | 82 | 50.6% |
| Sometimes | 152 | 10.8% | 81 | 11.5% | 19 | 11.4% | 11 | 6.8% | 26 | 14.1% | 25 | 13.2% | 71 | 10.1% | 16 | 9.1% | 16 | 10.1% | 14 | 6.7% | 25 | 15.4% |
| Often | 184 | 13.1% | 99 | 14.1% | 24 | 14.5% | 22 | 13.6% | 27 | 14.6% | 26 | 13.7% | 85 | 12.1% | 22 | 12.6% | 14 | 8.9% | 29 | 13.8% | 20 | 12.3% |
| Always | 457 | 32.5% | 214 | 30.4% | 71 | 42.8% | 57 | 35.2% | 48 | 25.9% | 38 | 20.0% | 243 | 34.5% | 72 | 41.1% | 59 | 37.3% | 77 | 36.7% | 35 | 21.6% |
| **u02 Could not always go to urinate when there was a need**[1] | | | | | | | | | | | | | | | | | | | | |
| Never | 869 | 61.7% | 436 | 62.0% | 87 | 52.4% | 101 | 62.3% | 110 | 59.5% | 138 | 72.6% | 433 | 61.4% | 115 | 65.7% | 92 | 58.2% | 117 | 55.7% | 109 | 67.3% |
| Sometimes | 410 | 29.1% | 202 | 28.7% | 64 | 38.6% | 38 | 23.5% | 57 | 30.8% | 43 | 22.6% | 208 | 29.5% | 38 | 21.7% | 48 | 30.4% | 77 | 36.7% | 45 | 27.8% |
| Often | 98 | 7.0% | 44 | 6.3% | 11 | 6.6% | 12 | 7.4% | 13 | 7.0% | 8 | 4.2% | 54 | 7.7% | 20 | 11.4% | 15 | 9.5% | 12 | 5.7% | 7 | 4.3% |
| Always | 31 | 2.2% | 21 | 3.0% | 4 | 2.4% | 11 | 6.8% | 5 | 2.7% | 1 | 0.5% | 10 | 1.4% | 2 | 1.1% | 3 | 1.9% | 4 | 1.9% | 1 | 0.6% |
| **u03 Worried that someone would see me while urinating** | | | | | | | | | | | | | | | | | | | | |
| Never | 725 | 51.5% | 362 | 51.5% | 64 | 38.6% | 74 | 45.7% | 84 | 45.4% | 140 | 73.7% | 363 | 51.5% | 79 | 45.1% | 69 | 43.7% | 101 | 48.1% | 114 | 70.4% |
| Sometimes | 292 | 20.7% | 141 | 20.1% | 36 | 21.7% | 29 | 17.9% | 51 | 27.6% | 25 | 13.2% | 151 | 21.4% | 37 | 21.1% | 35 | 22.2% | 48 | 22.9% | 31 | 19.1% |
| Often | 163 | 11.6% | 82 | 11.7% | 31 | 18.7% | 21 | 13.0% | 24 | 13.0% | 6 | 3.2% | 81 | 11.5% | 16 | 9.1% | 24 | 15.2% | 33 | 15.7% | 8 | 4.9% |
| Always | 228 | 16.2% | 118 | 16.8% | 35 | 21.1% | 38 | 23.5% | 26 | 14.1% | 19 | 10.0% | 110 | 15.6% | 43 | 24.6% | 30 | 19.0% | 28 | 13.3% | 9 | 5.6% |
| **u04 Experience difficulty controlling urge to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 982 | 69.7% | 488 | 69.4% | 104 | 62.7% | 104 | 64.2% | 128 | 69.2% | 152 | 80.0% | 494 | 69.7% | 123 | 70.3% | 102 | 64.6% | 151 | 71.9% | 118 | 72.8% |
| Sometimes | 318 | 22.6% | 164 | 23.3% | 49 | 29.5% | 43 | 26.5% | 43 | 23.2% | 29 | 15.3% | 154 | 21.7% | 37 | 21.1% | 40 | 25.3% | 41 | 19.5% | 36 | 22.2% |
| Often | 74 | 5.3% | 31 | 4.4% | 10 | 6.0% | 8 | 4.9% | 9 | 4.9% | 4 | 2.1% | 43 | 6.1% | 12 | 6.9% | 13 | 8.2% | 15 | 7.1% | 3 | 1.9% |
| Always | 34 | 2.4% | 20 | 2.8% | 3 | 1.8% | 7 | 4.3% | 5 | 2.7% | 5 | 2.6% | 14 | 2.0% | 3 | 1.7% | 3 | 1.9% | 3 | 1.4% | 5 | 3.1% |
| **u05 Experienced pain during urination** | | | | | | | | | | | | | | | | | | | | |
| Never | 1218 | 86.5% | 600 | 85.3% | 153 | 92.2% | 132 | 81.5% | 160 | 86.5% | 155 | 81.6% | 618 | 87.7% | 161 | 92.0% | 137 | 86.7% | 183 | 87.1% | 137 | 84.6% |
| Sometimes | 134 | 9.5% | 76 | 10.8% | 12 | 7.2% | 20 | 12.3% | 21 | 11.4% | 23 | 12.1% | 58 | 8.2% | 10 | 5.7% | 15 | 9.5% | 20 | 9.5% | 13 | 8.0% |
| Often | 25 | 1.8% | 11 | 1.6% | 0 | 0.0% | 7 | 4.3% | 0 | 0.0% | 4 | 2.1% | 14 | 2.0% | 2 | 1.1% | 3 | 1.9% | 3 | 1.4% | 6 | 3.7% |
| Always | 31 | 2.2% | 16 | 2.3% | 1 | 0.6% | 3 | 1.9% | 4 | 2.2% | 8 | 4.2% | 15 | 2.1% | 2 | 1.1% | 3 | 1.9% | 4 | 1.9% | 6 | 3.7% |
| **u06 Had difficulty finding a clean place to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 774 | 55.0% | 396 | 56.3% | 73 | 44.0% | 92 | 56.8% | 104 | 56.2% | 127 | 66.8% | 378 | 53.6% | 85 | 48.6% | 82 | 51.9% | 110 | 52.4% | 101 | 62.3% |
| Sometimes | 225 | 16.0% | 113 | 16.1% | 32 | 19.3% | 22 | 13.6% | 31 | 16.8% | 28 | 14.7% | 112 | 15.9% | 26 | 14.9% | 25 | 15.8% | 32 | 15.2% | 29 | 17.6% |
| Often | 132 | 9.4% | 56 | 8.0% | 18 | 10.8% | 9 | 5.6% | 17 | 9.2% | 12 | 6.3% | 76 | 10.8% | 17 | 9.7% | 17 | 10.8% | 26 | 12.4% | 16 | 9.7% |
| Always | 277 | 19.7% | 138 | 19.6% | 43 | 25.9% | 39 | 24.1% | 33 | 17.8% | 23 | 12.1% | 139 | 19.7% | 47 | 26.9% | 34 | 21.5% | 42 | 20.0% | 16 | 9.7% |
| **u07 Felt afraid I would fall when going to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1246 | 88.5% | 626 | 89.0% | 159 | 95.8% | 154 | 95.1% | 176 | 95.1% | 137 | 72.1% | 620 | 87.9% | 166 | 94.9% | 144 | 91.1% | 195 | 92.9% | 115 | 71.0% |
| Sometimes | 93 | 6.6% | 44 | 6.3% | 4 | 2.4% | 5 | 3.1% | 9 | 4.9% | 26 | 13.7% | 49 | 7.0% | 8 | 4.6% | 11 | 7.0% | 9 | 4.3% | 21 | 13.0% |
| Often | 21 | 1.5% | 10 | 1.4% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 9 | 4.7% | 11 | 1.6% | 0 | 0.0% | 3 | 1.9% | 2 | 1.0% | 6 | 3.7% |
| Always | 48 | 3.4% | 23 | 3.3% | 3 | 1.8% | 2 | 1.2% | 0 | 0.0% | 18 | 9.5% | 25 | 3.5% | 1 | 0.6% | 0 | 0.0% | 4 | 1.9% | 20 | 12.3% |
| **u08 Felt worried that I would step on urine**[2] | | | | | | | | | | | | | | | | | | | | |
| Never | 873 | 62.0% | 448 | 63.8% | 82 | 49.4% | 98 | 60.5% | 118 | 63.8% | 150 | 79.4% | 425 | 60.3% | 93 | 53.1% | 87 | 55.1% | 127 | 60.5% | 118 | 72.8% |
| Sometimes | 255 | 18.1% | 125 | 17.8% | 38 | 22.9% | 30 | 18.5% | 35 | 18.9% | 22 | 11.6% | 130 | 18.4% | 36 | 20.6% | 29 | 18.4% | 38 | 18.1% | 27 | 16.7% |
| Often | 109 | 7.7% | 50 | 7.1% | 20 | 12.0% | 12 | 7.4% | 14 | 7.6% | 4 | 2.1% | 59 | 8.4% | 12 | 6.9% | 19 | 12.0% | 23 | 11.0% | 5 | 3.1% |
| Always | 170 | 12.1% | 79 | 11.3% | 26 | 15.7% | 22 | 13.6% | 18 | 9.7% | 13 | 6.9% | 91 | 12.9% | 34 | 19.4% | 23 | 14.6% | 22 | 10.5% | 12 | 7.4% |
| **u09 Worried people would talk about me if they saw me** | | | | | | | | | | | | | | | | | | | | |
| Never | 1115 | 79.2% | 561 | 79.8% | 112 | 67.5% | 118 | 72.8% | 154 | 83.2% | 177 | 93.2% | 554 | 78.6% | 129 | 73.7% | 121 | 76.6% | 162 | 77.1% | 142 | 87.7% |
| Sometimes | 103 | 7.3% | 47 | 6.7% | 15 | 9.0% | 17 | 10.5% | 9 | 4.9% | 6 | 3.2% | 56 | 7.9% | 16 | 9.1% | 12 | 7.6% | 14 | 6.7% | 14 | 8.6% |
| Often | 83 | 5.9% | 38 | 5.4% | 17 | 10.2% | 7 | 4.3% | 10 | 5.4% | 4 | 2.1% | 45 | 6.4% | 12 | 6.9% | 8 | 5.1% | 21 | 10.0% | 4 | 2.5% |
| Always | 107 | 7.6% | 57 | 8.1% | 22 | 13.3% | 20 | 12.3% | 12 | 6.5% | 3 | 1.6% | 50 | 7.1% | 18 | 10.3% | 17 | 10.8% | 13 | 6.2% | 2 | 1.2% |

**Table 3.2b: Frequency of participant responses for urination module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to urinate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **u10 Felt concerned I would get an infection if I was urinating in an unsuitable/ dirty place[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 581 | 41.3% | 296 | 42.1% | 51 | 30.7% | 54 | 33.3% | 74 | 40.0% | 117 | 62% | 285 | 40.4% | 54 | 30.9% | 54 | 34.2% | 82 | 39.0% | 95 | 58.6% |
| Sometimes | 190 | 13.5% | 102 | 14.5% | 23 | 13.9% | 20 | 12.3% | 33 | 17.8% | 26 | 14% | 88 | 12.5% | 21 | 12.0% | 20 | 12.7% | 26 | 12.4% | 21 | 13.0% |
| Often | 132 | 9.4% | 78 | 11.1% | 22 | 13.3% | 20 | 12.3% | 24 | 13.0% | 11 | 6% | 55 | 7.8% | 16 | 9.1% | 7 | 4.4% | 21 | 10.0% | 11 | 6.8% |
| Always | 505 | 35.9% | 228 | 32.4% | 70 | 42.2% | 68 | 42.0% | 54 | 29.2% | 36 | 19% | 277 | 39.3% | 84 | 48.0% | 77 | 48.7% | 81 | 38.6% | 35 | 21.6% |
| **u11 Feared I would be harmed by animals or insects when I went to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1166 | 82.8% | 580 | 82.5% | 133 | 80.1% | 134 | 82.7% | 152 | 82.2% | 161 | 83.9% | 586 | 83.1% | 134 | 76.1% | 130 | 82.3% | 173 | 82.4% | 149 | 92.0% |
| Sometimes | 123 | 8.7% | 60 | 8.5% | 16 | 9.6% | 17 | 10.5% | 15 | 8.1% | 12 | 6.3% | 63 | 8.9% | 18 | 10.2% | 17 | 10.8% | 19 | 9.0% | 9 | 5.6% |
| Often | 18 | 1.3% | 11 | 1.6% | 4 | 2.4% | 1 | 0.6% | 5 | 2.7% | 1 | 0.5% | 7 | 1.0% | 3 | 1.7% | 2 | 1.3% | 2 | 1.0% | 0 | 0.0% |
| Always | 101 | 7.2% | 52 | 7.4% | 13 | 7.8% | 10 | 6.2% | 13 | 7.0% | 16 | 8.3% | 49 | 7.0% | 20 | 11.4% | 9 | 5.7% | 16 | 7.6% | 4 | 2.5% |
| **u12 Feared I would be harmed by someone when I went to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1294 | 91.9% | 651 | 92.6% | 153 | 92.2% | 152 | 93.8% | 170 | 91.9% | 176 | 92.6% | 643 | 91.2% | 149 | 85.1% | 145 | 91.8% | 192 | 91.4% | 157 | 96.9% |
| Sometimes | 48 | 3.4% | 20 | 2.8% | 4 | 2.4% | 5 | 3.1% | 7 | 3.8% | 4 | 2.1% | 28 | 4.0% | 8 | 4.6% | 5 | 3.2% | 12 | 5.7% | 3 | 1.9% |
| Often | 8 | 0.6% | 4 | 0.6% | 2 | 1.2% | 0 | 0.0% | 2 | 1.1% | 0 | 0.0% | 4 | 0.6% | 2 | 1.1% | 1 | 0.6% | 1 | 0.5% | 0 | 0.0% |
| Always | 58 | 4.1% | 28 | 4.0% | 7 | 4.2% | 5 | 3.1% | 6 | 3.2% | 10 | 5.3% | 30 | 4.3% | 16 | 9.1% | 7 | 4.4% | 5 | 2.4% | 2 | 1.2% |
| **u13 Felt scared urinating in the dark at night** | | | | | | | | | | | | | | | | | | | | |
| Never | 628 | 44.6% | 322 | 45.8% | 54 | 32.5% | 61 | 37.7% | 86 | 46.5% | 121 | 63.7% | 306 | 43.4% | 49 | 28.0% | 50 | 31.6% | 101 | 48.1% | 106 | 65.4% |
| Sometimes | 246 | 17.5% | 126 | 17.9% | 32 | 19.3% | 24 | 14.8% | 40 | 21.6% | 30 | 15.8% | 120 | 17.0% | 30 | 17.1% | 20 | 12.7% | 43 | 20.5% | 27 | 16.7% |
| Often | 156 | 11.1% | 74 | 10.5% | 23 | 13.9% | 25 | 15.4% | 21 | 11.4% | 5 | 2.6% | 82 | 11.6% | 23 | 13.1% | 27 | 17.1% | 26 | 12.4% | 6 | 3.7% |
| Always | 378 | 26.8% | 181 | 25.7% | 57 | 34.3% | 52 | 32.1% | 38 | 20.5% | 34 | 17.9% | 197 | 27.9% | 73 | 41.7% | 61 | 38.6% | 40 | 19.0% | 23 | 14.2% |
| **u14 Had people tease me when they saw me urinating** | | | | | | | | | | | | | | | | | | | | |
| Never | 1393 | 98.9% | 697 | 99.1% | 164 | 98.8% | 161 | 99.4% | 183 | 98.9% | 189 | 99.5% | 696 | 98.7% | 172 | 98.3% | 153 | 96.8% | 209 | 99.5% | 162 | 100% |
| Sometimes | 10 | 0.7% | 4 | 0.6% | 1 | 0.6% | 1 | 0.6% | 1 | 0.5% | 1 | 0.5% | 6 | 0.9% | 2 | 1.1% | 3 | 1.9% | 1 | 0.5% | 0 | 0.0% |
| Often | 3 | 0.2% | 2 | 0.3% | 1 | 0.6% | 0 | 0.0% | 1 | 0.5% | 0 | 0.0% | 1 | 0.1% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| Always | 2 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 0.3% | 1 | 0.6% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| **u15 Felt concerned I would get an infection if urinated on someone else's urine** | | | | | | | | | | | | | | | | | | | | |
| Never | 581 | 41.3% | 300 | 42.7% | 52 | 31.3% | 54 | 33.3% | 75 | 40.5% | 119 | 62.6% | 281 | 39.9% | 54 | 30.9% | 54 | 34.2% | 82 | 39.0% | 91 | 56.2% |
| Sometimes | 200 | 14.2% | 105 | 14.9% | 22 | 13.3% | 22 | 13.6% | 37 | 20.0% | 24 | 12.6% | 95 | 13.5% | 19 | 10.9% | 18 | 11.4% | 33 | 15.7% | 25 | 15.4% |
| Often | 145 | 10.3% | 76 | 10.8% | 22 | 13.3% | 16 | 9.9% | 23 | 12.4% | 15 | 7.9% | 69 | 9.8% | 21 | 12.0% | 12 | 7.6% | 19 | 9.0% | 17 | 10.5% |
| Always | 482 | 34.2% | 222 | 31.6% | 70 | 42.2% | 70 | 43.2% | 50 | 27.0% | 32 | 16.8% | 260 | 36.9% | 81 | 46.3% | 74 | 46.8% | 76 | 36.2% | 29 | 17.9% |
| **u16 Felt scared of ghosts when I went to urinate at night** | | | | | | | | | | | | | | | | | | | | |
| Never | 648 | 46.0% | 326 | 46.4% | 47 | 28.3% | 58 | 35.8% | 92 | 49.7% | 129 | 67.9% | 322 | 45.7% | 53 | 30.3% | 50 | 31.6% | 101 | 48.1% | 118 | 72.8% |
| Sometimes | 246 | 17.5% | 130 | 18.5% | 35 | 21.1% | 27 | 16.7% | 37 | 20.0% | 31 | 16.3% | 116 | 16.5% | 33 | 18.9% | 27 | 17.1% | 37 | 17.6% | 19 | 11.7% |
| Often | 149 | 10.6% | 69 | 9.8% | 30 | 18.1% | 16 | 9.9% | 17 | 9.2% | 6 | 3.2% | 80 | 11.3% | 23 | 13.1% | 21 | 13.3% | 27 | 12.9% | 9 | 5.6% |
| Always | 365 | 25.9% | 178 | 25.3% | 54 | 32.5% | 61 | 37.7% | 39 | 21.1% | 24 | 12.6% | 187 | 26.5% | 66 | 37.7% | 60 | 38.0% | 45 | 21.4% | 16 | 9.9% |
| **u17 Had difficulty finding a private place to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 736 | 52.3% | 373 | 53.1% | 68 | 41.0% | 83 | 51.2% | 97 | 52.4% | 125 | 65.8% | 363 | 51.5% | 80 | 45.7% | 78 | 49.4% | 107 | 51.0% | 98 | 59.8% |
| Sometimes | 316 | 22.4% | 150 | 21.3% | 37 | 22.3% | 27 | 16.7% | 47 | 25.4% | 39 | 20.5% | 166 | 23.5% | 39 | 22.3% | 35 | 22.2% | 46 | 21.9% | 46 | 28.0% |
| Often | 190 | 13.5% | 91 | 12.9% | 31 | 18.7% | 19 | 11.7% | 26 | 14.1% | 15 | 7.9% | 99 | 14.0% | 31 | 17.7% | 23 | 14.6% | 34 | 16.2% | 11 | 6.7% |
| Always | 166 | 11.8% | 89 | 12.7% | 30 | 18.1% | 33 | 20.4% | 15 | 8.1% | 11 | 5.8% | 77 | 10.9% | 25 | 14.3% | 22 | 13.9% | 23 | 11.0% | 7 | 4.3% |
| **u18 Had difficulty or pain sitting or getting up for urination** | | | | | | | | | | | | | | | | | | | | |
| Never | 981 | 69.7% | 488 | 69.4% | 132 | 79.5% | 121 | 74.7% | 151 | 81.6% | 84 | 44.2% | 493 | 69.9% | 150 | 85.7% | 120 | 75.9% | 150 | 71.4% | 73 | 45.1% |
| Sometimes | 229 | 16.3% | 108 | 15.4% | 27 | 16.3% | 22 | 13.6% | 20 | 10.8% | 39 | 20.5% | 121 | 17.2% | 21 | 12.0% | 24 | 15.2% | 44 | 21.0% | 32 | 19.8% |
| Often | 75 | 5.3% | 39 | 5.5% | 3 | 1.8% | 10 | 6.2% | 8 | 4.3% | 18 | 9.5% | 36 | 5.1% | 1 | 0.6% | 6 | 3.8% | 7 | 3.3% | 22 | 13.6% |
| Always | 123 | 8.7% | 68 | 9.7% | 4 | 2.4% | 9 | 5.6% | 6 | 3.2% | 49 | 25.8% | 55 | 7.8% | 3 | 1.7% | 8 | 5.1% | 9 | 4.3% | 35 | 21.6% |

