



Toileting behaviors and lower urinary tract symptoms: A cross-sectional study of diverse women in the United States

Diane K. Newman^{a,*}, Kathryn L. Burgio^b, Charles Cain^c, Jeni Hebert-Beirne^d, Lisa Kane Low^e, Mary H. Palmer^f, Ariana L. Smith^a, Leslie Rickey^g, Kyle Rudser^c, Shelia Gahagan^h, Bernard L. Harlowⁱ, Aimee S. James^j, D. Yvette Lacoursiere^k, Cecilia T. Hardacker^l, Jean F. Wyman^m

^a Division of Urology, Department of Surgery, Perelman School of Medicine, University of Pennsylvania, 3rd FL West, Perelman Bldg, 34th & Civic Center Blvd, Philadelphia, PA 19104 United States

^b Department of Medicine, Division of Gerontology, Geriatrics and Palliative Care, University of Alabama at Birmingham and Birmingham, Atlanta Geriatric Research, Education and Clinical Center, Department of Veterans Affairs, Birmingham, AL, United States

^c Division of Biostatistics, University of Minnesota, Minneapolis, MN, United States

^d Division of Community Health Sciences, School of Public Health, University of Illinois Chicago, Chicago, IL, United States

^e Nursing, Women's Studies and Department of Obstetrics and Gynecology, University of Michigan, United States

^f Aging, University of North Carolina at Chapel Hill, School of Nursing, United States

^g Departments of Urology and Obstetrics, Gynecology and Reproductive Sciences, Yale University School of Medicine, New Haven, CT, United States

^h Division of Academic General Pediatrics, University of California, La Jolla, San Diego, CA, United States

ⁱ Department of Epidemiology, Boston University School of Public Health, Boston, MA, United States

^j Division of Public Health Sciences, Department of Surgery, Washington University School of Medicine, Saint Louis, MO, United States

^k Department of Obstetrics, Gynecology & Reproductive Sciences, University of California, La Jolla, San Diego, CA, United States

^l Director of Education, Howard Brown Health, Chicago, IL Adjunct Instructor, Rush University College of Nursing, United States

^m Nursing Research, University of Minnesota, School of Nursing, Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Bethesda, MD, United States

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ABSTRACT

Background: Toileting behaviors are increasingly recognized as factors potentially contributing to development of lower urinary tract symptoms (LUTS).

Objectives: To examine adult women's toileting behaviors and LUTS across age and race/ethnicity groups and relationships between toileting behaviors and LUTS.

Design: Planned secondary analysis of questionnaire data collected in a focus group study on bladder health.

Settings: Questionnaires were completed at the conclusion of focus groups conducted in community settings affiliated with seven research centers across the United States.

Participants: Community-living women regardless of LUTS status.

Methods: Forty-four focus groups were conducted with 360 adolescent and adult cisgender women. After each focus group, participants completed questionnaires to assess toileting behaviors (Toileting Behaviors-Women's Elimination Behaviors Scale (TB-WEB)) and their experience of LUTS (Lower Urinary Tract Symptom Tool). This analysis includes quantitative data from the subgroup of 316 participants who completed the questionnaires.

* Corresponding author.

E-mail address: diane.newman@penntestmed.upenn.edu (D.K. Newman).

Results: Participants ranged in age from 18 to 93 years (Mean= 50.2 years). A significant effect for age was found for delayed voiding behavior, reported by 76.5% of women ages 18–25 years and 21.9% of those 75+ years ($p < 0.001$). Conversely, reports of premature voiding were lowest in the youngest and higher in the oldest three age groups ($p = 0.022$). Racial/ethnic differences were found for three domains of toileting behavior. Black and Hispanic women expressed a stronger preference for voiding at home rather than away from home (98.9%, 93.5%, respectively) compared to White women (90.4%, $p = 0.041$), were more likely to void prematurely (37.6%, 33.3% vs. 21.2%, $p = 0.048$) and to crouch, squat, or stand rather than sit to void when away from home (69.9%, 58.3% vs. 41.3%, $p < 0.001$). Four toileting behavior domains were significantly associated with LUTS. Premature voiding was associated with any bothersome LUTS (OR= 2.5; 95% confidence interval [CI]= 1.3–4.8) and any bothersome storage LUTS (OR = 2.9; CI= 1.5–5.5). Delayed voiding was associated with bothersome emptying symptoms (OR=2.8; CI= 1.1–6.6). Straining to void was associated with bothersome storage symptoms (OR=2.0; CI= 1.0–3.7), bothersome emptying symptoms (OR= 3.7; CI= 1.9–7.3), and any bothersome LUTS (OR= 2.3; CI= 1.2–4.3). Preference for non-sitting positions to void when away from home was associated with bothersome emptying symptoms (OR= 2.5; CI= 1.3–4.8) and any bothersome LUTS (OR= 1.8; CI= 1.0–3.2).

Conclusions: These findings highlight the need for research to understand underpinnings of age and racial/ethnic differences in toileting behaviors and identify mechanisms by which toileting behaviors might influence development of LUTS over time. Understanding causal pathways is important in the development of public health interventions to encourage toileting behaviors that support bladder health.

Contributions of the paper

What is already known about the topic? 2,3 bullets

Lower urinary tract symptoms are prevalent in adult women across the life course.

Certain toileting behaviors have the potential to affect bladder function and development of LUTS over time.

There are minimal data available on toileting behaviors in adult women and their long-term impact on bladder function.

What this paper adds 2,3 bullets

Decisions to delay voiding or to void prematurely are associated with age, with younger women often choosing to delay voiding and older women more commonly choosing to void prematurely.

Racial and ethnic differences in toileting position while voiding away from home were noted, with more Black and Hispanic women hovering or squatting to avoid sitting on a toilet seat.