**Table 3.2c: Frequency of participant responses for urination module questions by random split halves and life stage categories.** ***(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to urinate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **u19 Had difficulty accessing water for urination** | | | | | | | | | | | | | | | | | | | | |
| Never | 1353 | 96.1% | 677 | 96.3% | 158 | 95.2% | 158 | 97.5% | 177 | 95.7% | 184 | 96.8% | 676 | 95.9% | 169 | 96.6% | 153 | 96.8% | 201 | 95.7% | 153 | 94.4% |
| Sometimes | 37 | 2.6% | 18 | 2.6% | 5 | 3.0% | 4 | 2.5% | 5 | 2.7% | 4 | 2.1% | 19 | 2.7% | 3 | 1.7% | 2 | 1.3% | 6 | 2.9% | 8 | 4.9% |
| Often | 5 | 0.4% | 2 | 0.3% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% | 3 | 0.4% | 1 | 0.6% | 0 | 0.0% | 1 | 0.5% | 1 | 0.6% |
| Always | 13 | 0.9% | 6 | 0.9% | 2 | 1.2% | 0 | 0.0% | 3 | 1.6% | 1 | 0.5% | 7 | 1.0% | 2 | 1.1% | 3 | 1.9% | 2 | 1.0% | 0 | 0.0% |
| **u20 Had to suppress urge because people were around and could not go** | | | | | | | | | | | | | | | | | | | | |
| Never | 703 | 49.9% | 359 | 51.1% | 62 | 37.3% | 79 | 48.8% | 90 | 48.6% | 128 | 67.4% | 344 | 48.8% | 70 | 40.0% | 81 | 51.3% | 95 | 45.2% | 98 | 60.5% |
| Sometimes | 581 | 41.3% | 284 | 40.4% | 83 | 50.0% | 64 | 39.5% | 79 | 42.7% | 58 | 30.5% | 297 | 42.1% | 84 | 48.0% | 59 | 37.3% | 94 | 44.8% | 60 | 37.0% |
| Often | 102 | 7.2% | 50 | 7.1% | 16 | 9.6% | 17 | 10.5% | 14 | 7.6% | 3 | 1.6% | 52 | 7.4% | 18 | 10.3% | 16 | 10.1% | 14 | 6.7% | 4 | 2.5% |
| Always | 22 | 1.6% | 10 | 1.4% | 5 | 3.0% | 2 | 1.2% | 2 | 1.1% | 1 | 0.5% | 12 | 1.7% | 3 | 1.7% | 2 | 1.3% | 7 | 3.3% | 0 | 0.0% |
| **u21 Had difficulty walking to urination place** | | | | | | | | | | | | | | | | | | | | |
| Never | 1317 | 93.5% | 660 | 93.9% | 159 | 95.8% | 155 | 95.7% | 177 | 95.7% | 169 | 88.9% | 657 | 93.2% | 169 | 96.6% | 152 | 96.2% | 197 | 93.8% | 139 | 85.8% |
| Sometimes | 54 | 3.8% | 25 | 3.6% | 3 | 1.8% | 5 | 3.1% | 6 | 3.2% | 11 | 5.8% | 29 | 4.1% | 4 | 2.3% | 5 | 3.2% | 10 | 4.8% | 10 | 6.2% |
| Often | 14 | 1.0% | 5 | 0.7% | 1 | 0.6% | 1 | 0.6% | 0 | 0.0% | 3 | 1.6% | 9 | 1.3% | 1 | 0.6% | 1 | 0.6% | 1 | 0.5% | 6 | 3.7% |
| Always | 23 | 1.6% | 13 | 1.8% | 3 | 1.8% | 1 | 0.6% | 2 | 1.1% | 7 | 3.7% | 10 | 1.4% | 1 | 0.6% | 0 | 0.0% | 2 | 1.0% | 7 | 4.3% |
| **u22 Had frequent pressure to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1036 | 73.6% | 518 | 73.7% | 141 | 84.9% | 123 | 75.9% | 130 | 70.3% | 124 | 65.3% | 518 | 73.5% | 148 | 84.6% | 112 | 70.9% | 156 | 74.3% | 102 | 63.0% |
| Sometimes | 140 | 9.9% | 69 | 9.8% | 11 | 6.6% | 14 | 8.6% | 26 | 14.1% | 18 | 9.5% | 71 | 10.1% | 11 | 6.3% | 20 | 12.7% | 21 | 10.0% | 19 | 11.7% |
| Often | 98 | 7.0% | 44 | 6.3% | 7 | 4.2% | 9 | 5.6% | 14 | 7.6% | 14 | 7.4% | 54 | 7.7% | 7 | 4.0% | 9 | 5.7% | 20 | 9.5% | 18 | 11.1% |
| Always | 134 | 9.5% | 72 | 10.2% | 7 | 4.2% | 16 | 9.9% | 15 | 8.1% | 34 | 17.9% | 62 | 8.8% | 9 | 5.1% | 17 | 10.8% | 13 | 6.2% | 23 | 14.2% |
| **u23 Had to do extra work washing clothes because of dirty conditions where urinating** | | | | | | | | | | | | | | | | | | | | |
| Never | 1331 | 94.5% | 665 | 94.6% | 154 | 92.8% | 155 | 95.7% | 171 | 92.4% | 185 | 97.4% | 666 | 94.5% | 162 | 92.6% | 151 | 95.6% | 198 | 94.3% | 155 | 95.7% |
| Sometimes | 62 | 4.4% | 30 | 4.3% | 10 | 6.0% | 6 | 3.7% | 11 | 5.9% | 3 | 1.6% | 32 | 4.5% | 12 | 6.9% | 3 | 1.9% | 10 | 4.8% | 7 | 4.3% |
| Often | 4 | 0.3% | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% | 0 | 0.0% | 3 | 0.4% | 0 | 0.0% | 2 | 1.3% | 1 | 0.5% | 0 | 0.0% |
| Always | 11 | 0.8% | 7 | 1.0% | 2 | 1.2% | 1 | 0.6% | 2 | 1.1% | 2 | 1.1% | 4 | 0.6% | 1 | 0.6% | 2 | 1.3% | 1 | 0.5% | 0 | 0.0% |
| **u24 Had to leave dependents (like children, sick or elderly) alone to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1242 | 88.2% | 631 | 89.8% | 160 | 96.4% | 116 | 71.6% | 168 | 90.8% | 187 | 98.4% | 611 | 86.7% | 167 | 95.4% | 110 | 69.6% | 177 | 84.3% | 157 | 96.9% |
| Sometimes | 114 | 8.1% | 52 | 7.4% | 6 | 3.6% | 29 | 17.9% | 14 | 7.6% | 3 | 1.6% | 62 | 8.8% | 5 | 2.9% | 30 | 19.0% | 23 | 11.0% | 4 | 2.5% |
| Often | 41 | 2.9% | 17 | 2.4% | 0 | 0.0% | 14 | 8.6% | 3 | 1.6% | 0 | 0.0% | 24 | 3.4% | 0 | 0.0% | 14 | 8.9% | 9 | 4.3% | 1 | 0.6% |
| Always | 11 | 0.8% | 3 | 0.4% | 0 | 0.0% | 3 | 1.9% | 0 | 0.0% | 0 | 0.0% | 8 | 1.1% | 3 | 1.7% | 4 | 2.5% | 1 | 0.5% | 0 | 0.0% |
| **u25 Had to stand while urinating because someone came** | | | | | | | | | | | | | | | | | | | | |
| Never | 671 | 47.7% | 346 | 49.2% | 59 | 35.5% | 91 | 56.2% | 64 | 34.6% | 132 | 69.5% | 325 | 46.1% | 75 | 42.9% | 67 | 42.4% | 82 | 39.0% | 101 | 62.3% |
| Sometimes | 659 | 46.8% | 320 | 45.5% | 95 | 57.2% | 62 | 38.3% | 108 | 58.4% | 55 | 28.9% | 339 | 48.1% | 92 | 52.6% | 75 | 47.5% | 118 | 56.2% | 54 | 33.3% |
| Often | 71 | 5.0% | 34 | 4.8% | 10 | 6.0% | 9 | 5.6% | 12 | 6.5% | 3 | 1.6% | 37 | 5.2% | 7 | 4.0% | 15 | 9.5% | 8 | 3.8% | 7 | 4.3% |
| Always | 7 | 0.5% | 3 | 0.4% | 2 | 1.2% | 0 | 0.0% | 1 | 0.5% | 0 | 0.0% | 4 | 0.6% | 1 | 0.6% | 1 | 0.6% | 2 | 1.0% | 0 | 0.0% |
| **u26 Had to suppress urge because did not have someone to accompany me[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1177 | 83.7% | 590 | 84.0% | 115 | 70.1% | 130 | 80.2% | 163 | 88.1% | 182 | 95.8% | 587 | 83.3% | 133 | 76.0% | 119 | 75.3% | 181 | 86.2% | 154 | 95.1% |
| Sometimes | 199 | 14.1% | 97 | 13.8% | 44 | 26.8% | 26 | 16.0% | 19 | 10.3% | 8 | 4.2% | 102 | 14.5% | 33 | 18.9% | 33 | 20.9% | 28 | 13.3% | 8 | 4.9% |
| Often | 25 | 1.8% | 14 | 2.0% | 5 | 3.0% | 6 | 3.7% | 3 | 1.6% | 0 | 0.0% | 11 | 1.6% | 7 | 4.0% | 3 | 1.9% | 1 | 0.5% | 0 | 0.0% |
| Always | 6 | 0.4% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 5 | 0.7% | 2 | 1.1% | 3 | 1.9% | 0 | 0.0% | 0 | 0.0% |
| **u27 Had trouble finding someone to watch dependents (like children, sick or elderly) so I could urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1287 | 91.4% | 651 | 92.6% | 161 | 97.0% | 128 | 79.0% | 173 | 93.5% | 189 | 99.5% | 636 | 90.2% | 174 | 99.4% | 121 | 76.6% | 182 | 86.7% | 159 | 98.1% |
| Sometimes | 95 | 6.7% | 44 | 6.3% | 5 | 3.0% | 27 | 16.7% | 11 | 5.9% | 1 | 0.5% | 51 | 7.2% | 1 | 0.6% | 26 | 16.5% | 22 | 10.5% | 2 | 1.2% |
| Often | 20 | 1.4% | 5 | 0.7% | 0 | 0.0% | 5 | 3.1% | 0 | 0.0% | 0 | 0.0% | 15 | 2.1% | 0 | 0.0% | 9 | 5.7% | 5 | 2.4% | 1 | 0.6% |
| Always | 6 | 0.4% | 3 | 0.4% | 0 | 0.0% | 2 | 1.2% | 1 | 0.5% | 0 | 0.0% | 3 | 0.4% | 0 | 0.0% | 2 | 1.3% | 1 | 0.5% | 0 | 0.0% |

**Table 3.2d: Frequency of participant responses for urination module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to urinate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **u28 Withheld water to control urge to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1278 | 90.8% | 647 | 92.0% | 147 | 88.6% | 151 | 93.2% | 174 | 94.1% | 175 | 92.1% | 631 | 89.5% | 154 | 88.0% | 138 | 87.3% | 194 | 92.4% | 145 | 89.5% |
| Sometimes | 101 | 7.2% | 45 | 6.4% | 16 | 9.6% | 8 | 4.9% | 11 | 5.9% | 10 | 5.3% | 56 | 7.9% | 13 | 7.4% | 16 | 10.1% | 14 | 6.7% | 13 | 8.0% |
| Often | 12 | 0.9% | 6 | 0.9% | 2 | 1.2% | 2 | 1.2% | 0 | 0.0% | 2 | 1.1% | 6 | 0.9% | 1 | 0.6% | 2 | 1.3% | 2 | 1.0% | 1 | 0.6% |
| Always | 17 | 1.2% | 5 | 0.7% | 1 | 0.6% | 1 | 0.6% | 0 | 0.0% | 3 | 1.6% | 12 | 1.7% | 7 | 4.0% | 2 | 1.3% | 0 | 0.0% | 3 | 1.9% |
| **u29 Had to suppress when workload was high[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 835 | 59.4% | 423 | 60.2% | 91 | 54.8% | 92 | 56.8% | 99 | 53.5% | 141 | 74.2% | 412 | 58.6% | 94 | 53.7% | 92 | 58.2% | 113 | 54.1% | 113 | 70.2% |
| Sometimes | 531 | 37.8% | 259 | 36.8% | 73 | 44.0% | 64 | 39.5% | 75 | 40.5% | 47 | 24.7% | 272 | 38.7% | 75 | 42.9% | 59 | 37.3% | 92 | 44.0% | 46 | 28.6% |
| Often | 36 | 2.6% | 20 | 2.8% | 2 | 1.2% | 6 | 3.7% | 10 | 5.4% | 2 | 1.1% | 16 | 2.3% | 4 | 2.3% | 6 | 3.8% | 4 | 1.9% | 2 | 1.2% |
| Always | 4 | 0.3% | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% | 0 | 0.0% | 3 | 0.4% | 2 | 1.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| **u30 Had men or boys harm or harass me when going to urinate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1407 | 99.9% | 703 | 100% | 166 | 100% | 162 | 100% | 185 | 100% | 190 | 100% | 704 | 99.9% | 175 | 100% | 157 | 99.4% | 210 | 100% | 162 | 100% |
| Sometimes | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| Often | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Always | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **u31 Worried others would get upset if asked to accompany for urination** | | | | | | | | | | | | | | | | | | | | |
| Never | 1265 | 89.8% | 638 | 90.8% | 134 | 80.7% | 141 | 87.0% | 177 | 95.7% | 186 | 97.9% | 627 | 88.9% | 154 | 88.0% | 128 | 81.0% | 190 | 90.5% | 155 | 95.7% |
| Sometimes | 121 | 8.6% | 57 | 8.1% | 29 | 17.5% | 18 | 11.1% | 8 | 4.3% | 2 | 1.1% | 64 | 9.1% | 18 | 10.3% | 21 | 13.3% | 19 | 9.0% | 6 | 3.7% |
| Often | 13 | 0.9% | 5 | 0.7% | 1 | 0.6% | 3 | 1.9% | 0 | 0.0% | 1 | 0.5% | 8 | 1.1% | 2 | 1.1% | 4 | 2.5% | 1 | 0.5% | 1 | 0.6% |
| Always | 9 | 0.6% | 3 | 0.4% | 2 | 1.2% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% | 6 | 0.9% | 1 | 0.6% | 5 | 3.2% | 0 | 0.0% | 0 | 0.0% |
| **u32 Had to suppress when I got an urge at night** | | | | | | | | | | | | | | | | | | | | |
| Never | 999 | 71.0% | 506 | 72.0% | 103 | 62.0% | 111 | 68.5% | 138 | 74.6% | 154 | 81.1% | 493 | 69.9% | 124 | 70.9% | 98 | 62.0% | 148 | 70.5% | 123 | 75.9% |
| Sometimes | 332 | 23.6% | 160 | 22.8% | 51 | 30.7% | 37 | 22.8% | 38 | 20.5% | 34 | 17.9% | 172 | 24.4% | 37 | 21.1% | 46 | 29.1% | 56 | 26.7% | 33 | 20.4% |
| Often | 64 | 4.5% | 34 | 4.8% | 9 | 5.4% | 14 | 8.6% | 9 | 4.9% | 2 | 1.1% | 30 | 4.3% | 11 | 6.3% | 10 | 6.3% | 5 | 2.4% | 4 | 2.5% |
| Always | 13 | 0.9% | 3 | 0.4% | 3 | 1.8% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 10 | 1.4% | 3 | 1.7% | 4 | 2.5% | 1 | 0.5% | 2 | 1.2% |

1.Chi-Square significant differences: U01, Stage C p=0.0285; U02, Stage A p=0.0.0036; U10, By overall split half group p=0.0217; U18, Stage C p=0.0436.

2. Missings: U08, 1 missing ($N_1$, stage D); U26: 1 missing ($N_1$, stage A); U29: 2 missing ($N_2$, stage C & stage D)

**Table 3.3a: Frequency of participant responses for defecation module questions by random split halves and life stage categories.**

***Question: How often have you experienced any of the following in the previous 30 days when going to defecate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **d01 Worried about not having a toilet to defecate**[1] | | | | | | | | | | | | | | | | | | | | |
| Never | 543 | 38.6% | 264 | 37.6% | 49 | 29.5% | 80 | 49.4% | 59 | 32.1% | 76 | 40.0% | 279 | 39.6% | 57 | 32.6% | 81 | 51.3% | 71 | 33.8% | 70 | 43.2% |
| Sometimes | 33 | 2.3% | 19 | 2.7% | 6 | 3.6% | 1 | 0.6% | 7 | 3.8% | 5 | 2.6% | 14 | 2.0% | 3 | 1.7% | 2 | 1.3% | 3 | 1.4% | 6 | 3.7% |
| Often | 78 | 5.5% | 37 | 5.3% | 15 | 9.0% | 7 | 4.3% | 11 | 6.0% | 4 | 2.1% | 41 | 5.8% | 12 | 6.9% | 6 | 3.8% | 14 | 6.7% | 9 | 5.6% |
| Always | 753 | 53.5% | 382 | 54.4% | 96 | 57.8% | 74 | 45.7% | 107 | 58.2% | 105 | 55.3% | 371 | 52.6% | 103 | 58.9% | 69 | 43.7% | 122 | 58.1% | 77 | 47.5% |
| **d02 Had to go far to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 582 | 41.3% | 282 | 40.1% | 52 | 31.3% | 94 | 58.0% | 59 | 31.9% | 77 | 40.5% | 300 | 42.6% | 60 | 34.3% | 92 | 58.2% | 79 | 37.6% | 69 | 42.6% |
| Sometimes | 68 | 4.8% | 31 | 4.4% | 9 | 5.4% | 3 | 1.9% | 11 | 5.9% | 8 | 4.2% | 37 | 5.2% | 6 | 3.4% | 5 | 3.2% | 13 | 6.2% | 13 | 8.0% |
| Often | 135 | 9.6% | 72 | 10.2% | 25 | 15.1% | 7 | 4.3% | 17 | 9.2% | 23 | 12.1% | 63 | 8.9% | 13 | 7.4% | 4 | 2.5% | 27 | 12.9% | 19 | 11.7% |
| Always | 623 | 44.2% | 318 | 45.2% | 80 | 48.2% | 58 | 35.8% | 98 | 53.0% | 82 | 43.2% | 305 | 43.3% | 96 | 54.9% | 57 | 36.1% | 91 | 43.3% | 61 | 37.7% |
| **d03 Defecation process/activity of defecation took a long time to complete** | | | | | | | | | | | | | | | | | | | | |
| Never | 596 | 42.3% | 297 | 42.2% | 57 | 34.3% | 90 | 55.6% | 69 | 37.3% | 81 | 42.6% | 299 | 42.4% | 63 | 36.0% | 85 | 53.8% | 85 | 40.5% | 66 | 40.7% |
| Sometimes | 133 | 9.4% | 72 | 10.2% | 27 | 16.3% | 10 | 6.2% | 20 | 10.8% | 15 | 7.9% | 61 | 8.7% | 18 | 10.3% | 10 | 6.3% | 14 | 6.7% | 19 | 11.7% |
| Often | 211 | 15.0% | 106 | 15.1% | 24 | 14.5% | 20 | 12.3% | 27 | 14.6% | 35 | 18.4% | 105 | 14.9% | 26 | 14.9% | 20 | 12.7% | 36 | 17.1% | 23 | 14.2% |
| Always | 468 | 33.2% | 228 | 32.4% | 58 | 34.9% | 42 | 25.9% | 69 | 37.3% | 59 | 31.1% | 240 | 34.0% | 68 | 38.9% | 43 | 27.2% | 75 | 35.7% | 54 | 33.3% |
| **d04 Experienced pain during defecation** | | | | | | | | | | | | | | | | | | | | |
| Never | 1097 | 77.5% | 536 | 76.2% | 144 | 86.7% | 124 | 76.5% | 138 | 74.6% | 130 | 68.4% | 561 | 79.6% | 154 | 88.0% | 125 | 79.1% | 166 | 79.0% | 116 | 71.6% |
| Sometimes | 166 | 11.7% | 86 | 12.2% | 16 | 9.6% | 15 | 9.3% | 26 | 14.1% | 29 | 15.3% | 80 | 11.3% | 12 | 6.9% | 18 | 11.4% | 25 | 11.9% | 25 | 15.4% |
| Often | 41 | 2.9% | 25 | 3.6% | 3 | 1.8% | 8 | 4.9% | 7 | 3.8% | 7 | 3.7% | 16 | 2.3% | 2 | 1.1% | 3 | 1.9% | 5 | 2.4% | 6 | 3.7% |
| Always | 104 | 7.3% | 56 | 8.0% | 3 | 1.8% | 15 | 9.3% | 14 | 7.6% | 24 | 12.6% | 48 | 6.8% | 7 | 4.0% | 12 | 7.6% | 14 | 6.7% | 15 | 9.3% |
| **d05 Had difficulty finding a clean place to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 724 | 51.4% | 360 | 51.2% | 69 | 41.6% | 98 | 60.5% | 93 | 50.3% | 100 | 52.6% | 364 | 51.6% | 80 | 45.7% | 95 | 60.1% | 100 | 47.6% | 89 | 54.9% |
| Sometimes | 195 | 13.8% | 101 | 14.4% | 27 | 16.3% | 16 | 9.9% | 28 | 15.1% | 30 | 15.8% | 94 | 13.3% | 24 | 13.7% | 16 | 10.1% | 30 | 14.3% | 24 | 14.8% |
| Often | 125 | 8.9% | 61 | 8.7% | 15 | 9.0% | 6 | 3.7% | 18 | 9.7% | 22 | 11.6% | 64 | 9.1% | 16 | 9.1% | 12 | 7.6% | 23 | 11.0% | 13 | 8.0% |
| Always | 364 | 25.9% | 181 | 25.7% | 55 | 33.1% | 42 | 25.9% | 46 | 24.9% | 38 | 20.0% | 183 | 26.0% | 55 | 31.4% | 35 | 22.2% | 57 | 27.1% | 36 | 22.2% |
| **d06 Could not access preferred location** | | | | | | | | | | | | | | | | | | | | |
| Never | 1019 | 72.4% | 516 | 73.4% | 114 | 68.7% | 127 | 78.4% | 135 | 73.0% | 140 | 73.7% | 503 | 71.3% | 119 | 68.0% | 119 | 75.3% | 145 | 69.0% | 120 | 74.1% |
| Sometimes | 259 | 18.4% | 130 | 18.5% | 40 | 24.1% | 22 | 13.6% | 32 | 17.3% | 36 | 18.9% | 129 | 18.3% | 30 | 17.1% | 18 | 11.4% | 47 | 22.4% | 34 | 21.0% |
| Often | 20 | 1.4% | 8 | 1.1% | 0 | 0.0% | 2 | 1.2% | 3 | 1.6% | 3 | 1.6% | 12 | 1.7% | 3 | 1.7% | 4 | 2.5% | 3 | 1.4% | 2 | 1.2% |
| Always | 110 | 7.8% | 49 | 7.0% | 12 | 7.2% | 11 | 6.8% | 15 | 8.1% | 11 | 5.8% | 63 | 8.9% | 23 | 13.1% | 17 | 10.8% | 15 | 7.1% | 6 | 3.7% |
| **d07 Worried I would fall when going to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1195 | 84.9% | 596 | 84.8% | 155 | 93.4% | 147 | 90.7% | 175 | 94.6% | 119 | 62.6% | 599 | 85.0% | 166 | 94.9% | 145 | 91.8% | 189 | 90.0% | 99 | 61.1% |
| Sometimes | 110 | 7.8% | 54 | 7.7% | 8 | 4.8% | 9 | 5.6% | 7 | 3.8% | 30 | 15.8% | 56 | 7.9% | 6 | 3.4% | 9 | 5.7% | 13 | 6.2% | 28 | 17.3% |
| Often | 49 | 3.5% | 25 | 3.6% | 3 | 1.8% | 5 | 3.1% | 1 | 0.5% | 16 | 8.4% | 24 | 3.4% | 1 | 0.6% | 3 | 1.9% | 6 | 2.9% | 14 | 8.6% |
| Always | 54 | 3.8% | 28 | 4.0% | 0 | 0.0% | 1 | 0.6% | 2 | 1.1% | 25 | 13.2% | 26 | 3.7% | 2 | 1.1% | 1 | 0.6% | 2 | 1.0% | 21 | 13.0% |
| **d08 Worried that people would see me defecating** | | | | | | | | | | | | | | | | | | | | |
| Never | 869 | 61.7% | 435 | 61.9% | 78 | 47.0% | 105 | 64.8% | 108 | 58.4% | 144 | 75.8% | 434 | 61.6% | 85 | 48.6% | 98 | 62.0% | 119 | 56.7% | 132 | 81.5% |
| Sometimes | 224 | 15.9% | 112 | 15.9% | 27 | 16.3% | 28 | 17.3% | 36 | 19.5% | 21 | 11.1% | 112 | 15.9% | 31 | 17.7% | 22 | 13.9% | 38 | 18.1% | 21 | 13.0% |
| Often | 118 | 8.4% | 64 | 9.1% | 27 | 16.3% | 9 | 5.6% | 17 | 9.2% | 11 | 5.8% | 54 | 7.7% | 20 | 11.4% | 8 | 5.1% | 23 | 11.0% | 3 | 1.9% |
| Always | 197 | 14.0% | 92 | 13.1% | 34 | 20.5% | 20 | 12.3% | 24 | 13.0% | 14 | 7.4% | 105 | 14.9% | 39 | 22.3% | 30 | 19.0% | 30 | 14.3% | 6 | 3.7% |
| **d09 Had to suppress urge when workload was high** | | | | | | | | | | | | | | | | | | | | |
| Never | 816 | 58.0% | 410 | 58.3% | 89 | 53.6% | 97 | 59.9% | 94 | 50.8% | 130 | 68.4% | 406 | 57.6% | 98 | 56.0% | 89 | 56.3% | 105 | 50.0% | 114 | 70.4% |
| Sometimes | 522 | 37.1% | 259 | 36.8% | 69 | 41.6% | 56 | 34.6% | 81 | 43.8% | 53 | 27.9% | 263 | 37.3% | 67 | 38.3% | 60 | 38.0% | 89 | 42.4% | 47 | 29.0% |
| Often | 62 | 4.4% | 30 | 4.3% | 8 | 4.8% | 7 | 4.3% | 9 | 4.9% | 6 | 3.2% | 32 | 4.5% | 9 | 5.1% | 8 | 5.1% | 14 | 6.7% | 1 | 0.6% |
| Always | 8 | 0.6% | 4 | 0.6% | 0 | 0.0% | 2 | 1.2% | 1 | 0.5% | 1 | 0.5% | 4 | 0.6% | 1 | 0.6% | 1 | 0.6% | 2 | 1.0% | 0 | 0.0% |

**Table 3.3b: Frequency of participant responses for defecation module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to defecate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **d10 Felt scared defecating in the dark at night** | | | | | | | | | | | | | | | | | | | | |
| Never | 579 | 41.1% | 295 | 42.0% | 43 | 25.9% | 61 | 37.7% | 78 | 42.2% | 113 | 59.5% | 284 | 40.3% | 49 | 28.0% | 48 | 30.4% | 85 | 40.5% | 102 | 63.0% |
| Sometimes | 307 | 21.8% | 152 | 21.6% | 44 | 26.5% | 24 | 14.8% | 50 | 27.0% | 34 | 17.9% | 155 | 22.0% | 36 | 20.6% | 36 | 22.8% | 56 | 26.7% | 27 | 16.7% |
| Often | 187 | 13.3% | 91 | 12.9% | 27 | 16.3% | 26 | 16.0% | 20 | 10.8% | 18 | 9.5% | 96 | 13.6% | 33 | 18.9% | 25 | 15.8% | 23 | 11.0% | 15 | 9.3% |
| Always | 335 | 23.8% | 165 | 23.5% | 52 | 31.3% | 51 | 31.5% | 37 | 20.0% | 25 | 13.2% | 170 | 24.1% | 57 | 32.6% | 49 | 31.0% | 46 | 21.9% | 18 | 11.1% |
| **d11 Worried people would talk about me if they saw me[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1161 | 82.5% | 583 | 82.9% | 121 | 72.9% | 126 | 77.8% | 160 | 86.5% | 176 | 92.6% | 578 | 82.0% | 138 | 78.9% | 130 | 82.3% | 161 | 76.7% | 149 | 92.0% |
| Sometimes | 83 | 5.9% | 33 | 4.7% | 9 | 5.4% | 12 | 7.4% | 8 | 4.3% | 4 | 2.1% | 50 | 7.1% | 18 | 10.3% | 10 | 6.3% | 14 | 6.7% | 8 | 4.9% |
| Often | 89 | 6.3% | 48 | 6.8% | 22 | 13.3% | 9 | 5.6% | 10 | 5.4% | 7 | 3.7% | 41 | 5.8% | 10 | 5.7% | 8 | 5.1% | 20 | 9.5% | 3 | 1.9% |
| Always | 75 | 5.3% | 39 | 5.5% | 14 | 8.4% | 15 | 9.3% | 7 | 3.8% | 3 | 1.6% | 36 | 5.1% | 9 | 5.1% | 10 | 6.3% | 15 | 7.1% | 2 | 1.2% |
| **d12 Feared I would be harmed by animals or insects when I went to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1089 | 77.3% | 541 | 77.0% | 119 | 71.7% | 127 | 78.4% | 142 | 76.8% | 153 | 80.5% | 548 | 77.7% | 131 | 74.9% | 124 | 78.5% | 155 | 73.8% | 138 | 85.2% |
| Sometimes | 142 | 10.1% | 73 | 10.4% | 21 | 12.7% | 20 | 12.3% | 16 | 8.6% | 16 | 8.4% | 69 | 9.8% | 17 | 9.7% | 13 | 8.2% | 24 | 11.4% | 15 | 9.3% |
| Often | 36 | 2.6% | 16 | 2.3% | 4 | 2.4% | 2 | 1.2% | 5 | 2.7% | 5 | 2.6% | 20 | 2.8% | 5 | 2.9% | 6 | 3.8% | 6 | 2.9% | 3 | 1.9% |
| Always | 141 | 10.0% | 73 | 10.4% | 22 | 13.3% | 13 | 8.0% | 22 | 11.9% | 16 | 8.4% | 68 | 9.6% | 22 | 12.6% | 15 | 9.5% | 25 | 11.9% | 6 | 3.7% |
| **d13 Got wounds on my feet when walking to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1402 | 99.6% | 702 | 99.9% | 166 | 100% | 162 | 100% | 184 | 99.5% | 190 | 100% | 700 | 99.3% | 173 | 98.9% | 157 | 99.4% | 209 | 99.5% | 161 | 99.4% |
| Sometimes | 3 | 0.2% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 3 | 0.4% | 1 | 0.6% | 0 | 0.0% | 1 | 0.5% | 1 | 0.6% |
| Often | 2 | 0.1% | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 1 | 0.5% | 0 | 0.0% | 1 | 0.1% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| Always | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **d14 Had to do extra work washing clothes because of dirty conditions where defecating[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 819 | 58.2% | 429 | 61.0% | 88 | 53.0% | 104 | 64.2% | 113 | 61.1% | 124 | 65.3% | 390 | 55.3% | 92 | 52.6% | 91 | 57.6% | 103 | 49.0% | 104 | 64.2% |
| Sometimes | 163 | 11.6% | 82 | 11.7% | 38 | 22.9% | 15 | 9.3% | 12 | 6.5% | 17 | 8.9% | 81 | 11.5% | 26 | 14.9% | 14 | 8.9% | 24 | 11.4% | 17 | 10.5% |
| Often | 97 | 6.9% | 33 | 4.7% | 13 | 7.8% | 8 | 4.9% | 7 | 3.8% | 5 | 2.6% | 64 | 9.1% | 10 | 5.7% | 10 | 6.3% | 31 | 14.8% | 13 | 8.0% |
| Always | 329 | 23.4% | 159 | 22.6% | 27 | 16.3% | 35 | 21.6% | 53 | 28.6% | 44 | 23.2% | 170 | 24.1% | 47 | 26.9% | 43 | 27.2% | 52 | 24.8% | 28 | 17.3% |
| **d15 Worried about getting an infection when going to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 862 | 61.2% | 442 | 62.9% | 78 | 47.0% | 101 | 62.3% | 118 | 63.8% | 145 | 76.3% | 420 | 59.6% | 82 | 46.9% | 94 | 59.5% | 120 | 57.1% | 124 | 76.5% |
| Sometimes | 168 | 11.9% | 83 | 11.8% | 30 | 18.1% | 15 | 9.3% | 23 | 12.4% | 15 | 7.9% | 85 | 12.1% | 28 | 16.0% | 17 | 10.8% | 25 | 11.9% | 15 | 9.3% |
| Often | 89 | 6.3% | 37 | 5.3% | 18 | 10.8% | 7 | 4.3% | 6 | 3.2% | 6 | 3.2% | 52 | 7.4% | 14 | 8.0% | 10 | 6.3% | 20 | 9.5% | 8 | 4.9% |
| Always | 289 | 20.5% | 141 | 20.1% | 40 | 24.1% | 39 | 24.1% | 38 | 20.5% | 24 | 12.6% | 148 | 21.0% | 51 | 29.1% | 37 | 23.4% | 45 | 21.4% | 15 | 9.3% |
| **d16 Had people tease me if they saw me defecating** | | | | | | | | | | | | | | | | | | | | |
| Never | 1392 | 98.9% | 696 | 99.0% | 161 | 97.0% | 161 | 99.4% | 184 | 99.5% | 190 | 100% | 696 | 98.7% | 173 | 98.9% | 156 | 98.7% | 207 | 98.6% | 160 | 98.8% |
| Sometimes | 11 | 0.8% | 5 | 0.7% | 3 | 1.8% | 1 | 0.6% | 1 | 0.5% | 0 | 0.0% | 6 | 0.9% | 2 | 1.1% | 0 | 0.0% | 3 | 1.4% | 1 | 0.6% |
| Often | 2 | 0.1% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| Always | 3 | 0.2% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 0.3% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 1 | 0.6% |
| **d17 Had difficulty or pain squatting for defecation** | | | | | | | | | | | | | | | | | | | | |
| Never | 933 | 66.3% | 452 | 64.3% | 129 | 77.7% | 117 | 72.2% | 143 | 73.3% | 125 | 65.8% | 481 | 68.2% | 146 | 83.4% | 125 | 79.1% | 150 | 71.4% | 60 | 37.0% |
| Sometimes | 253 | 18.0% | 133 | 18.9% | 26 | 15.7% | 28 | 17.3% | 24 | 12.3% | 39 | 20.5% | 120 | 17.0% | 19 | 10.9% | 20 | 12.7% | 41 | 19.5% | 40 | 24.7% |
| Often | 68 | 4.8% | 32 | 4.6% | 3 | 1.8% | 4 | 2.5% | 9 | 4.6% | 15 | 7.9% | 36 | 5.1% | 3 | 1.7% | 5 | 3.2% | 7 | 3.3% | 21 | 13.0% |
| Always | 154 | 10.9% | 86 | 12.2% | 8 | 4.8% | 13 | 8.0% | 9 | 4.6% | 11 | 5.8% | 68 | 9.6% | 7 | 4.0% | 8 | 5.1% | 12 | 5.7% | 41 | 25.3% |
| **d18 Felt scared of ghosts when I went to defecate at night[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 576 | 40.9% | 285 | 40.5% | 41 | 24.7% | 55 | 34.0% | 75 | 40.5% | 114 | 60.0% | 291 | 41.3% | 46 | 26.3% | 41 | 25.9% | 95 | 45.2% | 109 | 67.3% |
| Sometimes | 328 | 23.3% | 170 | 24.2% | 48 | 28.9% | 31 | 19.1% | 54 | 29.2% | 37 | 19.5% | 158 | 22.4% | 36 | 20.6% | 42 | 26.6% | 52 | 24.8% | 28 | 17.3% |
| Often | 196 | 13.9% | 102 | 14.5% | 38 | 22.9% | 29 | 17.9% | 21 | 11.4% | 14 | 7.4% | 94 | 13.3% | 29 | 16.6% | 30 | 19.0% | 24 | 11.4% | 11 | 6.8% |
| Always | 308 | 21.9% | 146 | 20.8% | 39 | 23.5% | 47 | 29.0% | 35 | 18.9% | 25 | 13.2% | 162 | 23.0% | 64 | 36.6% | 45 | 28.5% | 39 | 18.6% | 14 | 8.6% |

**Table 3.3c: Frequency of participant responses for defecation module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to defecate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **d19 Had difficulty walking to defecation place** | | | | | | | | | | | | | | | | | | | | |
| Never | 1128 | 80.1% | 563 | 80.1% | 135 | 81.3% | 138 | 85.2% | 157 | 84.9% | 133 | 70.0% | 565 | 80.1% | 144 | 82.3% | 139 | 88.0% | 171 | 81.4% | 111 | 68.5% |
| Sometimes | 173 | 12.3% | 85 | 12.1% | 22 | 13.3% | 18 | 11.1% | 18 | 9.7% | 27 | 14.2% | 88 | 12.5% | 16 | 9.1% | 14 | 8.9% | 30 | 14.3% | 28 | 17.3% |
| Often | 48 | 3.4% | 23 | 3.3% | 4 | 2.4% | 3 | 1.9% | 8 | 4.3% | 8 | 4.2% | 25 | 3.5% | 5 | 2.9% | 3 | 1.9% | 7 | 3.3% | 10 | 6.2% |
| Always | 59 | 4.2% | 32 | 4.6% | 5 | 3.0% | 3 | 1.9% | 2 | 1.1% | 22 | 11.6% | 27 | 3.8% | 10 | 5.7% | 2 | 1.3% | 2 | 1.0% | 13 | 8.0% |
| **d20 Had to find someone to look after my work so I could defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 838 | 59.5% | 416 | 59.2% | 89 | 53.6% | 78 | 48.1% | 106 | 57.3% | 143 | 75.3% | 422 | 59.9% | 109 | 62.3% | 74 | 46.8% | 116 | 55.2% | 123 | 75.9% |
| Sometimes | 465 | 33.0% | 239 | 34.0% | 68 | 41.0% | 63 | 38.9% | 67 | 36.2% | 41 | 21.6% | 226 | 32.1% | 56 | 32.0% | 63 | 39.9% | 71 | 33.8% | 36 | 22.2% |
| Often | 86 | 6.1% | 41 | 5.8% | 9 | 5.4% | 16 | 9.9% | 11 | 5.9% | 5 | 2.6% | 45 | 6.4% | 8 | 4.6% | 15 | 9.5% | 19 | 9.0% | 3 | 1.9% |
| Always | 19 | 1.3% | 7 | 1.0% | 0 | 0.0% | 5 | 3.1% | 1 | 0.5% | 1 | 0.5% | 12 | 1.7% | 2 | 1.1% | 6 | 3.8% | 4 | 1.9% | 0 | 0.0% |
| **d21 Had difficulty accessing water for defecation[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1289 | 91.5% | 643 | 91.5% | 148 | 89.2% | 151 | 93.2% | 164 | 88.6% | 180 | 94.7% | 646 | 91.6% | 157 | 89.7% | 139 | 88.0% | 194 | 92.4% | 156 | 96.3% |
| Sometimes | 51 | 3.6% | 30 | 4.3% | 11 | 6.6% | 6 | 3.7% | 6 | 3.2% | 7 | 3.7% | 21 | 3.0% | 4 | 2.3% | 5 | 3.2% | 8 | 3.8% | 4 | 2.5% |
| Often | 15 | 1.1% | 10 | 1.4% | 3 | 1.8% | 1 | 0.6% | 6 | 3.2% | 0 | 0.0% | 5 | 0.7% | 1 | 0.6% | 0 | 0.0% | 4 | 1.9% | 0 | 0.0% |
| Always | 53 | 3.8% | 20 | 2.8% | 4 | 2.4% | 4 | 2.5% | 9 | 4.9% | 3 | 1.6% | 33 | 4.7% | 13 | 7.4% | 14 | 8.9% | 4 | 1.9% | 2 | 1.2% |
| **d22 Changing and washing clothes used only for defecation increased workload[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 632 | 44.9% | 330 | 46.9% | 72 | 43.4% | 67 | 41.4% | 78 | 42.2% | 113 | 59.5% | 302 | 42.8% | 78 | 44.6% | 63 | 39.9% | 78 | 37.1% | 83 | 51.2% |
| Sometimes | 180 | 12.8% | 84 | 11.9% | 33 | 19.9% | 16 | 9.9% | 20 | 10.8% | 15 | 7.9% | 96 | 13.6% | 19 | 10.9% | 22 | 13.9% | 26 | 12.4% | 29 | 17.9% |
| Often | 85 | 6.0% | 38 | 5.4% | 16 | 9.6% | 8 | 4.9% | 10 | 5.4% | 4 | 2.1% | 47 | 6.7% | 13 | 7.4% | 12 | 7.6% | 18 | 8.6% | 4 | 2.5% |
| Always | 511 | 36.3% | 251 | 35.7% | 45 | 27.1% | 71 | 43.8% | 77 | 41.6% | 58 | 30.5% | 260 | 36.9% | 65 | 37.1% | 61 | 38.6% | 88 | 41.9% | 46 | 28.4% |
| **d23 Had difficulty cleaning/washing myself after defecation[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1297 | 92.1% | 648 | 92.2% | 150 | 90.4% | 153 | 94.4% | 167 | 90.3% | 178 | 93.7% | 649 | 92.1% | 157 | 89.7% | 139 | 88.0% | 197 | 93.8% | 156 | 96.3% |
| Sometimes | 52 | 3.7% | 27 | 3.8% | 9 | 5.4% | 4 | 2.5% | 12 | 6.5% | 2 | 1.1% | 25 | 3.5% | 5 | 2.9% | 6 | 3.8% | 9 | 4.3% | 5 | 3.1% |
| Often | 13 | 0.9% | 8 | 1.1% | 3 | 1.8% | 0 | 0.0% | 1 | 0.5% | 4 | 2.1% | 5 | 0.7% | 2 | 1.1% | 1 | 0.6% | 2 | 1.0% | 0 | 0.0% |
| Always | 46 | 3.3% | 20 | 2.8% | 4 | 2.4% | 5 | 3.1% | 5 | 2.7% | 6 | 3.2% | 26 | 3.7% | 11 | 6.3% | 12 | 7.6% | 2 | 1.0% | 1 | 0.6% |
| **d24 Had to suppress urge to defecate because people were around** | | | | | | | | | | | | | | | | | | | | |
| Never | 743 | 52.8% | 379 | 53.9% | 68 | 41.0% | 100 | 61.7% | 84 | 45.4% | 127 | 66.8% | 364 | 51.6% | 63 | 36.0% | 92 | 58.2% | 105 | 50.0% | 104 | 64.2% |
| Sometimes | 551 | 39.1% | 275 | 39.1% | 79 | 47.6% | 51 | 31.5% | 88 | 47.6% | 57 | 30.0% | 276 | 39.1% | 84 | 48.0% | 53 | 33.5% | 85 | 40.5% | 54 | 33.3% |
| Often | 92 | 6.5% | 39 | 5.5% | 16 | 9.6% | 7 | 4.3% | 11 | 5.9% | 5 | 2.6% | 53 | 7.5% | 24 | 13.7% | 10 | 6.3% | 17 | 8.1% | 2 | 1.2% |
| Always | 22 | 1.6% | 10 | 1.4% | 3 | 1.8% | 4 | 2.5% | 2 | 1.1% | 1 | 0.5% | 12 | 1.7% | 4 | 2.3% | 3 | 1.9% | 3 | 1.4% | 2 | 1.2% |
| **d25 Had to suppress urge because I can only defecate at certain times of the day** | | | | | | | | | | | | | | | | | | | | |
| Never | 1127 | 80.0% | 569 | 80.9% | 116 | 69.9% | 122 | 75.3% | 157 | 84.9% | 174 | 91.6% | 558 | 79.1% | 125 | 71.4% | 121 | 76.6% | 164 | 78.1% | 148 | 91.4% |
| Sometimes | 239 | 17.0% | 109 | 15.5% | 44 | 26.5% | 32 | 19.8% | 20 | 10.8% | 13 | 6.8% | 130 | 18.4% | 43 | 24.6% | 32 | 20.3% | 41 | 19.5% | 14 | 8.6% |
| Often | 34 | 2.4% | 21 | 3.0% | 5 | 3.0% | 6 | 3.7% | 7 | 3.8% | 3 | 1.6% | 13 | 1.8% | 6 | 3.4% | 4 | 2.5% | 3 | 1.4% | 0 | 0.0% |
| Always | 8 | 0.6% | 4 | 0.6% | 1 | 0.6% | 2 | 1.2% | 1 | 0.5% | 0 | 0.0% | 4 | 0.6% | 1 | 0.6% | 1 | 0.6% | 2 | 1.0% | 0 | 0.0% |
| **d26 Feared I would be harmed by someone when I went to defecate[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1336 | 94.9% | 678 | 96.4% | 161 | 97.0% | 159 | 98.1% | 176 | 95.1% | 182 | 95.8% | 658 | 93.3% | 154 | 88.0% | 150 | 94.9% | 199 | 94.8% | 155 | 95.7% |
| Sometimes | 38 | 2.7% | 12 | 1.7% | 2 | 1.2% | 2 | 1.2% | 4 | 2.2% | 4 | 2.1% | 26 | 3.7% | 10 | 5.7% | 3 | 1.9% | 8 | 3.8% | 5 | 3.1% |
| Often | 8 | 0.6% | 4 | 0.6% | 0 | 0.0% | 0 | 0.0% | 4 | 2.2% | 0 | 0.0% | 4 | 0.6% | 2 | 1.1% | 1 | 0.6% | 0 | 0.0% | 1 | 0.6% |
| Always | 26 | 1.8% | 9 | 1.3% | 3 | 1.8% | 1 | 0.6% | 1 | 0.5% | 4 | 2.1% | 17 | 2.4% | 9 | 5.1% | 4 | 2.5% | 3 | 1.4% | 1 | 0.6% |
| **d27 Had trouble finding someone to watch dependents (like children, sick or elderly) so I could defecate[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1253 | 89.0% | 640 | 91.0% | 163 | 98.2% | 114 | 70.4% | 175 | 94.6% | 188 | 98.9% | 613 | 87.0% | 172 | 98.3% | 109 | 69.0% | 175 | 83.3% | 157 | 96.9% |
| Sometimes | 110 | 7.8% | 46 | 6.5% | 2 | 1.2% | 36 | 22.2% | 6 | 3.2% | 2 | 1.1% | 64 | 9.1% | 2 | 1.1% | 34 | 21.5% | 24 | 11.4% | 4 | 2.5% |
| Often | 36 | 2.6% | 12 | 1.7% | 0 | 0.0% | 10 | 6.2% | 2 | 1.1% | 0 | 0.0% | 24 | 3.4% | 0 | 0.0% | 12 | 7.6% | 11 | 5.2% | 1 | 0.6% |
| Always | 9 | 0.6% | 5 | 0.7% | 1 | 0.6% | 2 | 1.2% | 2 | 1.1% | 0 | 0.0% | 4 | 0.6% | 1 | 0.6% | 3 | 1.9% | 0 | 0.0% | 0 | 0.0% |

**Table 3.3d: Frequency of participant responses for defecation module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to defecate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **d28 Had trouble controlling urge to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1107 | 78.2% | 558 | 79.4% | 128 | 77.1% | 125 | 77.2% | 143 | 77.3% | 162 | 85.3% | 549 | 77.9% | 131 | 74.9% | 124 | 78.5% | 164 | 78.1% | 130 | 80.2% |
| Sometimes | 254 | 17.9% | 124 | 17.6% | 35 | 21.1% | 32 | 19.8% | 35 | 18.9% | 22 | 11.6% | 130 | 18.4% | 36 | 20.6% | 27 | 17.1% | 42 | 20.0% | 25 | 15.4% |
| Often | 31 | 2.2% | 16 | 2.3% | 3 | 1.8% | 2 | 1.2% | 6 | 3.2% | 5 | 2.6% | 15 | 2.1% | 6 | 3.4% | 4 | 2.5% | 3 | 1.4% | 2 | 1.2% |
| Always | 16 | 1.1% | 5 | 0.7% | 0 | 0.0% | 3 | 1.9% | 1 | 0.5% | 1 | 0.5% | 11 | 1.6% | 2 | 1.1% | 3 | 1.9% | 1 | 0.5% | 5 | 3.1% |
| **d29 Worried about defecating in the same place as others** | | | | | | | | | | | | | | | | | | | | |
| Never | 858 | 60.9% | 428 | 60.9% | 79 | 47.6% | 107 | 66.0% | 108 | 58.4% | 134 | 70.5% | 430 | 61.0% | 84 | 48.0% | 104 | 65.8% | 123 | 58.6% | 119 | 73.5% |
| Sometimes | 199 | 14.1% | 101 | 14.4% | 36 | 21.7% | 14 | 8.6% | 27 | 14.6% | 24 | 12.6% | 98 | 13.9% | 33 | 18.9% | 17 | 10.8% | 32 | 15.2% | 16 | 9.9% |
| Often | 101 | 7.2% | 48 | 6.8% | 14 | 8.4% | 7 | 4.3% | 17 | 9.2% | 10 | 5.3% | 53 | 7.5% | 13 | 7.4% | 8 | 5.1% | 20 | 9.5% | 12 | 7.4% |
| Always | 150 | 10.7% | 126 | 17.9% | 37 | 22.3% | 34 | 21.0% | 33 | 17.8% | 22 | 11.6% | 124 | 17.6% | 45 | 25.7% | 29 | 18.4% | 35 | 16.7% | 16 | 9.9% |
| **d30 Had to stand while defecating because someone came** | | | | | | | | | | | | | | | | | | | | |
| Never | 627 | 44.5% | 310 | 44.1% | 49 | 29.5% | 87 | 53.7% | 66 | 35.7% | 108 | 56.8% | 317 | 45.0% | 59 | 33.7% | 85 | 53.8% | 80 | 38.1% | 93 | 57.4% |
| Sometimes | 614 | 43.6% | 310 | 44.1% | 89 | 53.6% | 60 | 37.0% | 92 | 49.7% | 69 | 36.3% | 304 | 43.1% | 79 | 45.1% | 60 | 38.0% | 102 | 48.6% | 63 | 38.9% |
| Often | 130 | 9.2% | 63 | 9.0% | 19 | 11.4% | 10 | 6.2% | 22 | 11.9% | 12 | 6.3% | 67 | 9.5% | 29 | 16.6% | 12 | 7.6% | 21 | 10.0% | 5 | 3.1% |
| Always | 37 | 2.6% | 20 | 2.8% | 9 | 5.4% | 5 | 3.1% | 5 | 2.7% | 1 | 0.5% | 17 | 2.4% | 8 | 4.6% | 1 | 0.6% | 7 | 3.3% | 1 | 0.6% |
| **d31 Withheld food to control urge to defecate[1]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1296 | 92.1% | 648 | 92.2% | 153 | 92.2% | 149 | 92.0% | 171 | 92.4% | 175 | 92.6% | 648 | 92.0% | 160 | 91.4% | 142 | 89.9% | 196 | 93.3% | 150 | 92.6% |
| Sometimes | 83 | 5.9% | 44 | 6.3% | 12 | 7.2% | 9 | 5.6% | 11 | 5.9% | 12 | 6.3% | 39 | 5.5% | 9 | 5.1% | 10 | 6.3% | 12 | 5.7% | 8 | 4.9% |
| Often | 24 | 1.7% | 9 | 1.3% | 1 | 0.6% | 3 | 1.9% | 3 | 1.6% | 2 | 1.1% | 15 | 2.1% | 4 | 2.3% | 5 | 3.2% | 2 | 1.0% | 4 | 2.5% |
| Always | 4 | 0.3% | 1 | 0.1% | 0 | 0.0% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 4 | 0.6% | 2 | 1.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% |
| **d32 Worried others would get upset if asked to accompany for defecation** | | | | | | | | | | | | | | | | | | | | |
| Never | 1260 | 89.5% | 629 | 89.5% | 140 | 84.3% | 140 | 86.4% | 169 | 91.4% | 180 | 94.7% | 631 | 89.5% | 151 | 86.3% | 137 | 86.7% | 191 | 91.0% | 152 | 93.8% |
| Sometimes | 115 | 8.2% | 60 | 8.5% | 20 | 12.0% | 17 | 10.5% | 14 | 7.6% | 9 | 4.7% | 55 | 7.8% | 18 | 10.3% | 14 | 8.9% | 18 | 8.6% | 5 | 3.1% |
| Often | 16 | 1.1% | 8 | 1.1% | 3 | 1.8% | 3 | 1.9% | 1 | 0.5% | 1 | 0.5% | 8 | 1.1% | 2 | 1.1% | 4 | 2.5% | 1 | 0.5% | 1 | 0.6% |
| Always | 17 | 1.2% | 6 | 0.9% | 3 | 1.8% | 2 | 1.2% | 1 | 0.5% | 0 | 0.0% | 11 | 1.6% | 4 | 2.3% | 3 | 1.9% | 0 | 0.0% | 4 | 2.5% |
| **d33 Worried about dependents (children, sick or elderly) who need me when I go to defecate[2]** | | | | | | | | | | | | | | | | | | | | |
| Never | 1248 | 88.6% | 640 | 91.0% | 162 | 97.6% | 119 | 73.5% | 171 | 92.4% | 188 | 98.9% | 608 | 86.2% | 169 | 96.6% | 106 | 67.1% | 179 | 85.2% | 154 | 95.1% |
| Sometimes | 80 | 5.7% | 28 | 4.0% | 3 | 1.8% | 16 | 9.9% | 7 | 3.8% | 2 | 1.1% | 52 | 7.4% | 2 | 1.1% | 28 | 17.7% | 16 | 7.6% | 6 | 3.7% |
| Often | 44 | 3.1% | 18 | 2.6% | 1 | 0.6% | 13 | 8.0% | 4 | 2.2% | 0 | 0.0% | 26 | 3.7% | 1 | 0.6% | 16 | 10.1% | 9 | 4.3% | 0 | 0.0% |
| Always | 36 | 2.6% | 17 | 2.4% | 0 | 0.0% | 14 | 8.6% | 3 | 1.6% | 0 | 0.0% | 19 | 2.7% | 3 | 1.7% | 8 | 5.1% | 6 | 2.9% | 2 | 1.2% |
| **d34 Worried that I have no money to build or maintain a toilet** | | | | | | | | | | | | | | | | | | | | |
| Never | 563 | 40.0% | 275 | 39.1% | 52 | 31.3% | 83 | 51.2% | 61 | 33.0% | 79 | 41.6% | 288 | 40.9% | 64 | 36.6% | 82 | 51.9% | 73 | 34.8% | 69 | 42.6% |
| Sometimes | 110 | 7.8% | 55 | 7.8% | 13 | 7.8% | 8 | 4.9% | 15 | 8.1% | 19 | 10.0% | 55 | 7.8% | 17 | 9.7% | 11 | 7.0% | 9 | 4.3% | 18 | 11.1% |
| Often | 98 | 7.0% | 51 | 7.3% | 12 | 7.2% | 5 | 3.1% | 21 | 11.4% | 13 | 6.8% | 47 | 6.7% | 9 | 5.1% | 6 | 3.8% | 20 | 9.5% | 12 | 7.4% |
| Always | 637 | 45.2% | 322 | 45.8% | 89 | 53.6% | 66 | 40.7% | 88 | 47.6% | 79 | 41.6% | 315 | 44.7% | 85 | 48.6% | 59 | 37.3% | 108 | 51.4% | 63 | 38.9% |
| **d35 Had men or boys harm or harass me when going to defecate** | | | | | | | | | | | | | | | | | | | | |
| Never | 1406 | 99.9% | 702 | 99.9% | 165 | 99.4% | 162 | 100% | 185 | 100% | 190 | 100% | 704 | 99.9% | 174 | 99.4% | 158 | 100% | 210 | 100% | 162 | 100% |
| Sometimes | 1 | 0.1% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Often | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Always | 1 | 0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.1% | 1 | 0.6% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |

**Table 3.3e: Frequency of participant responses for defecation module questions by random split halves and life stage categories. *(Continued).***

***Question: How often have you experienced any of the following in the previous 30 days when going to defecate?***

| | ***Full Sample*** | | ***Sub-Sample $N_1$*** | | | | | | | | ***Sub-Sample $N_2$*** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All N=1408 | | All $N_1$=703 | | 1. Unmarried (UM) n=166 | | 2. Recently Married (RM) n=162 | | 3. Married (M) n=185 | | 4. Over 49 (OW) n=190 | | All $N_2$=705 | | 1. Unmarried (UM) n=175 | | 2. Recently Married (RM) n=158 | | 3. Married (M) n=210 | | 4. Over 49 (OW) n=162 | |
| **d36 Have had to go back and forth to defecation location because could not find privacy** | | | | | | | | | | | | | | | | | | | | |
| Never | 928 | 65.9% | 474 | 67.4% | 93 | 56.0% | 118 | 72.8% | 125 | 67.6% | 138 | 72.6% | 454 | 64.4% | 102 | 58.3% | 115 | 72.8% | 128 | 61.0% | 109 | 67.3% |
| Sometimes | 326 | 23.2% | 155 | 22.0% | 50 | 30.1% | 23 | 14.2% | 39 | 21.1% | 43 | 22.6% | 171 | 24.3% | 50 | 28.6% | 28 | 17.7% | 54 | 25.7% | 39 | 24.1% |
| Often | 131 | 9.3% | 66 | 9.4% | 19 | 11.4% | 20 | 12.3% | 19 | 10.3% | 8 | 4.2% | 65 | 9.2% | 14 | 8.0% | 13 | 8.2% | 25 | 11.9% | 13 | 8.0% |
| Always | 23 | 1.6% | 8 | 1.1% | 4 | 2.4% | 1 | 0.6% | 2 | 1.1% | 1 | 0.5% | 15 | 2.1% | 9 | 5.1% | 2 | 1.3% | 3 | 1.4% | 1 | 0.6% |

1. Missings: D01, 1 missing ($N_1$, stage D); D31, 1 missing (N1, stage D)

2. Chi-Square significant differences: D11, Stage A p=0.0.0236; D14, by overall split half group p=0.0069 and Stage A, C=0.0004; D18, Stage A p=0.0287; D21, Stage A p=0.0284; D22, Stage D p=0.0410; D23, Stage D p=0.0434; D26, Stages A: p=0.0165; D27, Stage C p=0.0006; D33, by overall split half group p=0.0225

**Table 3.4a: Factor loadings, factor co-variations, and model fit statistics for random split-half sample EFA ($N_1$=703) and CFA models ($N_2$=705), baseline and final MIMIC models ($N_2$=708), and final CFA model ($N_2$=708) with deletions based on DIF.**

| Factors | Item | EFA ($N_1$=703) | CFA ($N_2$=705) | Baseline MIMIC Model ($N_2$=705) | Final MIMIC Model, 10 Modifications ($N_2$=705) | CFA, with deletions based on DIF ($N_2$=705) |
|---|---|---|---|---|---|---|
| ***Factor 1: Potential Harms*** | | | | | | |
| Worried about not having a proper facility to urinate | U01 | 0.697 | 0.825 * | 0.830 * | 0.830 * | 0.824 * |
| Worried that someone would see me while urinating | U03 | 0.714 | 0.828 * | 0.824 * | 0.824 * | 0.819 * |
| Had difficulty finding clean place to urinate | U06 | 0.773 | 0.883 * | 0.889 * | 0.889 * | 0.885 * |
| Felt worried that I would step on urine | U08 | 0.758 | 0.853 * | 0.856 * | 0.856 * | 0.855 * |
| Felt concerned I would get an infection if I was urinating in an unsuitable/dirty place | U10 | 0.822 | 0.963 * | 0.962 * | 0.962 * | 0.964 * |
| Feared I would be harmed by animals or insects when I went to urinate | U11 | 0.821 | 0.806 * | 0.799 * | 0.799 * | 0.811 * |
| Feared I would be harmed by someone when I went to urinate | U12 | 0.910 | 0.817 * | 0.803 * | 0.803 * | 0.825 * |
| Felt concerned I would get an infection if I urinated on someone else's urine | U15 | 0.810 | 0.953 * | 0.951 * | 0.951 * | 0.956 * |
| Feared I would be harmed by animals or insects when I went to defecate | D12 | 0.791 | 0.724 * | 0.733 * | 0.733 * | 0.717 * |
| Worried about getting an infection when going to defecate | D15 | 0.779 | 0.958 * | 0.961 * | 0.961 * | 0.943 * |
| Feared I would be harmed by someone when I went to defecate | D26 | 0.706 | 0.798 * | 0.808 * | 0.808 * | 0.794 * |
| **Factor 2: *Social expectations resultant repercussions*** | | | | | | |
| Could not always go to urinate when there was a need | U02 | 0.766 | 0.680 * | 0.695 * | 0.694 * | 0.681 * |
| Experienced difficulty controlling urge to urinate | U04 | 0.702 | 0.658 * | 0.681 * | 0.680 * | 0.656 * |
| Worried people would talk about me if they saw me | U09 | 0.863 | 0.785 * | 0.780 * | 0.779 * | 0.792 * |
| Had difficulty finding a private place to urinate | U17 | 0.760 | 0.866 * | 0.864 * | 0.863 * | 0.871 * |
| Had to suppress urge because people were around and could not go | U20 | 0.766 | 0.852 * | 0.850 * | 0.849 * | 0.855 * |
| Had to stand while urinating because someone came | U25 | 0.610 | 0.760 * | 0.762 * | 0.761 * | 0.752 * |
| Had to suppress urge because did not have someone to accompany me[+] | U26 | 0.773 | 0.724 * | 0.723 * | 0.676 * | - |
| Had to suppress [urination] when workload was high | U29 | 0.594 | 0.587 * | 0.583 * | 0.582 * | 0.580 * |
| Worried others would get upset if asked to accompany for urination | U31 | 0.856 | 0.707 * | 0.704 * | 0.703 * | 0.684 * |
| Had to suppress when I got an urge at night | U32 | 0.704 | 0.593 * | 0.598 * | 0.597 * | 0.586 * |
| Had to suppress urge [to defecate] when workload was high | D09 | 0.563 | 0.656 * | 0.655 * | 0.654 * | 0.636 * |
| Worried people would talk about me if they saw me | D11 | 0.803 | 0.816 * | 0.814 * | 0.814 * | 0.811 * |
| Had to suppress urge because I can only defecate at certain times of the day | D25 | 0.661 | 0.792 * | 0.790 * | 0.789 * | 0.771 * |
| Had trouble controlling urge to defecate | D28 | 0.553 | 0.700 * | 0.729 * | 0.728 * | 0.695 * |
| **Factor 3: *Physical exertion or strain*** | | | | | | |
| Experienced pain during urination[+] | U05 | 0.601 | 0.583 * | 0.639 * | 0.636 * | - |
| Had difficulty accessing water for urination | U19 | 0.612 | 0.833 * | 0.872 * | 0.873 * | 0.852 * |
| Had frequent pressure to urinate[+] | U22 | 0.431 | - | - | - | - |
| Had to do extra work washing clothes because of dirty conditions where urinating | U23 | 0.715 | 0.758 * | 0.755 * | 0.758 * | 0.752 * |
| Withheld water to control urge to urinate | U28 | 0.387 | 0.567 * | 0.568 * | 0.571 * | 0.564 * |
| Experienced pain during defecation[+] | D04 | 0.492 | 0.370 * | 0.433 * | 0.426 * | - |
| Had difficulty accessing water for defecation | D21 | 0.674 | 0.906 * | 0.882 * | 0.884 * | 0.915 * |
| Had difficulty cleaning/washing myself after defecation | D23 | 0.709 | 0.835 * | 0.825 * | 0.828 * | 0.848 * |
| Withheld food to control urge to defecate | D31 | 0.585 | 0.694 * | 0.700 * | 0.703 * | 0.669 * |

**Table 3.4b: Factor loadings, factor co-variations, and model fit statistics for random split-half sample EFA ($N_1$=703) and CFA models ($N_2$=705), baseline and final MIMIC models ($N_2$=708), and final CFA model ($N_2$=708) with deletions based on DIF. *(Continued).***

| Factors | Item | EFA ($N_1$=703) | CFA ($N_2$=705) | Baseline MIMIC Model ($N_2$=705) | Final MIMIC Model, 10 Modifications ($N_2$=705) | CFA, with deletions based on DIF ($N_2$=705) |
|---|---|---|---|---|---|---|
| **Factor 4: *Night Concerns*** | | | | | | |
| Felt scared urinating in the dark at night | U13 | 0.809 | 0.919 * | 0.923 * | 0.923 * | 0.920 * |
| Felt scared of ghosts when I went to urinate at night | U16 | 0.870 | 0.950 * | 0.946 * | 0.946 * | 0.952 * |
| Felt scared defecating in the dark at night | D10 | 0.722 | 0.918 * | 0.920 * | 0.920 * | 0.914 * |
| Felt scared of ghosts when I went to defecate at night | D18 | 0.793 | 0.915 * | 0.918 * | 0.918 * | 0.914 * |
| **Factor 5: S*ocial support*** | | | | | | |
| Had to leave dependents (like children, sick, or elderly) alone to urinate | U24 | 0.907 | 0.889 * | 0.880 * | 0.897 * | 0.915 * |
| Had trouble finding someone to watch dependents (children, sick, elderly) so I could urinate | U27 | 0.928 | 0.939 * | 0.945 * | 0.956 * | 0.962 * |
| Had to find someone to look after my work so I could defecate[+] | D20 | 0.619 | 0.791 * | 0.769 * | 0.881 * | - |
| Had trouble finding someone to watch dependents so I could defecate | D27 | 0.933 | 0.919 * | 0.913 * | 0.928 * | 0.942 * |
| Worried others would get upset if asked to accompany for defecation[+] | D32 | 0.481 | 0.876 * | 0.867 * | 1.033 * | - |
| Worried about dependents (children, sick or elderly) who need me when I go to defecate | D33 | 0.920 | 0.906 * | 0.905 * | 0.918 * | 0.933 * |
| **Factor 6: *Physical agility*** | | | | | | |
| Had difficulty or pain sitting or getting up for urination | U18 | 0.878 | 0.925 * | 0.920 * | 0.920 * | 0.920 * |
| Worried I would fall when going to defecate | D07 | 0.801 | 0.758 * | 0.782 * | 0.782 * | 0.763 * |
| Had difficulty or pain squatting for defecation | D17 | 0.920 | 0.951 * | 0.936 * | 0.936 * | 0.954 * |
| Had difficulty walking to defecation place[+] | D19 | 0.713 | - | - | - | - |
| **Factor 7: *Defecation place*** | | | | | | |
| Worried about not having a toilet to defecate | D01 | 0.945 | 0.885 * | 0.886 * | 0.885 * | 0.900 * |
| Had to go far to defecate | D02 | 0.851 | 0.799 * | 0.806 * | 0.804 * | 0.808 * |
| Defecation process/ activity of defecation took a long time to complete | D03 | 0.804 | 0.782 * | 0.797 * | 0.795 * | 0.801 * |
| Had difficulty finding a clean place to defecate | D05 | 0.879 | 0.876 * | 0.884 * | 0.884 * | 0.888 * |
| Could not access preferred location | D06 | 0.739 | 0.865 * | 0.870 * | 0.869 * | 0.885 * |
| Worried that someone would see me defecating[+] | D08 | 0.828 | 0.869 * | 0.859 * | 0.813 * | - |
| Had to do extra work washing clothes because of dirty conditions where defecating | D14 | 0.683 | 0.770 * | 0.772 * | 0.770 * | 0.779 * |
| Had to suppress the urge to defecate because people were around[+] | D24 | 0.799 | 0.851 * | 0.845 * | 0.821 * | - |
| Worried about defecating in the same place as others | D29 | 0.852 | 0.944 * | 0.938 * | 0.937 * | 0.963 * |

**Table 3.4c: Factor loadings, factor co-variations, and model fit statistics for random split-half sample EFA ($N_1$=703) and CFA models ($N_2$=705), baseline and final MIMIC models ($N_2$=708), and final CFA model ($N_2$=708) with deletions based on DIF. *(Continued).***

| Factors | Item | EFA ($N_1$=703) | CFA ($N_2$=705) | Baseline MIMIC Model ($N_2$=705) | Final MIMIC Model, 10 Modifications ($N_2$=705) | CFA, with deletions based on DIF ($N_2$=705) |
|---|---|---|---|---|---|---|
| **Factor Covariates** | | | | | | |
| Factor 2 | | | | | | |
| *With Factor 1* | | | 0.770 * | 0.756 * | 0.756 * | 0.780 * |
| Factor 3 | | | | | | |
| *With Factor 1* | | | 0.488 * | 0.486 * | 0.486 * | 0.516 |
| *With Factor 2* | | | 0.583 * | 0.585 * | 0.585 * | 0.570 * |
| Factor 4 | | | | | | |
| *With Factor 1* | | | 0.697 * | 0.675 * | 0.675 * | 0.698 * |
| *With Factor 2* | | | 0.601 * | 0.578 * | 0.578 * | 0.604 * |
| *With Factor 3* | | | 0.401 * | 0.398 * | 0.398 * | 0.415 * |
| Factor 5 | | | | | | |
| *With Factor 1* | | | 0.463 * | 0.484 * | 0.483 * | 0.424 * |
| *With Factor 2* | | | 0.538 * | 0.549 * | 0.548 * | 0.440 * |
| *With Factor 3* | | | 0.406 * | 0.439 * | 0.438 * | 0.352 * |
| *With Factor 4* | | | 0.433 * | 0.416 * | 0.416 * | 0.387 * |
| Factor 6 | | | | | | |
| *With Factor 1* | | | 0.243 * | 0.469 * | 0.469 * | 0.244 * |
| *With Factor 2* | | | 0.387 * | 0.614 * | 0.614 * | 0.385 * |
| *With Factor 3* | | | 0.573 * | 0.671 * | 0.671 * | 0.437 * |
| *With Factor 4* | | | 0.069 | 0.353 * | 0.353 * | 0.068 |
| *With Factor 5* | | | 0.217 * | 0.410 * | 0.409 * | 0.166 * |
| Factor 7 | | | | | | |
| *With Factor 1* | | | 0.782 * | 0.784 * | 0.784 * | 0.770 * |
| **Model Fit Statistics** | | | | | | |
| RMSEA | | 0.034 | 0.057 | 0.055 | 0.055 | 0.060 |
| CFI[+,+] | | - | 0.936 | 0.934 | 0.935 | 0.944 |
| TLI[+,+] | | - | 0.933 | 0.930 | 0.931 | 0.941 |

*p ≤ 0.050.

+Items in initial EFA model but removed during CFA because of a negative variance (D19) or low factor loading of <0.150 (U22), or later deleted as a result of DIF.

+,+CFI and TLI not provided in MPLUS for EFA carried out with PROMAX rotation.

**Table 3.5a: Structural Regressions, Direct Effects, and Model Fit Statistics of MIMIC Models ($N_2$=705)**

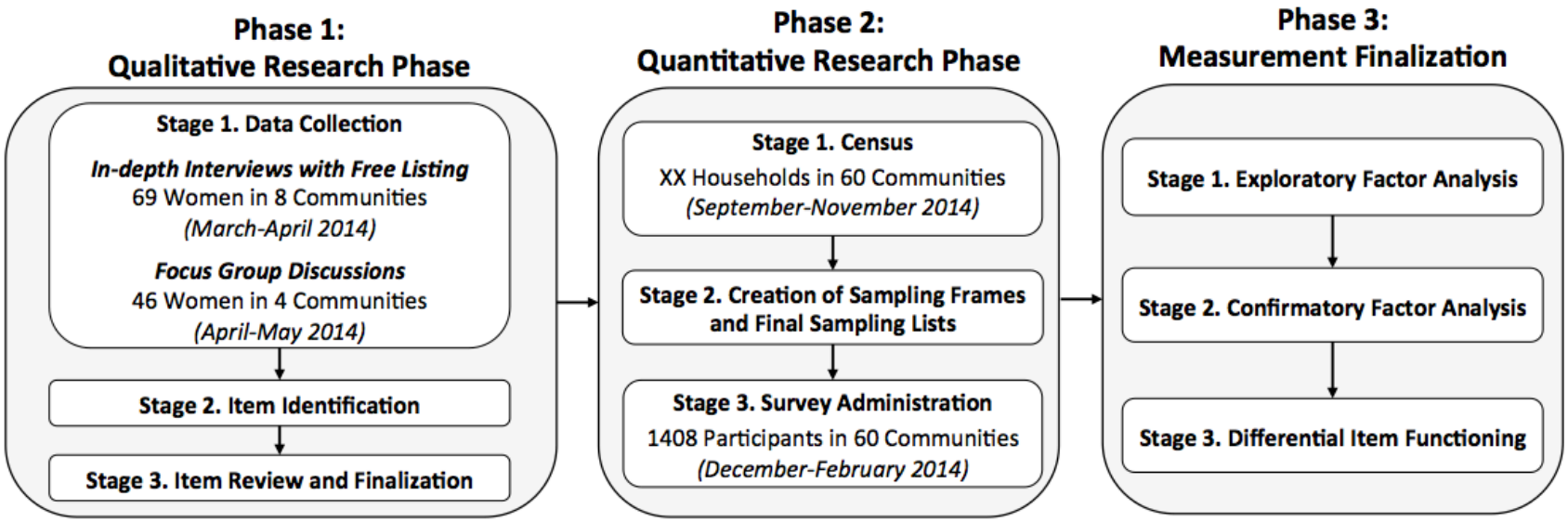
| | Baseline MIMIC Model ($N_2$=705) | MIMIC Model, 1 Mod. ($N_2$=705) | MIMIC Model, 2 Mods. ($N_2$=705) | MIMIC Model, 3 Mods. ($N_2$=705) | MIMIC Model, 4 Mods. ($N_2$=705) | MIMIC Model, 5 Mods. ($N_2$=705) | MIMIC Model, 6 Mods. ($N_2$=705) | MIMIC Model, 7 Mods. ($N_2$=705) | MIMIC Model, 8 Mods. ($N_2$=705) | MIMIC Model, 9 Mods. ($N_2$=705) | Final MIMIC Model, 10 Mods. ($N_2$=705) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Structural Regressions (Indirect Effects; Ref: Stage 1: Adolescents)** | | | | | | | | | | | |
| *On Factor 1* | | | | | | | | | | | |
| Stage 2: Recently Married Women | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 | -0.064 |
| Stage 3: Married Women (> 3 yrs.) | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* | -0.104* |
| Stage 4: Women over age 49 | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* | -0.296* |
| *On Factor 2* | | | | | | | | | | | |
| Stage 2: Recently Married Women | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| Stage 3: Married Women (> 3 yrs.) | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 | -0.036 |
| Stage 4: Women over age 49 | -0.239* | -0.239* | -0.239* | -0.239* | -0.239* | -0.239* | -0.239* | -0.239* | -0.227* | -0.227* | -0.227* |
| *On Factor 3* | | | | | | | | | | | |
| Stage 2: Recently Married Women | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 |
| Stage 3: Married Women (> 3 yrs.) | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 | -0.041 |
| Stage 4: Women over age 49 | -0.023 | -0.023 | -0.023 | -0.023 | -0.076 | -0.076 | -0.140* | -0.140* | -0.140* | -0.140* | -0.140* |
| *On Factor 4* | | | | | | | | | | | |
| Stage 2: Recently Married Women | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 |
| Stage 3: Married Women (> 3 yrs.) | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* | -0.226* |
| Stage 4: Women over age 49 | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* | -0.425* |
| *On Factor 5* | | | | | | | | | | | |
| Stage 2: Recently Married Women | 0.350* | 0.431* | 0.427* | 0.521* | 0.521* | 0.521* | 0.521* | 0.513* | 0.513* | 0.513* | 0.513* |
| Stage 3: Married Women (> 3 yrs.) | 0.208* | 0.201* | 0.278* | 0.264* | 0.264* | 0.264* | 0.264* | 0.354* | 0.354* | 0.354* | 0.354* |
| Stage 4: Women over age 49 | -0.091 | -0.088 | -0.088 | -0.084 | -0.084 | -0.084 | -0.084 | -0.082 | -0.082 | -0.082 | -0.082 |
| *On Factor 6* | | | | | | | | | | | |
| Stage 2: Recently Married Women | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* | 0.110* |
| Stage 3: Married Women (> 3 yrs.) | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* | 0.184* |
| Stage 4: Women over age 49 | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* | 0.547* |
| *On Factor 7* | | | | | | | | | | | |
| Stage 2: Recently Married Women | -0.178* | -0.178* | -0.178* | -0.178* | -0.178* | -0.179* | -0.179* | -0.179* | -0.179* | -0.179* | -0.179* |
| Stage 3: Married Women (> 3 yrs.) | -0.067 | -0.067 | -0.067 | -0.067 | -0.067 | -0.067 | -0.067 | -0.067 | -0.067 | -0.068 | -0.068 |
| Stage 4: Women over age 49 | -0.203* | -0.203* | -0.203* | -0.203* | -0.203* | -0.184* | -0.184* | -0.184* | -0.184* | -0.167* | -0.147* |

**Table 3.5b: Structural Regressions, Direct Effects, and Model Fit Statistics of MIMIC Models ($N_2$=705) *(Continued)***

| | Baseline MIMIC Model ($N_2$=705) | MIMIC Model, 1 Mod. ($N_2$=705) | MIMIC Model, 2 Mods. ($N_2$=705) | MIMIC Model, 3 Mods. ($N_2$=705) | MIMIC Model, 4 Mods. ($N_2$=705) | MIMIC Model, 5 Mods. ($N_2$=705) | MIMIC Model, 6 Mods. ($N_2$=705) | MIMIC Model, 7 Mods. ($N_2$=705) | MIMIC Model, 8 Mods. ($N_2$=705) | MIMIC Model, 9 Mods. ($N_2$=705) | Final MIMIC Model, 10 Mods. ($N_2$=705) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Direct Effects (DIF)** | | | | | | | | | | | |
| **D32** 'Worried others would get upset if asked to accompany for defecation' (factor 5) *On S2: Recently Married Women* | | -0.407* | -0.418* | -0.533* | -0.533* | -0.533* | -0.533* | -0.534* | -0.534* | -0.534* | -0.534* |
| **D32** 'Worried others would get upset if asked to accompany for defecation' (factor 5) *On S3: Married Women (> 3 yrs.)* | | | -0.399* | -0.397* | -0.397* | -0.397* | -0.397* | -0.494* | -0.494* | -0.494* | -0.494* |
| **D20** 'Had to find someone to look after my work so I could defecate' (factor 5) *On S2: Recently Married Women* | | | | -0.276* | -0.276* | -0.276* | -0.276* | -0.283* | -0.283* | -0.283* | -0.283* |
| **D04** 'Experienced pain during defecation' (factor 3) *On* S4: Women over age 49 | | | | | 0.266* | 0.266* | 0.293* | 0.293* | 0.293* | 0.293* | 0.293* |
| **D08** 'Worried that someone would see me defecating' (factor 7) *On S4: Women over age 49* | | | | | | -0.233* | -0.233* | -0.233* | -0.233* | -0.247* | -0.263* |
| **U05** 'Experienced pain during urination' (factor 3) *On S4: Women over age 49* | | | | | | | 0.262* | 0.262* | 0.262* | 0.262* | 0.262* |
| **D20** 'Had to find someone to look after my work so I could defecate' (factor 5) *On S3: Married Women (> 3 yrs.)* | | | | | | | | -0.214* | -0.214* | -0.214* | -0.214* |
| **U26** 'Had to suppress urge because did not have someone to accompany me' (factor 2) *On S4: Women over age 49* | | | | | | | | | -0.230* | -0.230* | -0.230* |
| **D30** 'Had to stand while defecating because someone came' (factor 7) *On S4: Women over age 49* | | | | | | | | | | -0.154* | -0.170* |
| **D24** 'Had to suppress the urge to defecate because people were around' (factor 7) *On S4: Women over age 49* | | | | | | | | | | | -0.174* |
| **Model Fit Statistics** | | | | | | | | | | | |
| RMSEA | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 |
| CFI[++] | 0.934 | 0.934 | 0.934 | 0.934 | 0.935 | 0.935 | 0.935 | 0.935 | 0.935 | 0.935 | 0.935 |
| TLI[++] | 0.930 | 0.930 | 0.930 | 0.931 | 0.931 | 0.931 | 0.931 | 0.931 | 0.931 | 0.931 | 0.931 |

*p ≤ 0.050.

**Figure 3.1. Schematic of Exploratory Sequential Mixed Methods Design used to create *Sanitation Insecurity* measure**



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# CHAPTER 4:

## The association between women's sanitation experiences and mental well being: A quantitative cross-sectional study in Rural, Odisha India

### Introduction

It is estimated that 2.4 billion people lack access to improved sanitation (defined as a facility that separates human excreta from human contact), and that 1 billion people practice open defecation globally[1]. To date, quantitative research on the health implications of improved sanitation has focused almost exclusively on the effect of infectious agents on disease. The effects of improved sanitation on infectious disease are substantial: eliminating exposure to human feces reduces risk of diseases, like diarrhea, trachoma, and soil-transmitted helminthes, which can result in stunting, cognitive impairment, tropical enteropathy, or death, particularly among children under age five[2-9]. While infectious disease health outcomes are critical, the World Health Organization defines health much more broadly, declaring that health is "a state of complete physical, mental and social well being and not merely the absence of disease or infirmity"[10].

Qualitative research has been used to explore how poor sanitation impacts women. This research reveals that women suffer assaults to their physical, mental, and social well being if they lack access to sanitation environments that properly accommodate their urination, defecation and menstrual hygiene needs. Women have reported shame if seen by others, fear of physical or sexual assault when accessing locations, and helplessness or lack of agency to change their sanitation conditions[11-16]. Qualitative research in India

found that physical, social, and sexual violence stressors negatively impacted women's sanitation experience, and that the perceived severity of these stressors varied depending on where women lived and their life stage[17, 18].

These studies testify to the significance of broadening out quantitative research on sanitation and health to include mental health outcomes. While qualitative research is invaluable in illuminating women's lived experiences and voiced concerns regarding sanitation, due to small sample sizes and purposive sampling, qualitative research has limited generalizability. In addition, qualitative research tools are typically open-ended, enabling participants to share their perspectives on sanitation based on what is most important to them, however this means that data are not collected systematically across all participants. While one woman may speak about fears she has when urinating at night, she may not speak of some of the concerns shared by others—even if they resonate for her—if they were not most prominent in her mind at the time of the interview. A quantitative approach is a valuable next step as it enables systematic data collection among a representative sample so that generalizations about the population can be made.

The present paper expands past research on sanitation and health by using quantitative methods to determine if sanitation is associated with mental well being, anxiety, depression, and distress. We explore this topic among women in rural Odisha, India. We evaluate the relationship between sanitation and these outcomes using two sanitation-related exposures. The first exposure is access to a functional household latrine. The second exposure is "Sanitation Insecurity", a locally-grounded measure created from the

voiced concerns of women to assess the frequency of their negative experiences related to sanitation[19, 20]. Recognizing that women have varied experiences and needs that require different attention based on life stage[21, 22], we incorporate life stage into our model to determine if life stage has varying effect on the outcomes.

## Methods

### Setting and Study Design

We conducted a cross-sectional study to evaluate the association between sanitation exposures and selected mental health outcomes. Data were collected from December 2014-February 2015 in rural communities of Odisha, India, a setting in which open defecation has historically been the norm. Our study took place in communities that previously participated in a cluster randomized controlled trial (CRT) designed to assess the impacts of a sanitation intervention (construction of household latrines as part of the government-funded Total Sanitation Campaign (TSC)) on diarrhea, soil-transmitted helminth infection, and child malnutrition [23-25]. Mean sanitation coverage increased from 9% to 63% in intervention communities and from 8% to 12% in control communities during the trial (conducted from May 2010-December 2013), which is consistent with coverage increases in other areas that have received latrines as part of the TSC[26]. The single pit, pour-flush latrines constructed were within the household compound, but outside of the dwelling. Only 36% of functional latrines in intervention villages showed signs of use, an unsurprising finding given that research across six other Indian states found that latrines provided by the government were least likely to be

used[27]. The intervention did not result in any reductions in any of the CRT outcomes of interest.

**Target Sample Size**

Based on power calculations, we aimed to survey 1440 participants from 60 communities. We used a simulation study to inform sample size. This simulation demonstrated power to detect 20% direct and cross-level interaction effects using multilevel (hierarchical) modeling for a continuous level-2 predictor to be greater than 96% for 60 clusters of 20 participants[28]. Power was sufficient for both continuous and dichotomous predictors in a base sample size of 1200. Our sample size (1400, 24 per community) allowed for attrition due to 1) incomplete surveys, 2) error in sampling (i.e. sampling ineligible or misclassified participants).

**Sampling Procedure**

We used a stratified, multi-stage, cluster sample design. The study sampled two units: communities and women living in these communities. We first identified 60 communities from the 100 communities that were engaged in the CRT. The 100 communities identified for the CRT were the first 100 to fit the selection criteria from a list of 385 where the TSC had yet to implement. We sought 30 communities that had been in the trial intervention arm and 30 that had been in the trial control arm in order to determine the influence of intervention status on outcomes. To be eligible for inclusion, former intervention communities needed to have latrine coverage greater than 25%, and former control communities needed to have latrine coverage less than 20%. These sanitation cut-

points were intended serve as proxies for good and poor coverage. We used data from the final trial data collection round in December 2014 to select eligible intervention communities, assuming little change in coverage since that time[24]. The control villages were in the process of receiving latrines, so we sought current data from a non-government organization (NGO) partner actively working to provide sanitation to these communities. Communities were deemed ineligible for inclusion if they had participated in any of the qualitative research activities undertaken to inform the current study[19, 20]. Only 31 communities in each arm met our eligibility criteria and we selected the 30 with the greatest coverage from the intervention arm and with the least coverage from the control arm. We do not believe that this selection process has any implications for inference, given that we included 97% of communities in each arm that met the eligibility criteria.

We sought to recruit 24 women living in each of these 60 communities, with variation in the sample by life stage. To create a sampling frame, we first conducted a census in each community to identify women over 18 years of age in each of four life stages: (1) unmarried, (2) married three years or less, (3) married over three years and age 49 or younger, and (4) women over 49 years of age of any marital status. This census allowed us to generate four sampling lists per community, one for each life stage category. Women were eligible to participate if they could be classified in one of the life stage categories lists. We randomly selected women from each list to take part in the study. We instructed data collectors (DCs) to survey six women per life stage category in each

community, as available, and to skip an eligible participant if another woman in the household had already been surveyed.

## Data Collection and Management

Over the course of four days, we trained a team of nine female data collectors and two supervisors to collect data, and pilot the survey in two communities not selected for inclusion. Training involved (1) a careful review of the survey instrument to make sure all questions were clear and that methods of recording answers were clear; (2) guidance on survey administration procedures (i.e. assuring that surveys were conducted in a private location to assure confidentiality); and (3) instruction for reading informed consent and seeking ethical approval. For quality control, we trained supervisors to review each survey as it was completed to be sure all questions were complete and answered appropriately.

All surveys were conducted in Oriya, the local language, and responses were recorded using pen and paper. Data was double entered using OpenEpi software and all inconsistencies were checked against surveys and corrected.

## Measures

### *Outcomes*

We selected four outcomes— mental well being, anxiety, depression and distress— because they each assess a different facet of mental health.

We used the World Health Organization Well being Index (WHO-5) to measure subjective mental well being.[29] Well being has no singular definition, but is generally agreed to be characterized by the presence of positive emotions, the absence of negative emotions, being satisfied with life, judging life positively, and feeling good[30-34]. Well being has been associated with longevity, quicker recovery from illness, lowered perception of pain and protection against cardiovascular disease risk[31, 35, 36]. In addition to its associations with other health-related outcomes, the WHO has declared well being to be an important health state unto itself[10]. WHO-5 has adequate validity as a screening tool for depression and as an outcome measure in research to evaluate differences between populations or over time[37]. It has been used in India with general populations, the elderly, and those with diabetes among others. The WHO-5 consists of five statements (i.e. 'I have felt cheerful and in good spirits', 'I have felt calm and relaxed') and asks participants to select one of six possible response options that best describes how frequently they have related to each statement in the previous two weeks. Responses range from '(0) At no time' to (5) All of the time'. Scores can range from 0-25. The higher the score, the better the well being; scores below 13 indicate poor well being (Cronbach's alpha from this sample=0.88).

We used the Hopkins Symptoms Checklist (HSCL) to assess three outcomes: anxiety, depression and non-specific emotional distress[38]. Anxiety is characterized by temporary worry or fear, and is normal for all persons to experience; anxiety disorders involve worry and fear that does not subside and may get worse[39]. Depression,

characterized by low mood, loss of interest in previously enjoyable activities, [40]and guilt, is an effective disorder that can evolve into a chronic condition or lead to suicide if left untreated[41]. Depression is associated with unhealthy behaviors like physical inactivity, poor diet, drinking, smoking, and sleep disorders that can lead to other chronic illnesses[42-45]. Distress is a broad category that includes symptoms related to anxiety, depression, and adjustment disorder[46].

The HSCL consists of 25 symptoms and asks respondents to indicate how much the symptoms bothered them in the previous week with four potential response options (not at all (1) to extremely (4)). The first ten symptoms assess anxiety (i.e. 'suddenly scared for no reason', 'nervousness or shakiness inside'), the next 15 assess depression (i.e. 'feeling low in energy', 'feeling hopeless about the future'), and the 25 collectively assess non-specific emotional distress. For each outcome, the score is the sum of the responses divided by the number of items. Scores greater than 1.75 indicate positive status for any of the three outcomes; the lower the score the less anxiety, depression, or distress. We omitted two items (one on sexual desire and the other on suicidal ideation) from the set of questions related to depression. The questions about sex were deemed inappropriate for unmarried women and we felt it unethical to solicit information about suicide without having an ability to provide clinical recourse. The final tool we utilized included 10 items for anxiety (Cronbach's alpha for our sample=0.81), 13 for depression (Cronbach's alpha from this sample=0.86), and 23 items for non-specific emotional distress (Cronbach's alpha from this sample=0.90). The HSCL was used to assess mental

health impacts of food insecurity in Tanzania and among women in northern India to develop a locally derived scale of 'Tension'[47, 48].

***Primary Exposures***

The primary exposures of interest were access to a functional latrine within the household compound and "sanitation insecurity" described below. We used a two-part question to assess access to a household latrine. We first asked participants if they had access to a latrine. If they responded yes, we then asked if the latrine was functional. We determined participants to have access to a functional latrine only if they responded yes to both questions.

We assessed sanitation-related experiences using the sanitation insecurity measure, a contextually-grounded validated measure designed to assess urination and defecation concerns and experiences across seven domains: 'Potential harms' (assessed women's perception of harm they may experience when urinating or defecating); 'Social expectations and repercussions' (assessed the social constraints women experience when urinating or defecating); 'Physical exertion or strain' (assessed women's concerns or experiences related to how they exerted or strained their bodies physically to manage basic defecation and urination needs); 'Night concerns' (assessed fears women had when urinating and defecating at night); 'Dependent support'(assessed women's concerns for her dependents when going to urinate or defecate); 'Physical agility' (assessed women's concerns related to falling or pain and difficulty when squatting to manage urination and defecation needs); and 'Defecation place' (assessed women's concerns related to her defecation location)[20].

Response options for each item in each domain ranged from Never (0) to Always (3). Participants receive a score for each domain, which is the sum of each item in the domain divided by the number of items answered in the domain. Scores could range from 0-3 per domain, aligning with the response options to facilitate interpretation. Higher values indicated greater frequency of having experiences associated with the domain.

***Covariates***

Our model includes individual-level covariates that have been previously found to influence mental health outcomes, including life stage, poverty (assessed by asking a participant if they had a 'Below the Poverty Line' or BPL card entitling them to support from the government), current health status, and perceived social support[22, 49], as well as two other covariates that are linked to sanitation behavior: access to water within the household compound and access to a room for bathing (typically a simple walled off without direct water access). Previous sanitation studies in Odisha also used BPL card possession as a proxy for poverty[24]. We assessed perceived social support using the Multidimensional Scale for Perceived Social Support (MSPSS)[50]. The 12-item scale has three dimensions that assess perceived social support from family, friends, and a significant other. Following Mohanty (2014) used items from only two of the dimensions (eight items), family and friends, because unmarried women were not likely to have a significant other[51]. The scale response options ranged from completely disagree (0) to completely agree (4). The final score was the sum of all questions divided by 5 (the

number of response options). Final scores can range from 0-4 and align with the response options to facilitate interpretability (Cronbach's alpha from this sample=0.85).

To determine if the previous intervention status of the community had any effect on the outcomes, we assessed intervention status at the community-level.

**Analysis**

For each outcome, we generated five successive hierarchical linear models that accounted for clustering of individual women (Level 1, L1) within communities (Level 2, L2). In model 1, we created an unconditional model to determine intraclass correlation coefficient (ICC), the proportion of variance that can be explained by the communities (clusters)[52]. In model 2 we ran a bivariate model that regressed the outcomes on latrine ownership. In model 3, we created a model with both latrine ownership and sanitation insecurity to determine if sanitation insecurity had an association with the outcomes despite latrine ownership. In model 4, we added all individual-level covariations. In model 5, we added intervention status, which was the cluster (community) level covariate.

Because of our sufficiently large number of level-2 units (communities), we used full maximum likelihood as the estimation method. We added all variables to the model without centering and did not include random effects for any individual-level variables, since we did not perceive there to be theoretical justification to assume that the relationship between the predictors and the outcomes would vary across communities.

For each outcome, we calculated the proportional reduction in variance and the proportional reduction in prediction error for each successive model, comparing each model to the more parsimonious model created prior[53].

We used SAS (version 9.3) to generate descriptive statistics about participants and we used HLM Software (version 7.1) for hierarchical linear models

### Ethics

The Institutional Review Board at Emory University (Atlanta, GA) and the Institutional Ethics Committee of KIIT University (Bhubaneswar, India) provided ethical approval of this study. Participants provided oral consent prior to the interviews.

## Results

### Sample size and socio-demographic characteristics

The final analytic sample consisted of 1347 participants, including 328 unmarried women (25%), 301 recently married women (22%), 376 women married over three years (28%), and 342 women over age 49 (25%) (Table 4.1). Sixty-one participants were excluded from analysis because of missing outcome data (N=2) or predictor data (N=59) which is a small percentage (5%) with missing data.

Almost all women were Hindu (99%); approximately half (45%) belonged to the general or forward caste, meaning they did not receive caste-based support from the government; 66% had a BPL card; 80% indicated they were not suffering from a current illness; 30% reported access to a primary water source within the household dwelling or compound, and 15% reported access to a bathing room.

Only 36% reported having access to a functional household latrine. Access to sanitation, water and bathing areas varied by life stage, with recently married women having the greatest access for these household facilities and unmarried women having the least access. Mean scores for all seven sanitation insecurity domains were fairly low overall, ranging from 0.1 (physical exertion /strain) to 1.2 (Night concerns) (Range=0 (never) to 3 (always)). For each of the five of the domains, scores were progressively lower along life stage categories. Additionally, scores were consistently lower for women who had access to a latrine compared to women who did not (Table 4.2).

**Participant Mental Well Being, Anxiety, Depression and Distress Scores**

The overall mean scores for well being (mean 13.9; Standard deviation (SD) 7.5; range: 0-25), anxiety (mean 1.9; SD 0.6; range: 1-4), depression (mean 1.8; SD 0.6; range: 1-4), and non-specific emotional distress (mean 1.8; SD 0.6; range: 1-4), were moderate overall. Scores were lower for well being and higher for anxiety, depression and distress at earlier life stages compared to later life stages (See Figures 4.1-4.4).

## Multivariate Results

### *Well being*

Model 1 revealed that the ICC was 0.05, indicating very little heterogeneity between the communities. In the full model (Model 5), there was a positive association between access to a functional household latrine and well being (β=3.37, P <0.001) (Table 4.3). There was a negative association between four domains of sanitation insecurity and emotional well being, despite latrine access ('Potential harms', 'Physical exertion or strain', 'Night concerns', and 'Physical Agility'). A one point increase in score for 'Potential harms' was associated with a 1.27 point decrease in well being score (P=0.007) and a one point increase in score for 'Physical exertion or strain' was associated with a 3.06 decrease in well being score (p<0.001). One of the sanitation insecurity domains (Domain 7: Defecation place) had a positive effect on well being (β=1.38, P =0.005). The 'Social expectations and resultant repercussions' and 'Dependent support' domains were unrelated to WHO-5 score. There was a negative association of life stage on well being; well being scores were progressively higher through the life stages compared with unmarried women, the referent group. There was no association between intervention status and well being.

### *Anxiety*

Model 1 revealed that the ICC was 0.07, indicating very little heterogeneity between the communities. In the final model (Model 5), there was no association between access to a functional latrine and anxiety scores (β=-0.05, P =0.430), despite an association with reduced anxiety scores in the bivariate model (Model 2) (β=-0.15, P <0.001) (Table 4.4).

Two sanitation insecurity domains were positively associated with anxiety scores. Specifically, every increase in 'Physical exertion or strain' was associated with a 0.55 increase in anxiety score (P <0.001) and every one point increase in 'Night concerns' was associated with a 0.22 increase in anxiety score (P <0.001). One domain had a negative association with anxiety scores; for every one point increase in 'Social expectations and resultant repercussions'' there was a 0.23 decrease in anxiety score (P <0.001). As with well being, there was an association between life stage and anxiety, with increasing effect as life stage progressed. There was no association between intervention status and anxiety.

***Depression***

Model 1 revealed that the ICC was 0.08, indicating very little heterogeneity between the communities. In the final model (Model 5), there was no association between access to a functional latrine and depression scores (β=-0.04, P =0.554), though there was a negative (reduction in depression) association in the bivariate model (Model 2) (β=-0.17, P <0.001) (Table 4.5). Three sanitation insecurity domains were associated with higher depression scores: 'Potential harms', ' Physical exertion or strain', and 'Night concerns'). For example, every one point increase in 'Potential harms' was associated with a 0.13 increase in depression score (P <0.001). Similar to the final anxiety model, 'Social expectations and resultant repercussions' had a negative effect on depression scores (β=-0.25, P <0.001). Consistent with well being and anxiety, there was a significant effect of life stage on depression scores. There was no association between intervention status and depression.

### *Non-Specific Emotional Distress*

The ICC was 0.08, indicating very little heterogeneity between the communities. In the final model (Model 5), there was no association between access to a functional latrine and distress scores (β=-0.04, P =0.452) despite a negative association in the bivariate model (Model 2) (β=-0.16, P <0.001) (Table 4.6). Three sanitation insecurity domains were significantly associated with higher depression scores: 'Potential harms', 'Physical exertion or strain', and 'Night concerns'. 'Social expectations and resultant repercussions' had a negative association with distress scores (β=-0.24, P <0.001). There was a significant association of life stage on distress scores. There was no association between intervention status and distress.

## Discussion

This is the first study to evaluate the associations between access to a functional household-latrine and sanitation insecurity with mental well being, anxiety, depression, and distress. While we found that access to a functional household latrine was associated with higher mental well being scores, access was not associated with anxiety, depression or distress. Women's sanitation insecurity domains were associated with all four outcomes, with most negatively associated with well being scores and positively associated with anxiety, depression, and distress scores, independent of access to a functional household latrine.

These findings demonstrate that women in rural Orissa, India may suffer assaults to their mental well being and higher levels of anxiety, depression and distress when urinating and defecating even if they have an available facility. Moreover, women may still experience sanitation insecurity even if they have a functional facility in the household. These findings suggest that sanitation-related interventions need to consider how technologies accommodate women's experiences beyond management of excreta in order to more comprehensively impact their health.

Both access to a functional household latrine and a specified area for bathing were significantly associated with higher mental well being, but not with any other outcome. Bathing areas are not typically evaluated because they are not associated with infectious disease outcomes, though women voiced concern about their ability to bathe after defecating [17-19]. Water, sanitation and hygiene (WASH) research has not previously assessed well being in evaluation studies, which may be a missed opportunity for understanding the non-disease impacts of WASH interventions and the possibility that interventions may differentially affect the populations they are intended to serve.

Evaluations of the impacts of sanitation facility access on well being should be carried out alongside an assessment of sanitation experience so that benefits of technology access are more precisely assessed. Using the contextually-grounded Sanitation Insecurity measure, we evaluated seven domains of Sanitation Insecurity while controlling for functional latrine access in the household. Four domains, each discussed below, were associated with a lower scores on mental health measures. The potential benefit of a

latrine on well being, therefore, could be negated completely if women have negative sanitation-related experiences.

Two domains of sanitation insecurity, specifically ‘Physical exertion or strain’ and ‘Night concerns’, had significant negative associations on all four outcomes, regardless of whether or not women had access to a functional household latrine. Specifically, both were associated with lower well being scores and higher scores of anxiety, depression, and distress. The effect of the ‘Physical exertion or strain’ domain highlights the impact of physical challenges associated with managing urination and defecation needs, such as accessing water, or washing the self or clothes afterwards. In their qualitative exploration of sanitation-related stressors in Odisha, India, Sahoo et al (2015) noted that participants described fetching water, post-defecation cleaning, and bathing to be necessary behaviors associated with urination and defecation that induced stress, a finding consistent with our own[17]. In a follow-up study to determine which sanitation-related activity was most stressful, fetching water for sanitation-related needs was considered to be among the most stressful activities (along with managing menstruation and defecating) for women in urban areas and among those who were newly married, pregnant and ‘established’ (a category that included all women married over three years, inclusive of older women)[18]. In a qualitative study of defecation behaviors in Odisha, India, participants indicated that they would practice open defecation despite owning a latrine because water fetching for anal-cleansing, flushing, and post-defecation bathing and clothes washing required hauling of 2 buckets of water to the latrine, a step that was unnecessary if they defecated in the open and accessed a nearby water body for these activities

afterwards[54]. Sanitation programs that do not address the physical exertion women may endure when urinating or defecating, therefore, may not only continue to fail, but may also miss an opportunity to improve well being and reduce anxiety, depression and distress.

Women's fears associated with urination and defecation at night were associated with all outcomes investigated. While it has been reported that women in India often chose to defecate in the cover of darkness to hide themselves and their activities[19, 54, 55], darkness caused them fear. To manage fear, women have reported seeking company, which they may not get, suppressing needs at night, or avoiding food and water in the evenings[18, 19]. Pregnant women feared not only for themselves, but for their unborn; women noted that a fright in the dark by someone or a ghost could cause harm to the baby, and potentially result in miscarriage[18, 19]. Latrines in the study villages were all located outside and several meters from the house. Some women reported having lights in their yards, whether they had a latrine or not, to make night defecation and urination less frightening, yet women in the qualitative study that informed the present study reported having no lights inside latrines and that they would often defecate outside a latrine at night because they were too afraid to go inside[19]. Sanitation programs that address women's 'Night concerns', potentially with low-cost lights, may not only have a positive impact on well being, anxiety, depression and distress, but may also reduce the amount of fecal pathogens in the environment.

Higher scores in the domain ‘Potential harms’, which focuses on women’s concerns about harm from people, animals, disease, and dirty conditions that are polluting, was significantly associated with lower well being scores and higher depression and distress scores. Recent studies increasingly have documented women’s fear of assault related to sanitation behaviors[13, 14, 19, 54, 56, 57]. There have been media reports of physical and sexual assault in India of girls who were openly defecating[58]. The frequency of sanitation-related violence is unknown, and future research should aim to understand how often physical and sexual assault occurs and how sanitation access and behaviors contribute to risk. Even without a full accounting of actual violence, our findings demonstrate that the fear of violence and harm, from men or other sources, has negative associations with mental health outcomes and efforts to enhance women’s sense of safety in sanitation programming are needed.

Finally, the domain ‘Physical agility’, which focuses on women’s experiences and concerns related to falling and squatting when urinating and defecating, had a significant impact on well being. In the qualitative research that informed this study, older women and women who were pregnant were the most likely to report these concerns[19]. Small enhancements to sanitation structures that provide stability to women with these concerns could be piloted.

Two domains of sanitation insecurity were associated with the outcomes in unanticipated directions. Higher scores in the domain ‘Defecation place’ was positively associated with well being scores. This may be because two of the items only ascertained if the

experience had happened, and were not designed to determine if the experience was a concern. Specifically, women were asked how frequently they had to go far to defecate and how frequently defecation took a long time. From qualitative research informing this work and from other researchers, we know that many women reported that going for open defecation is considered enjoyable specifically because it provides the opportunity to spend time away from the house and to 'roam' or walk around with friends[19, 27, 54]. In future applications of the tool, adapting the language of these two items to clearly indicate whether or not they are associated with worry is recommended.

Higher values on the domain about 'Social expectations and resultant repercussions' were significantly associated with lower anxiety, depression, and distress scores. Items in this domain focused on suppression because of social constraints, such as having work to do, having people around, or only being able to go at certain times of the day. It is possible that this domain did not perform as expected because the items are related to what it means for women in these communities to be, as Joshi et al (2011) note, 'a good woman'[11]. In other words, they are expected to attend to their needs only at specific times, only when people are not around, only when they have no work that takes priority, and they should be concerned if people see them and talk about them. Answering positively to these questions, therefore, may be a demonstration that they are sacrificing as expected and thus do not suffer anxiety, depression or distress as a result. Follow-up research on this domain is warranted.

Across all outcomes we found that life stage played an important role and has a greater effect as life stages progress, a supposition previously hypothesized but not tested[22]. We also controlled for covariates, like social support and illness status, which are known to have impacts on well being and mental health outcomes. That these covariates were significant is consistent with previous literature.

**Strengths and Limitations**

A key strength to this research is that is the first to assess both sanitation access and sanitation insecurity, an indication of sanitation experience, on a range of mental health outcomes and to do so with a population-based sample of women representing four unique life stages. We noted that some domains of the sanitation insecurity measure were associated with outcomes in a direction not anticipated. While we were able to provide some explanation as to what may account for these associations, more research is necessary to understand why these relationships exist and what improvements to the measure can be made.

While this research has moved beyond qualitative research to quantify associations between women's experiences and mental health outcomes, there are still limits to causal inference due to its cross sectional design. Application of the sanitation insecurity measure in a trial assessing mental health outcomes would enable determination of causality.

There are people in these rural Odisha communities about whom we were not able to learn. We did not purposefully aim to collect a large sample of pregnant women, nor did we try to engage girls younger than 18. We also excluded women who were too infirm to participate, missing their perspectives as well. We also did not collect information from men, preventing us from understanding outcomes related to their access and experiences and seeing how they differ from that of women. Our focus on women was justified given the qualitative research that has explicitly described their sanitation experiences to be stress inducing. Further research should incorporate these other populations to understand mental health outcomes associated with sanitation access and Sanitation Insecurity.

This research has enabled assessment of sanitation beyond access, but it does not capture all sanitation-related experiences women may have. Managing menstruation is challenging for women in rural India as well[18, 19, 56] and the sanitation insecurity measure did not capture menstruation concerns or experiences. Future research should focus on evaluating menstruation experiences in a similar manner.

**Conclusion**

Women's sanitation experiences have mixed associations with well being, anxiety, depression and distress, despite access to a functional household latrine. Future research should continue to explore sanitation experience to better understand these associations and to assess mental health outcomes associated with sanitation to determine if similar conclusions are reached. If these studies reach conclusions similar to those reached here, sanitation initiatives could consider how to ameliorate women's negative experiences of

sanitation, thinking dynamically beyond the access to facilities, in order to improve their overall health.

**Table 4.1: Demographic characteristics of survey participants, overall and by life stage in rural Orissa, India (N=1347)**

| | All | | 1. Unmarried (UM) | | 2. Recently Married (RM) | | 3. Married (M) | | 4. Over 49 (OW) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of Participants** | 1347 | | 328 | 24% | 301 | 22% | 376 | 28% | 342 | 25% |
| **Former Intervention Community** | 677 | 50.3% | 163 | 49.7% | 149 | 49.5% | 194 | 51.6% | 171 | 50.0% |
| **Age** (Range: 18-100) | 36.6 | (17.9) | 21.2 | (3.0) | 23.9 | (3.0) | 35.4 | (7.0) | 63.7 | (10.0) |
| **Hindu** | 1329 | 98.7% | 326 | 99.4% | 296 | 98.3% | 368 | 97.9% | 339 | 99.1% |
| **Caste**[1] | | | | | | | | | | |
| Brahmin | 37 | 2.8% | 10 | 3.1% | 7 | 2.3% | 12 | 3.2% | 8 | 2.3% |
| Forward / General Caste | 599 | 44.5% | 146 | 44.6% | 141 | 47.0% | 162 | 43.1% | 150 | 43.9% |
| Scheduled Caste (SC) | 240 | 17.8% | 50 | 15.3% | 58 | 19.3% | 73 | 19.4% | 59 | 17.3% |
| Other Backward Caste (OBC) | 439 | 32.6% | 116 | 35.5% | 85 | 28.3% | 121 | 32.2% | 117 | 34.2% |
| Scheduled Tribe (ST) | 11 | 0.8% | 2 | 0.6% | 2 | 0.7% | 3 | 0.8% | 4 | 1.2% |
| Don't Know | 19 | 1.4% | 3 | 0.9% | 7 | 2.3% | 5 | 1.3% | 4 | 1.2% |
| **Education** | | | | | | | | | | |
| None | 323 | 24.0% | 3 | 0.9% | 6 | 2.0% | 78 | 20.7% | 236 | 69.0% |
| Some Primary | 392 | 29.1% | 51 | 15.5% | 65 | 21.6% | 178 | 47.3% | 98 | 28.7% |
| Some Secondary | 562 | 41.7% | 228 | 69.5% | 217 | 72.1% | 109 | 29.0% | 8 | 2.3% |
| Higher than Secondary | 70 | 5.2% | 46 | 14.0% | 13 | 4.3% | 11 | 2.9% | 0 | 0.0% |
| **Below Poverty Line (BPL) Card** | 889 | 66.0% | 226 | 68.9% | 192 | 63.8% | 234 | 62.2% | 237 | 69.3% |
| **Children** | 874 | 64.9% | 0 | 0.0% | 173 | 57.5% | 366 | 97.3% | 335 | 98.0% |
| **Number of Children** | 2.0 | (2.2) | 0 | (0.0) | 0.6 | (0.6) | 2.4 | (1.2) | 4.6 | (2.2) |
| **No Current Illness** | 1079 | 80.1% | 298 | 90.9% | 282 | 93.7% | 313 | 83.2% | 186 | 54.4% |
| **Social Support** (Potential and actual range: 0-4) | 2.7 | (1.0) | 3.3 | (0.9) | 2.8 | (1.0) | 2.5 | (0.9) | 2.1 | (0.8) |
| **Household Water and Sanitation Access** | | | | | | | | | | |
| Functional Latrine in Household | 483 | 35.9% | 92 | 28.1% | 143 | 47.5% | 117 | 31.1% | 131 | 38.3% |
| Primary Drinking Water Source within Dwelling/Compound | 402 | 29.8% | 82 | 25.0% | 114 | 37.9% | 102 | 27.1% | 104 | 30.4% |
| Bathing Room in Household | 204 | 15.1% | 25 | 7.6% | 85 | 28.2% | 48 | 12.8% | 46 | 13.5% |
| **Sanitation Insecurity Domains (potential score range: 0-3)** | | | | | | | | | | |
| 1: Potential Harms (Actual range: 0-3, Cronbach's alpha=0.90) | 0.8 | (0.8) | 1.0 | (0.8) | 0.9 | (0.8) | 0.8 | (0.7) | 0.5 | (0.6) |
| 2: Social Expectations & Repercussions (Actual range: 0-2.2, Cronbach's alpha=0.86) | 0.4 | (0.4) | 0.5 | (0.5) | 0.5 | (0.5) | 0.4 | (0.4) | 0.3 | (0.3) |
| 3: Physical Exertion / Strain (Actual range: 0-2.7, Cronbach's alpha=0.64) | 0.1 | (0.3) | 0.1 | (0.3) | 0.1 | (0.3) | 0.1 | (0.2) | 0.1 | (0.2) |
| 4: Night Concerns (Actual range: 0-3, Cronbach's alpha=0.91) | 1.2 | (1.1) | 1.6 | (1.1) | 1.5 | (1.1) | 1.1 | (1.0) | 0.7 | (0.9) |
| 5: Social Support (Actual range: 0-3, Cronbach's alpha=0.89) | 0.2 | (0.4) | 0.0 | (0.2) | 0.4 | (0.7) | 0.2 | (0.4) | 0.0 | (0.1) |
| 6: Physical Agility (Actual range: 0-3, Cronbach's alpha=0.81) | 0.5 | (0.8) | 0.2 | (0.4) | 0.3 | (0.6) | 0.3 | (0.6) | 1.1 | (1.0) |
| 7: Defecation Place (Actual range: 0-3, Cronbach's alpha=0.90) | 1.1 | (0.9) | 1.3 | (0.9) | 1.0 | (1.0) | 1.2 | (0.9) | 1.0 | (0.8) |
| **Mental Health Outcomes** | | | | | | | | | | |
| WHO5 Well-Being (Potential and actual range: 0-25) | 13.9 | (7.5) | 16.6 | (6.9) | 15.8 | (6.9) | 13.3 | (7.3) | 10.1 | (7.0) |
| HSCL Anxiety (Potential and actual range 1-4) | 1.9 | (0.6) | 1.8 | (0.6) | 1.9 | (0.7) | 1.8 | (0.6) | 2.0 | (0.6) |
| HSCL Depression (Potential and actual range 1-4) | 1.8 | (0.6) | 1.7 | (0.6) | 1.8 | (0.6) | 1.8 | (0.6) | 2.1 | (0.6) |
| HSCL Non-Specific Emotional Distress (Potential range: 1-4, actual range: 1-3.8) | 1.8 | (0.6) | 1.7 | (0.5) | 1.8 | (0.6) | 1.8 | (0.5) | 2.0 | (0.6) |

Data are number and percent or mean and (standard deviation).

1. For *Caste:* 2 missing, one from stage 1 and ne from stage 2.

**Table 4.2a: Sanitation Insecurity Scores, overall and and by life stage in Rural Orissa, India (N=1347)**

| Sanitation Insecurity | All | | | | 1. Unmarried (UM) | | | | 2. Recently Married (RM) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No Latrine n=864 | | Latrine n=483 | | No Latrine n=236 | | Latrine n=92 | | No Latrine n=158 | | Latrine n=143 | |
| 1: Potential Harms (Range: 0-3) | 0.96 | (0.8) | 0.46 | (0.6)* | 1.13 | (0.8) | 0.63 | (0.7)* | 1.23 | (0.7) | 0.48 | (0.6)* |
| 2: Social Expectations & Repercussions (No Latrine Range: 0-2.2; Latrine Range: 0-1.8) | 0.52 | (0.5) | 0.27 | (0.3)* | 0.59 | (0.5) | 0.36 | (0.4)* | 0.70 | (0.5) | 0.29 | (0.4)* |
| 3: Physical Exertion / Strain (No Latrine Range: 0-2.7; Latrine Range: 0-1.8) | 0.13 | (0.3) | 0.08 | (0.2)* | 0.15 | (0.4) | 0.11 | (0.3) | 0.19 | (0.4) | 0.07 | (0.2)* |
| 4: Night Concerns (Range: 0-3) | 1.39 | (1.1) | 0.80 | (1.0)* | 1.72 | (1.0) | 1.16 | (1.1)* | 1.96 | (1.0) | 1.02 | (1.0)* |
| 5: Social Support (Range: 0-3) | 0.16 | (0.5) | 0.14 | (0.4) | 0.04 | (0.2) | 0.02 | (0.2) | 0.51 | (0.7) | 0.34 | (0.6)* |
| 6: Physical Agility (Range: 0-3) | 0.53 | (0.8) | 0.38 | (0.7)* | 0.24 | (0.5) | 0.09 | (0.3)* | 0.41 | (0.7) | 0.22 | (0.5)* |
| 7: Defecation Place (No Latrine Range: 0-3; Latrine Range: 0-2.8) | 1.63 | (0.7) | 0.20 | (0.4)* | 1.67 | (0.7) | 0.28 | (0.5)* | 1.71 | (0.7) | 0.12 | (0.3)* |

*P<0.05: Indicates significant difference between those that have a latrine and those that do not.

**Table 4.2b: Sanitation Insecurity Scores, overall and and by life stage in Rural Orissa, India (N=1347)**

| Sanitation Insecurity | 3. Married (M) | | | | 4. Over 49 (OW) | | | |
|---|---|---|---|---|---|---|---|---|
| | No Latrine n=259 | | Latrine n=117 | | No Latrine n=211 | | Latrine n=131 | |
| 1: Potential Harms (Range: 0-3) | 0.94 | (0.8) | 0.42 | (0.5)* | 0.57 | (0.7) | 0.37 | (0.6)* |
| 2: Social Expectations & Repercussions (No Latrine Range: 0-2.2; Latrine Range: 0-1.8) | 0.53 | (0.4) | 0.27 | (0.3)* | 0.31 | (0.3) | 0.19 | (0.2)* |
| 3: Physical Exertion / Strain (No Latrine Range: 0-2.7; Latrine Range: 0-1.8) | 0.11 | (0.3) | 0.06 | (0.1)* | 0.09 | (0.2) | 0.07 | (0.2) |
| 4: Night Concerns (Range: 0-3) | 1.26 | (1.0) | 0.63 | (0.9)* | 0.77 | (1.0) | 0.46 | (0.8)* |
| 5: Social Support (Range: 0-3) | 0.18 | (0.5) | 0.10 | (0.3) | 0.02 | (0.1) | 0.03 | (0.2) |
| 6: Physical Agility (Range: 0-3) | 0.32 | (0.6) | 0.25 | (0.6) | 1.18 | (1.0) | 0.88 | (1.0)* |
| 7: Defecation Place (No Latrine Range: 0-3; Latrine Range: 0-2.8) | 1.67 | (0.7) | 0.16 | (0.4)* | 1.46 | (0.7) | 0.27 | (0.4)* |

*P<0.05: Indicates significant difference between those that have a latrine and those that do not.

**Table 4.3: Association between latrine ownership, sanitation insecurity, individual and cluster level covariates and well-being scores (WHO5) in rural Orissa, India (Participants=1347, Communities=60)**

| | Fixed Effects<br>*Parameter estimate, standard error, confidence interval, p-value* | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Unconditional** | | | | **Ownership of Functional Latrine** | | | | **Ownership of Functional Latrine and Sanitation Insecurity** | | | | **Ownership of Functional Latrine, Sanitation Insecurity, and Individual Level Covariates** | | | | **Ownership of Functional Latrine, Sanitation Insecurity, and Individual and Cluster Level Covariates** | | | |
| **Parameter** | **Model 1** | | | | **Model 2** | | | | **Model 3** | | | | **Model 4** | | | | **Model 5** | | | |
| **Intercept, $\gamma_{00}$** | 13.1 | 0.34 | (13.7, 14.4) | <0.001* | 12.1 | 0.37 | (12.9, 11.4) | <0.001* | 12.9 | 0.73 | (14.3, 11.5) | <0.001* | 4.9 | 1.74 | (8.3, 1.4) | 0.007* | 4.6 | 1.77 | (8.1, 1.1) | 0.012* |
| *Level 1 (individual)* | | | | | | | | | | | | | | | | | | | | |
| **Ownership of a functional latrine, $\gamma_{10}$** | | | | | 2.8 | 0.54 | (3.9, 1.8) | <0.001* | 3.8 | 0.77 | (5.3, 2.3) | <0.001* | 3.4 | 0.75 | (4.9, 2.0) | <0.001* | 3.4 | 0.76 | (4.9, 1.9) | <0.001* |
| **Sanitation Insecurity** | | | | | | | | | | | | | | | | | | | | |
| 1: Potential Harms, $\gamma_{20}$ | | | | | | | | | -0.9 | 0.50 | (0.1, -1.9) | 0.078 | -1.3 | 0.47 | (-0.4, -2.2) | 0.007* | -1.3 | 0.47 | (-0.4, -2.2) | 0.007* |
| 2: Social expectations & repercussions, $\gamma_{30}$ | | | | | | | | | 1.2 | 0.76 | (2.6, -0.3) | 0.126 | 0.8 | 0.72 | (2.2, -0.6) | 0.276 | 0.8 | 0.72 | (2.2, -0.6) | 0.276 |
| 3: Physical exertion or strain, $\gamma_{40}$ | | | | | | | | | -1.8 | 0.92 | (0.0, -3.6) | 0.044* | -3.0 | 0.86 | (-1.4, -4.7) | <0.001* | -3.1 | 0.86 | (-1.4, -4.7) | <0.001* |
| 4: Night Concerns, $\gamma_{50}$ | | | | | | | | | -0.1 | 0.27 | (0.5, -0.6) | 0.851 | -0.6 | 0.26 | (-0.1, -1.1) | 0.027* | -0.6 | 0.26 | (-0.1, -1.1) | 0.024* |
| 5: Dependent support, $\gamma_{60}$ | | | | | | | | | -0.6 | 0.61 | (0.6, -1.8) | 0.365 | -0.4 | 0.61 | (0.7, -1.6) | 0.463 | -0.4 | 0.61 | (0.7, -1.6) | 0.458 |
| 6: Physical agility, $\gamma_{70}$ | | | | | | | | | -3.2 | 0.30 | (-2.6, -3.7) | <0.001* | -1.4 | 0.34 | (-0.7, -2.1) | <0.001* | -1.4 | 0.34 | (-0.7, -2.1) | <0.001* |
| 7: Defecation place, $\gamma_{80}$ | | | | | | | | | 0.9 | 0.52 | (1.9, -0.1) | 0.077 | 1.3 | 0.49 | (2.3, 0.4) | 0.007* | 1.4 | 0.50 | (2.4, 0.4) | 0.005* |
| **Life Stage (Stage 1: Unmarried as referent)** | | | | | | | | | | | | | | | | | | | | |
| Stage 2: Recently Married, $\gamma_{90}$ | | | | | | | | | | | | | -1.3 | 0.63 | (0.0, -2.5) | 0.044 | -1.3 | 0.63 | (0.0, -2.5) | 0.047* |
| Stage 3: Married over 3 years, $\gamma_{100}$ | | | | | | | | | | | | | -2.7 | 0.57 | (-1.6, -3.8) | <0.001* | -2.7 | 0.57 | (-1.6, -3.8) | <0.001* |
| Stage 4: Over 49 years old, $\gamma_{110}$ | | | | | | | | | | | | | -4.3 | 0.72 | (-2.9, -5.7) | <0.001* | -4.3 | 0.72 | (-2.9, -5.7) | <0.001* |
| **Water access within dwelling / compound, $\gamma_{120}$** | | | | | | | | | | | | | 0.5 | 0.55 | (1.6, -0.6) | 0.338 | 0.5 | 0.55 | (1.6, -0.6) | 0.358 |
| **Bathing Area within dwelling / compound, $\gamma_{130}$** | | | | | | | | | | | | | 1.7 | 0.73 | (3.1, 0.3) | 0.020* | 1.8 | 0.73 | (3.2, 0.3) | 0.016* |
| **Possession of 'BPL' card, $\gamma_{140}$** | | | | | | | | | | | | | 0.4 | 0.46 | (1.3, -0.5) | 0.395 | 0.4 | 0.46 | (1.3, -0.5) | 0.403 |
| **No current illness, $\gamma_{150}$** | | | | | | | | | | | | | 2.4 | 0.58 | (3.5, 1.2) | <0.001* | 2.4 | 0.58 | (3.5, 1.2) | <0.001* |
| **Social Support, $\gamma_{160}$** | | | | | | | | | | | | | 1.6 | 0.24 | (2.1, 1.1) | <0.001* | 1.6 | 0.24 | (2.1, 1.1) | <0.001* |
| *Level 2 (community)* | | | | | | | | | | | | | | | | | | | | |
| **Intervention Status, $\gamma_{01}$** | | | | | | | | | | | | | | | | | 0.5 | 0.59 | (1.6, -0.7) | 0.411 |
| | **Random Parameters**<br>*Variance Component, Standard Deviation, p-value* | | | | | | | | | | | | | | | | | | | |
| Intercept, u0 | 3.0 | 1.7 | <0.001* | | 2.3 | 1.5 | <0.001* | | 1.9 | 1.4 | <0.001* | | 1.6 | 1.3 | <0.001* | | 1.6 | 1.3 | <0.001* | |
| Level-1, *r* | 53.6 | 7.3 | | | 52.3 | 7.2 | | | 45.5 | 6.7 | | | 39.4 | 6.3 | | | 39.4 | 6.3 | | |
| | **Additional Model Components** | | | | | | | | | | | | | | | | | | | |
| ICC | 0.1 | | | | | | | | | | | | | | | | | | | |
| Deviance | 9232.2 | | | | 9193.2 | | | | 9004.4 | | | | 8810.2 | | | | 8809.3 | | | |
| # Estimated Parameters | 3.0 | | | | 4.0 | | | | 11.0 | | | | 19.0 | | | | 20.0 | | | |
| Variance Reduction,τ00 | | | | | 0.2 | | | | 0.2 | | | | 0.2 | | | | 0.0 | | | |
| Variance Reduction, $\delta^2$ | | | | | 0.0 | | | | 0.1 | | | | 0.1 | | | | 0.0 | | | |
| AIC | | | | | -9185.2 | | | | -8982.4 | | | | -8772.2 | | | | -8769.3 | | | |
| BIC | | | | | -9164.4 | | | | -8925.1 | | | | -8673.3 | | | | -8665.2 | | | |

*Significant at p <0.05

**Table 4.4: Association between latrine ownership, sanitation insecurity, individual and cluster level covariates and anxiety scores (HSCL, Q1-10) in rural Orissa, India (Participants=1347, Communities=60)**

**Fixed Effects**

*Parameter estimate, standard error, confidence interval, p-value*

| | Unconditional | | | | Ownership of Functional Latrine | | | | Ownership of Functional Latrine and Sanitation Insecurity | | | | Ownership of Functional Latrine, Sanitation Insecurity, and Individual Level Covariates | | | | Ownership of Functional Latrine, Sanitation Insecurity, and Individual and Cluster Level Covariates | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Model 1** | | | | **Model 2** | | | | **Model 3** | | | | **Model 4** | | | | **Model 5** | | | |
| **Intercept, $\gamma_{00}$** | 1.85 | 0.03 | (1.9, 1.8) | <0.001* | 1.90 | 0.03 | (2.0, 1.8) | <0.001* | 1.64 | 0.06 | (1.8, 1.5) | <0.001* | 1.93 | 0.14 | (2.2, 1.7) | <0.001* | 1.88 | 0.14 | (2.2, 1.6) | <0.001* |
| *Level 1 (individual)* | | | | | | | | | | | | | | | | | | | | |
| **Ownership of a functional latrine, $\gamma_{10}$** | | | | | -0.15 | 0.04 | (-0.1, -0.2) | <0.001* | -0.05 | 0.06 | (0.1, -0.2) | 0.366 | -0.04 | 0.06 | (0.1, -0.2) | 0.558 | -0.05 | 0.06 | (0.1, -0.2) | 0.430 |
| **Sanitation Insecurity** | | | | | | | | | | | | | | | | | | | | |
| 1: Potential Harms, $\gamma_{20}$ | | | | | | | | | -0.01 | 0.04 | (0.1, -0.1) | 0.794 | 0.01 | 0.04 | (0.1, -0.1) | 0.708 | 0.01 | 0.04 | (0.1, -0.1) | 0.715 |
| 2: Social expectations & repercussions, $\gamma_{30}$ | | | | | | | | | -0.26 | 0.06 | (-0.1, -0.4) | <0.001* | -0.23 | 0.06 | (-0.1, -0.3) | <0.001* | -0.23 | 0.06 | (-0.1, -0.3) | <0.001* |
| 3: Physical exertion or strain, $\gamma_{40}$ | | | | | | | | | 0.48 | 0.07 | (0.6, 0.3) | <0.001* | 0.55 | 0.07 | (0.7, 0.4) | <0.001* | 0.55 | 0.07 | (0.7, 0.4) | <0.001* |
| 4: Night Concerns, $\gamma_{50}$ | | | | | | | | | 0.20 | 0.02 | (0.2, 0.2) | <0.001* | 0.22 | 0.22 | (0.7, -0.2) | <0.001* | 0.22 | 0.02 | (0.3, 0.2) | <0.001* |
| 5: Dependent support, $\gamma_{60}$ | | | | | | | | | 0.00 | 0.05 | (0.1, -0.1) | 0.926 | 0.00 | 0.05 | (0.1, -0.1) | 0.968 | 0.00 | 0.05 | (0.1, -0.1) | 0.975 |
| 6: Physical agility, $\gamma_{70}$ | | | | | | | | | 0.12 | 0.02 | (0.2, 0.1) | <0.001* | 0.01 | 0.03 | (0.1, 0.0) | 0.846 | 0.00 | 0.03 | (0.1, -0.1) | 0.900 |
| 7: Defecation place, $\gamma_{80}$ | | | | | | | | | 0.02 | 0.04 | (0.1, -0.1) | 0.705 | 0.01 | 0.04 | (0.1, -0.1) | 0.732 | 0.02 | 0.04 | (0.1, -0.1) | 0.599 |
| **Life Stage (Stage 1: Unmarried as referent)** | | | | | | | | | | | | | | | | | | | | |
| Stage 2: Recently Married, $\gamma_{90}$ | | | | | | | | | | | | | 0.16 | 0.05 | (0.3, 0.1) | 0.002* | 0.16 | 0.05 | (0.3, 0.1) | 0.002* |
| Stage 3: Married over 3 years, $\gamma_{100}$ | | | | | | | | | | | | | 0.13 | 0.05 | (0.2, 0.0) | 0.003* | 0.13 | 0.05 | (0.2, 0.0) | 0.003* |
| Stage 4: Over 49 years old, $\gamma_{110}$ | | | | | | | | | | | | | 0.28 | 0.06 | (0.4, 0.2) | <0.001* | 0.29 | 0.06 | (0.4, 0.2) | <0.001* |
| **Water access within dwelling / compound, $\gamma_{120}$** | | | | | | | | | | | | | 0.06 | 0.04 | (0.1, 0.0) | 0.168 | 0.06 | 0.04 | (0.1, 0.0) | 0.202 |
| **Bathing Area within dwelling / compound, $\gamma_{130}$** | | | | | | | | | | | | | -0.10 | 0.06 | (0.0, -0.2) | 0.080 | -0.09 | 0.06 | (0.0, -0.2) | 0.114 |
| **Possession of 'BPL' card, $\gamma_{140}$** | | | | | | | | | | | | | 0.04 | 0.04 | (0.1, 0.0) | 0.328 | 0.04 | 0.04 | (0.1, 0.0) | 0.341 |
| **No current illness, $\gamma_{150}$** | | | | | | | | | | | | | -0.21 | 0.05 | (-0.1, -0.3) | <0.001* | -0.21 | 0.05 | (-0.1, -0.3) | <0.001* |
| **Social Support, $\gamma_{160}$** | | | | | | | | | | | | | -0.03 | 0.02 | (0.0, -0.1) | 0.123 | -0.03 | 0.02 | (0.0, -0.1) | 0.130 |
| *Level 2 (community)* | | | | | | | | | | | | | | | | | | | | |
| **Intervention Status, $\gamma_{01}$** | | | | | | | | | | | | | | | | | 0.09 | 0.05 | (0.2, 0.0) | 0.070 |

**Random Parameters**

*Variance Component, Standard Deviation, p-value*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intercept, u0 | 0.02 | 0.2 | <0.001* | 0.02 | 0.2 | <0.001* | 0.02 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | 0.01 | 0.1 | <0.001* | |
| Level-1, *r* | 0.33 | 0.6 | | 0.33 | 0.6 | | 0.27 | 0.5 | | 0.25 | 0.5 | | 0.25 | 0.5 | | |

**Additional Model Components**

| | | | | | |
|---|---|---|---|---|---|
| ICC | 0.07 | | | | |
| Deviance | 2396.3 | 2378.5 | 2104.1 | 2017.7 | 2013.4 |
| # Estimated Parameters | 3.0 | 4.0 | 11.0 | 19.0 | 20.0 |
| Variance Reduction,$\tau 00$ | | -0.1 | 0.4 | -0.1 | 0.1 |
| Variance Reduction, $\delta^2$ | | 0.2 | 0.2 | 0.1 | 0.0 |
| AIC | | -2370.5 | -2082.1 | -1979.7 | -1973.4 |
| BIC | | -2349.7 | -2024.8 | -1880.8 | -1869.3 |

*Significant at p <0.05

**Table 4.5: Association between latrine ownership, sanitation insecurity, individual and cluster level covariates and depression scores (HSCL, Q11-23) in rural Orissa, India (Participants=1347, Communities=60)**

**Fixed Effects**

*Parameter estimate, standard error, confidence interval, p-value*

| | Unconditional | Ownership of Functional Latrine | Ownership of Functional Latrine and Sanitation Insecurity | Ownership of Functional Latrine, Sanitation Insecurity, and Individual Level Covariates | Ownership of Functional Latrine, Sanitation Insecurity, and Individual and Cluster Level Covariates |
|---|---|---|---|---|---|
| **Parameter** | **Model 1** | **Model 2** | **Model 3** | **Model 4** | **Model 5** |
| **Intercept, $\gamma_{00}$** | 1.86 0.03 (1.9, 1.8) <0.001* | 1.91 0.04 (2.0, 1.8) <0.001* | 1.62 0.06 (1.7, 1.5) <0.001* | 2.18 0.14 (2.5, 1.9) <0.001 | 2.15 0.15 (2.4, 1.9) <0.001* |
| *Level 1 (individual)* | | | | | |
| **Ownership of a functional latrine, $\gamma_{10}$** | | -0.17 0.05 (-0.1, -0.3) <0.001* | -0.04 0.06 (0.1, -0.2) 0.562 | -0.03 0.06 (0.1, -0.2) 0.624 | -0.04 0.06 (0.1, -0.2) 0.554 |
| **Sanitation Insecurity** | | | | | |
| 1: Potential Harms, $\gamma_{20}$ | | | 0.09 0.04 (0.2, 0.0) 0.024 | 0.13 0.04 (0.2, 0.1) <0.001* | 0.13 0.04 (0.2, 0.1) <0.001* |
| 2: Social expectations & repercussions, $\gamma_{30}$ | | | -0.30 0.06 (-0.2, -0.4) <0.001* | -0.25 0.06 (-0.1, -0.4) <0.001* | -0.25 0.06 (-0.1, -0.4) <0.001* |
| 3: Physical exertion or strain, $\gamma_{40}$ | | | 0.53 0.07 (0.7, 0.4) <0.001* | 0.62 0.07 (0.8, 0.5) <0.001* | 0.62 0.07 (0.8, 0.5) <0.001* |
| 4: Night Concerns, $\gamma_{50}$ | | | 0.08 0.02 (0.1, 0.0) <0.001* | 0.12 0.02 (0.2, 0.1) <0.001* | 0.12 0.02 (0.2, 0.1) <0.001* |
| 5: Dependent support, $\gamma_{60}$ | | | -0.01 0.05 (0.1, -0.1) 0.860 | -0.01 0.05 (0.1, -0.1) 0.812 | -0.01 0.05 (0.1, -0.1) 0.812 |
| 6: Physical agility, $\gamma_{70}$ | | | 0.18 0.02 (0.2, 0.1) <0.001* | 0.01 0.03 (0.1, 0.0) 0.843 | 0.00 0.03 (0.1, -0.1) 0.868 |
| 7: Defecation place, $\gamma_{80}$ | | | 0.06 0.04 (0.1, 0.0) 0.166 | 0.03 0.04 (0.1, 0.0) 0.403 | 0.04 0.04 (0.1, 0.0) 0.356 |
| **Life Stage (Stage 1: Unmarried as referent)** | | | | | |
| Stage 2: Recently Married, $\gamma_{90}$ | | | | 0.14 0.05 (0.2, 0.0) 0.006* | 0.15 0.05 (0.2, 0.0) 0.005* |
| Stage 3: Married over 3 years, $\gamma_{100}$ | | | | 0.15 0.05 (0.2, 0.1) 0.001* | 0.15 0.05 (0.2, 0.1) 0.001* |
| Stage 4: Over 49 years old, $\gamma_{110}$ | | | | 0.39 0.06 (0.5, 0.3) <0.001* | 0.39 0.06 (0.5, 0.3) <0.001* |
| **Water access within dwelling / compound, $\gamma_{120}$** | | | | -0.05 0.05 (0.0, -0.1) 0.288 | -0.05 0.05 (0.0, -0.1) 0.265 |
| **Bathing Area within dwelling / compound, $\gamma_{130}$** | | | | -0.04 0.06 (0.1, -0.2) 0.552 | -0.03 0.06 (0.1, -0.1) 0.606 |
| **Possession of 'BPL' card, $\gamma_{140}$** | | | | 0.05 0.04 (0.1, 0.0) 0.178 | 0.05 0.04 (0.1, 0.0) 0.180 |
| **No current illness, $\gamma_{150}$** | | | | -0.27 0.05 (-0.2, -0.4) <0.001* | -0.27 0.05 (-0.2, -0.4) <0.001* |
| **Social Support, $\gamma_{160}$** | | | | -0.08 0.02 (0.0, -0.1) <0.001* | -0.08 0.02 (0.0, -0.1) <0.001* |
| *Level 2 (community)* | | | | | |
| **Intervention Status, $\gamma_{01}$** | | | | | 0.05 0.05 (0.2, -0.1) 0.357 |

**Random Parameters**

*Variance Component, Standard Deviation, p-value*

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intercept, u0 | 0.03 | 0.2 | <0.001* | 0.03 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | | | |
| Level-1, *r* | 0.36 | 0.6 | | 0.36 | 0.6 | | 0.30 | 0.5 | | 0.26 | 0.5 | | 0.27 | 0.5 | | | | |

**Additional Model Components**

| | | | | | |
|---|---|---|---|---|---|
| ICC | 0.08 | | | | |
| Deviance | 2523.3 | 2504.2 | 2256.5 | 2087.2 | 2086.1 |
| # Estimated Parameters | 3.0 | 4.0 | 11.0 | 19.0 | 20.0 |
| Variance Reduction,τ00 | | 0.1 | 0.4 | 0.1 | 0.4 |
| Variance Reduction, $\delta^2$ | | 0.0 | 0.2 | 0.1 | 0.0 |
| AIC | | -2496.22 | -2234.50 | -2049.2 | -2046.06 |
| BIC | | -2475.40 | -2177.24 | -1950.2 | -1941.95 |

*Significant at p <0.05

**Table 4.6: Association between latrine ownership, sanitation insecurity, individual and cluster level covariates and non-specific emotional distress scores (HSCL, Q1-23) in rural Orissa, India (Participants=1347, Communities=60)**

**Fixed Effects**

*Parameter estimate, standard error, confidence interval, p-value*

| | Unconditional | Ownership of Functional Latrine | Ownership of Functional Latrine and Sanitation Insecurity | Ownership of Functional Latrine, Sanitation Insecurity, and Individual Level Covariates | Ownership of Functional Latrine, Sanitation Insecurity, and Individual and Cluster Level Covariates |
|---|---|---|---|---|---|
| **Parameter** | **Model 1** | **Model 2** | **Model 3** | **Model 4** | **Model 5** |
| **Intercept, $\gamma_{00}$** | 1.85 0.03 (1.9, 1.8) <0.001* | 1.91 0.03 (2.0, 1.8) <0.001* | 1.63 0.05 (1.7, 1.5) <0.001* | 2.07 0.13 (2.3, 1.8) <0.001* | 2.04 0.13 (2.3, 1.8) <0.001* |
| *Level 1 (individual)* | | | | | |
| **Ownership of a functional latrine, $\gamma_{10}$** | | -0.16 0.04 (-0.1, -0.2) <0.001* | -0.04 0.06 (0.1, -0.2) 0.423 | -0.03 0.06 (0.1, -0.1) 0.546 | -0.04 0.06 (0.1, -0.2) 0.452 |
| **Sanitation Insecurity** | | | | | |
| 1: Potential Harms, $\gamma_{20}$ | | | 0.05 0.04 (0.1, 0.0) 0.182 | 0.08 0.03 (0.1, 0.0) 0.019* | 0.08 0.03 (0.2, 0.0) 0.020* |
| 2: Social expectations & repercussions, $\gamma_{30}$ | | | -0.29 0.05 (-0.2, -0.4) <0.001* | -0.24 0.05 (-0.1, -0.3) <0.001* | -0.24 0.05 (-0.1, -0.3) <0.001* |
| 3: Physical exertion or strain, $\gamma_{40}$ | | | 0.51 0.07 (0.6, 0.4) <0.001* | 0.59 0.06 (0.7, 0.5) <0.001* | 0.59 0.06 (0.7, 0.5) <0.001* |
| 4: Night Concerns, $\gamma_{50}$ | | | 0.13 0.02 (0.2, 0.1) <0.001* | 0.17 0.02 (0.2, 0.1) <0.001* | 0.17 0.02 (0.2, 0.1) <0.001* |
| 5: Dependent support, $\gamma_{60}$ | | | 0.00 0.04 (0.1, -0.1) 0.939 | -0.01 0.04 (0.1, -0.1) 0.886 | -0.01 0.04 (0.1, -0.1) 0.885 |
| 6: Physical agility, $\gamma_{70}$ | | | 0.15 0.02 (0.2, 0.1) <0.001* | 0.01 0.02 (0.1, 0.0) 0.825 | 0.00 0.02 (0.1, 0.0) 0.862 |
| 7: Defecation place, $\gamma_{80}$ | | | 0.04 0.04 (0.1, 0.0) 0.285 | 0.03 0.04 (0.1, 0.0) 0.480 | 0.03 0.04 (0.1, 0.0) 0.404 |
| **Life Stage (Stage 1: Unmarried as referent)** | | | | | |
| Stage 2: Recently Married, $\gamma_{90}$ | | | | 0.15 0.05 (0.2, 0.1) 0.001* | 0.15 0.05 (0.2, 0.1) 0.001* |
| Stage 3: Married over 3 years, $\gamma_{100}$ | | | | 0.14 0.04 (0.2, 0.1) <0.001* | 0.14 0.04 (0.2, 0.1) <0.001* |
| Stage 4: Over 49 years old, $\gamma_{110}$ | | | | 0.34 0.05 (0.4, 0.2) <0.001* | 0.34 0.05 (0.5, 0.2) <0.001* |
| **Water access within dwelling / compound, $\gamma_{120}$** | | | | 0.00 0.04 (0.1, -0.1) 0.989 | 0.00 0.04 (0.1, -0.1) 0.946 |
| **Bathing Area within dwelling / compound, $\gamma_{130}$** | | | | -0.07 0.05 (0.0, -0.2) 0.218 | -0.06 0.05 (0.1, -0.2) 0.267 |
| **Possession of 'BPL' card, $\gamma_{140}$** | | | | 0.04 0.03 (0.1, 0.0) 0.189 | 0.04 0.03 (0.1, 0.0) 0.192 |
| **No current illness, $\gamma_{150}$** | | | | -0.24 0.04 (-0.2, -0.3) <0.001* | -0.24 0.04 (-0.2, -0.3) <0.001* |
| **Social Support, $\gamma_{160}$** | | | | -0.06 0.02 (0.0, -0.1) <0.001* | -0.06 0.02 (0.0, -0.1) <0.001* |
| *Level 2 (community)* | | | | | |
| **Intervention Status, $\gamma_{01}$** | | | | | 0.07 0.07 (0.2, -0.1) 0.162 |

**Random Parameters**

*Variance Component, Standard Deviation, p-value*

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intercept, u0 | 0.03 | 0.2 | <0.001* | 0.03 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | 0.02 | 0.1 | <0.001* | 0.01 | 0.1 | <0.001* | | | |
| Level-1, *r* | 0.29 | 0.6 | | 0.29 | 0.6 | | 0.23 | 0.5 | | 0.21 | 0.5 | | 0.21 | 0.5 | | | | |

**Additional Model Components**

| | | | | | |
|---|---|---|---|---|---|
| ICC | 0.1 | | | | |
| Deviance | 2235.2 | 2212.9 | 2256.5 | 1758.5 | 1756.0 |
| # Estimated Parameters | 3.0 | 4.0 | 11.0 | 19.0 | 20.0 |
| Variance Reduction,τ00 | | 0.0 | 0.4 | 0.0 | 0.1 |
| Variance Reduction, $\delta^2$ | | 0.0 | 0.2 | 0.1 | 0.0 |
| AIC | | -2204.9 | -1893.9 | -1720.5 | -1716.0 |
| BIC | | -2184.6 | -1836.6 | -1621.6 | -1611.9 |

*Significant at p <0.05

**Figure 4.1. Well Being Scores (WHO 5) among study participants in Rural Orissa, India.**
Box plots show minimum and maximum values among respondents, median, mean, and first and third quartiles. Dotted line represents the 'threshold'; scores below this line represent poor well being.

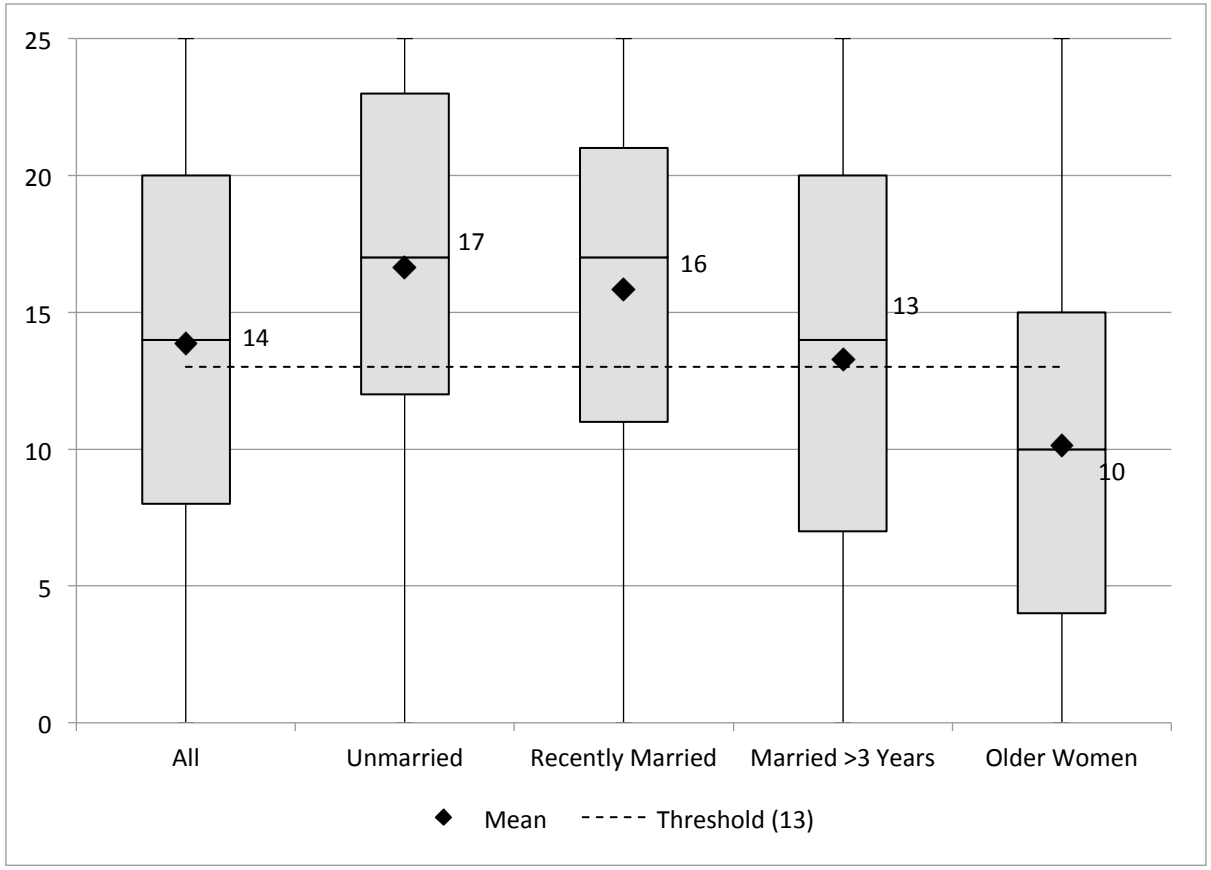


**Figure 4.2. Anxiety Scores (HSCL Q1-10) among study participants in Rural Orissa, India.**
Box plots show minimum and maximum values among respondents, median, mean, and first and third quartiles. Dotted line represents the 'threshold'; scores above this line indicate positive status for anxiety.

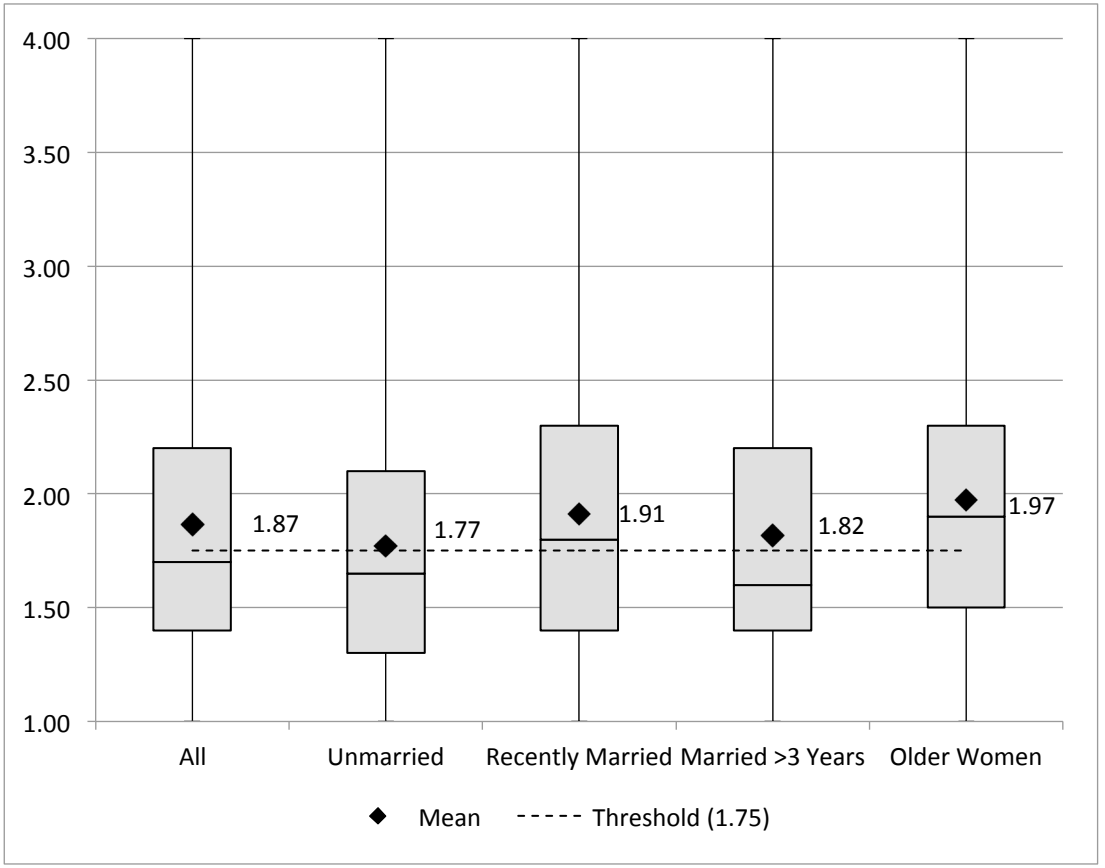


**Figure 4.3. Depression Scores (HSCL Q11-23) among study participants in Rural Orissa, India.**
Box plots show minimum and maximum values among respondents, median, mean, and first and third quartiles. Dotted line represents the 'threshold'; scores above this line indicate positive status for depression.

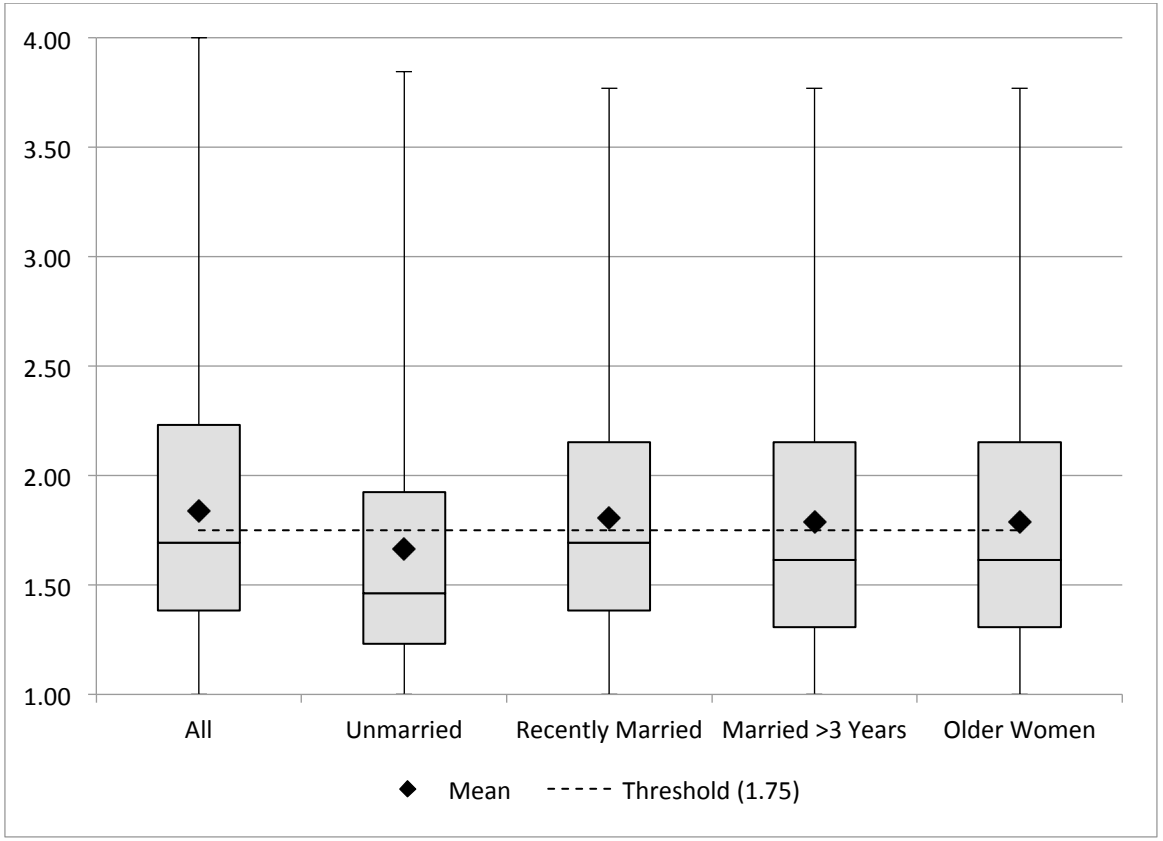
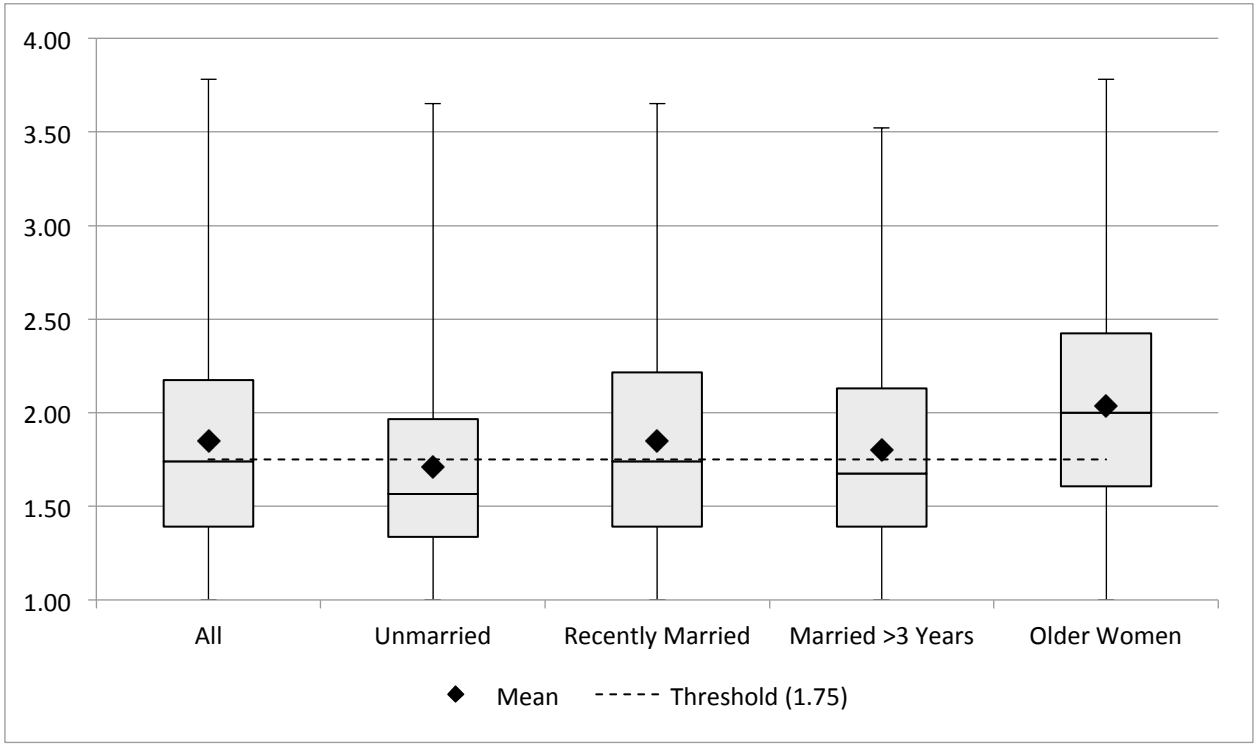


**Figure 4.4. Non-Specific Emotional Distress Scores (HSCL Q1-23) among study participants in Rural Orissa, India.**
Box plots show minimum and maximum values among respondents, median, mean, and first and third quartiles.
Dotted line represents the 'threshold'; scores above this line indicate positive status for non-specific emotional distress.



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# CHAPTER 5:

## Conclusion

The research that comprises this dissertation is the first to elucidate the sanitation experiences of women at different stages of the life course and to determine how the intensity of those experiences impact mental health outcomes, facets of health that are under-explored in the water, sanitation, and hygiene (WASH) sector. We used an exploratory, sequential mixed methods design—specifically the instrument development model—to guide three phases of this research[1]. First, Chapter 1 described the use of qualitative research methods to understand the sanitation-related concerns and experiences of women in rural Odisha, India and to define the concept of sanitation insecurity. Second, Chapter 2 outlined how the qualitative findings were used to develop a survey instrument to determine women's sanitation insecurity, specifically how often women had concerns about or negative experiences with sanitation, and conducted exploratory and confirmatory factor analysis to refine a measure of the construct. Third, Chapter 3 documented how sanitation insecurity—using the measure described in Chapter 2—was associated with four mental health outcomes: mental well-being, anxiety, depression, and distress.

In the text that follows I summarize the aims, methods and findings of each of the three studies in turn; reflect on the three research papers as a collective; and provide recommendations for future research.

## Summaries of the three papers

### Paper 1:

### Understanding and Defining Sanitation Insecurity: Women's Gendered Experiences of Urination, Defecation, and Menstrual Hygiene Management in Rural Odisha, India

The primary goal of this research was to develop a culturally grounded definition of what sanitation insecurity means to women in rural Odisha, India. To arrive at this definition, this work aimed to understand women's experiences of sanitation by documenting their urination, defecation and menstruation related concerns and developing a conceptual model to explain the factors that contribute to their positive and negative experiences. Defining and coming to understand if and how women experience sanitation insecurity may provide insight into why women choose to use or not to use toilets and help ensure that the next generation of interventions and programs better suit women's needs.

This research was conducted in March –April 2014 within a sub-sample of villages previously engaged in a cluster randomized trial in Orissa, India evaluating the impact of a rural sanitation intervention within the context of the Total Sanitation Campaign[2]. Following standard approaches in cultural domain analysis, Free-List Interviews (FLIs) with 69 women in eight communities (3 intervention and 5 control) and Focus Group Discussions (FGDs) with 46 women in four communities (2 intervention and 2 control) were used to understand women's voiced concerns and to build an understanding of sanitation insecurity[3, 4].

This research revealed that women in rural Odisha, India have a myriad of concerns related to urination, defecation and menstrual hygiene management. These concerns fell into one or more of four key domains: the gendered context, the physical environment, the social environment, and personal needs and constraints. Women also reported that the intensity of their concerns varied temporally, whether over the course of the day or year. A definition of sanitation insecurity was proposed based on the findings:

> Insufficient and uncertain access to adequate facilities and resources for independently, comfortably, safely, hygienically, and privately urinating, defecating, and managing menses in a culturally acceptable manner at any time of day or year as needs arise.

This definition integrates the four domains identified as well as temporal variation: the physical environment (insufficient and uncertain access, adequate facilities, comfort, cleanliness), the social environment (safety, privacy, independence, cultural acceptability), the gendered context (as needs arise), personal needs (urination, defecation, menstruation), and temporal variability (any time of the day or year).

The activities of the sanitation sector and national governments have been motivated largely by the Millennium Development Goal (MDG) target to increase coverage of 'improved sanitation', focusing efforts on the engineering and construction of toilets that separate human excreta from the physical environment. Our findings indicate that women

need more than facilities that change their physical environment, but also need interventions to enable urinating, defecating, and managing menstruation independently, comfortably, safely, hygienically, privately, and as needed. Women's sanitation insecurity should be quantitatively evaluated. A quantitative assessment of sanitation insecurity would enable future programs to evaluate women's sanitation-related experiences, to determine if sanitation programs impact sanitation insecurity, and how sanitation insecurity may influence other outcomes, like mental health.

**Paper 2:**

**Assessing Women's Experiences of Sanitation Insecurity: The Development of a Novel Measure**

The aim of this paper was to document the development of a novel measure for sanitation insecurity. While some of the experiences women have when trying to address their sanitation-related needs have been documented, no measure of sanitation insecurity previously existed to quantify the extent to which women have sanitation-related concerns and negative experiences, or how frequently these concerns or experiences occurred. A sanitation insecurity measure would enable researchers to assess the determinants of this insecurity and its impacts on other health indicators, such as well-being and mental health, and determine if and how sanitation interventions effectively ameliorate women's concerns and negative experiences.

To create and validate a measure of sanitation insecurity, we followed an exploratory, sequential mixed methods design[1]. During phase one (qualitative phase, described in-depth in paper one), we conducted research to develop a culturally grounded concept of sanitation insecurity and to generate items for the scale. During phase two, the quantitative phase, we conducted a census of eligible communities to create a sampling frame and administered a survey with the scale items to a probability-based sample of women in those communities. During phase three, the measurement finalization phase, we explored the factor structure of the sanitation insecurity items using exploratory factor analysis (EFA), used confirmatory factor analysis (CFA) to test the factor structure identified in the EFA, and used multiple indicator multiple causes (MIMIC) models to test for measurement non-invariance, or differential item functioning (DIF), of specific scale items.

From this process, we recommended a final sanitation insecurity measure consisting of 50 items in seven domains: (‘Potential harms’, ‘Social expectations and repercussions’, ‘Physical exertion or strain’, ‘Night concerns’, ‘Dependent support’, ‘Physical agility’, and ‘Defecation place’). All item loadings on the factors were significant and the model fit was adequate (RMSEA=0.060; CFI= 0.944; TLI=0.941). All factors covaried significantly.

With this measure, sanitation interventions can be evaluated to determine if they significantly improve women’s experiences, moving beyond simpler assessments that solely evaluate hardware. Scores resulting from this measure also can be used to

determine if there is a relationship between women's level of sanitation insecurity and their health, with attention to facets of health beyond infectious disease, like mental health.

**Paper 3:**

**The association between women's sanitation experiences and mental well-being: A quantitative cross-sectional study in Rural, Odisha India**

The aim of this paper was to quantitatively evaluate how sanitation impacts mental well-being, anxiety, depression and distress among women in rural Odisha, India. We evaluated the impact of sanitation on these outcomes using two sanitation-related exposures: access to a functional household latrine and Sanitation Insecurity, a locally grounded measure created from the voiced concerns of women to assess the frequency of their negative experiences related to sanitation. We recognized that women have varied experiences and needs that require different attention based on life stage[5]. We intentionally incorporated life stage into our study design to determine if life stage has varying effect on the outcomes.

We conducted a cross-sectional study to evaluate the association between sanitation exposures and mental health outcomes, specifically well-being, anxiety, depression and distress. Data were collected from December 2014-February 2015 in rural communities of Odisha, India in communities previously engaged in a 100-community cluster

randomized controlled trial designed to assess the impacts of a sanitation intervention (toilet provision) on diarrhea, soil-transmitted helminth infection, and child malnutrition as part of the government-funded Total Sanitation Campaign[2, 6] The intervention did not result in any significant reductions in any of the outcomes of interest. Based on power calculations, we aimed to survey 1440 participants from 60 communities (30 previously in intervention arm and 30 previously in control arm). We sought to recruit 24 women living in each of these 60 communities, with variation in the sample by life stage (6 women per life stage category). We used hierarchical linear modeling for analyses to model clustering of women within communities.

While we found that access to a functional latrine in the household was associated with higher mental well-being scores, access was not significantly associated with anxiety, depression or distress. Women's sanitation insecurity domains were, however, significantly associated with all four outcomes, with most negatively associated with mental well-being scores and positively associated with anxiety, depression, and distress scores (i.e., more symptoms of these conditions), independent of access to a functional household latrine. These findings demonstrated that women may suffer assaults to their mental well-being and an increase in anxiety, depression and distress when urinating and defecating, even if they have an available facility. Moreover, women may still experience sanitation insecurity even if they have a functional facility in the household. These findings suggest that sanitation-related interventions need to consider how technologies accommodate women's experiences beyond management of excreta in order to more fully impact their health.

**Synthesis: Reflections on the findings of the three research papers as a collective**

Due to the iterative nature of the exploratory, sequential mixed methods design utilized to carry out this research, the findings across each of the three studies were largely consistent; the results of the final study did not contradict those of the first. The final study did, however, reveal that various domains of sanitation insecurity conceptualized in the initial qualitative phase (physical environment, social environment, personal constraints) had differential associations with the mental health outcomes evaluated.

Of the four domains of concerns conceptualized during the qualitative phase of the study (chapter 1)—specifically the gendered context, the physical environment, the social environment, and personal needs and constraints—I hypothesized that the items created for the sanitation insecurity measure (chapter 2) would specifically reflect three of those domains once factor analysis was carried out. (I did not expect items associated with the gendered context domain to constitute a domain unto themselves as the items in that domain were also associated with one of the three other domains). Upon carrying out factor analyses to create the sanitation insecurity measure, the items fell into one of seven factors and each factor broadly corresponded to one of the three domains as hypothesized. Specifically, three factors largely concerned the physical environment: 'Potential harms', 'Night concerns' and 'Defecation place'; two factors related to the social environment: 'Social expectations and repercussions' and 'Dependent Support'; and two factors dealt with women's personal constraints: 'Physical exertion or strain' and 'Physical agility'.

Considering that the domains emerging from the qualitative phase were confirmed during the measurement creation phase, I expected that factors corresponding to each of these three domains would be associated with the mental health outcomes modeled in the final study. Particularly, I hypothesized that higher scores for each of the sanitation insecurity factors would be associated with lower well being scores (indicating poorer well-being) and with higher scores on in the measures of anxiety, depression, and distress (indicating greater severity of either of these conditions).

Despite my hypotheses, not all of the domains—physical environment, social environment, and personal constraints—were associated with the final outcomes in the direction expected. At least some factors corresponding to the domain 'personal constraints', were significantly associated with each of the metal health outcomes investigated and most, though not all, in the direction anticipated. At least some factors corresponding to the domain 'physical environment' were significantly associated with each of the mental health outcomes investigated and most were associated in the direction anticipated. No factors corresponding to the domain 'social environment' were associated with any of the mental health outcomes investigated in the direction anticipated.

That none of the factors associated with the Social environment have a significant association with the mental health outcomes investigated does not necessarily represent a contradiction of the findings from the qualitative phase of this research. Rather, the concerns noted by women in the qualitative phase that are related to the Social environment are still valid; the concerns just may not be strong enough to have an impact

on well-being, anxiety, depression, and distress. In addition, as explained in the discussion of paper 3, the same issues that are concerns for women may also reflect the behaviors that they are expected to perform. In other words, women may be concerned that they have to suppress their urination or defecation needs when people are around, but they may have a greater concern about people seeing them, shaming them, and causing harm to their reputation if they are not able to suppress. As a result, their concern about suppression may just be an inconvenience, a cost they pay for protecting their reputation, which may cause harm to their mental health if compromised.

Overall, this research demonstrates that women had varied concerns—varied sanitation insecurities—related to their urination and defecation behaviors and not all of the factors that comprise those concerns were associated with each of the mental health outcomes explored. While the qualitative phase was critical in elucidating the range of concerns women had related to sanitation, the creation of the sanitation insecurity measure and the assessment of the relationship between that measure and mental health outcomes demonstrate that there are limitations to what qualitative research can reveal. Without a population-based survey to evaluate associations with mental health outcomes, only assumptions about the concerns noted in the qualitative phase and their relationship with mental health could be made.

**Next Steps: Opportunities and Recommendations for Future Research**

The research from this dissertation is the first to demonstrate that women have negative sanitation-related experiences that lead them to be sanitation insecure, and that this sanitation insecurity is associated with poor mental health outcomes, even when they

have access to an improved sanitation facility. Further research is warranted to confirm this association, to understand if this association exists with populations not included in this work, and to explore if and how other facets of sanitation experience, like menstruation, are also associated with mental health outcomes. Opportunities exist to pursue some of these research questions with data already collected or with research endeavors currently ongoing.

## Opportunities to use existing data

### *Menstruation Insecurity*

Paper 1 reports on the concerns and negative experiences that women have associated with menstruation in rural Odisha, India and a menstruation-specific measure, a measure of Menstruation Insecurity, should be developed to determine if there are any associations between these concerns and experiences and well-being, anxiety, depression or distress. While the definition of sanitation insecurity presented in paper 1 includes menstrual hygiene, the measure created for sanitation insecurity (paper 2) intentionally excluded items related to menstruation so that the measure could be used with women who were not menstruating (i.e. those who had never experienced a menstrual cycle, were pregnant, recently gave birth, or who had reached menopause).

Menstruation-related items were created and included in the same survey that included the sanitation insecurity items and the mental health outcome measures. Exploratory and confirmatory factor analyses can be performed on these items to create a measure of Menstruation Insecurity, using the same procedures as outlines in paper 2. Hierarchical

linear modeling can be conducted to determine the relationship between Menstruation Insecurity and mental health outcomes, as in paper 3. In addition, both sanitation insecurity and Menstruation Insecurity, along with sanitation access, can be modeled together to determine their collective association with mental health outcomes.

***Opportunities associated with ongoing research***

Assessing the association between Sanitation and Menstruation Insecurity on mental health outcomes in communities receiving an enhanced sanitation intervention

We evaluated sanitation insecurity and its association with mental health outcomes within communities that received a government-supported sanitation intervention that was sub-optimal in achieving the sanitation coverage desired[7]. Research is currently ongoing to evaluate the health impact of an enhanced sanitation intervention designed and led by the Orissa-based organization Gram Vikas. Gram Vikas requires 100% community consensus before supporting households to build facilities, which include a pit-latrine and an enclosed bathing area, each with their own door and piped water supply for flushing, cleaning, or bathing. A piped water source is also provided to the household, but the water is not made accessible until all households have completed construction of sanitation and bathing facilities. This intervention approach has been shown to reduce severe cases of diarrhea by 30%-50%[8], a finding vastly different from previous studies that saw no health impact with construction of toilets alone[2, 9].

An opportunity exists to collect data on sanitation insecurity, menstruation insecurity, and mental health outcomes in communities that have and have not benefitted from the Gram

Vikas sanitation program. Such a cross sectional study in the same geographical area would enable an assessment of whether or not women's experiences of Sanitation and Menstruation Insecurity is different as a result of having access to a different sanitation intervention. In addition, the association between sanitation insecurity, menstruation insecurity, and well-being, anxiety, depression, and distress can also be assessed. Findings from this new cross-sectional study, still limited in understanding causal effect, can serve to confirm or contradict current findings.

## Recommendations for additional research

### *Replication of research during monsoon season*

Women who participated in the qualitative research reported concerns about urinating, defecating and managing menstruation that were unique to the monsoon season, such as difficulty accessing locations for their needs, concern for falling and hurting themselves, and getting wet and sick due to exposure to the rains, and how attending to their behaviors during the monsoon was more challenging. Survey data was collected for the current study during non-monsoon months and urination, defecation, and menstruation items specifically related to concerns about the monsoon were deliberately excluded. Future research should attempt to evaluate sanitation insecurity, menstruation insecurity and mental health outcomes during the monsoon season to determine if seasonal variability influences insecurity scores and associations with outcomes.

### *Longitudinal Research*

The current research is cross-sectional, which limits our ability to attribute causality. A longitudinal study, while not the gold standard for assessing causality, could enable assessment of if and how sanitation insecurity and associated outcomes change as a result of a sanitation program. Sanitation insecurity and outcomes could be assessed prior to and after a program. If changes were noted, a randomized trial would be warranted to truly attribute causality.

### *Impact Evaluation*

Sanitation insecurity and mental health measures should be incorporated into future sanitation impact evaluation studies. By assessing sanitation insecurity at baseline and endline during a randomized controlled trial, we could determine the impact of the intervention on sanitation insecurity. Further, mental health outcomes could also be assessed to determine if changes in sanitation insecurity scores were associated with mental health outcomes as well. Findings from an impact evaluation of this design could influence sanitation programming and policy.

## Conclusion

The research presented in this dissertation is novel. While other researchers have reported concerns and negative experiences women have when urinating, defecating and managing menstruation, none have attempted to document the full range of concerns women have when practicing these three behaviors or to identify if and how concerns

vary at different stages of the life course. This research is also the first to conceptualize the construct sanitation insecurity and to create an associated measure in order to quantify the existence and frequency of women's sanitation-related concerns and negative experiences. Finally, while other researchers have reported that women's sanitation experiences may negatively impact mental health, these studies have been qualitative and therefore limited in their ability to determine if true associations exist. Using the novel sanitation insecurity measure, this research is the first to quantitatively determine that associations between negative sanitation experiences and mental health outcomes do exist and warrant further research.

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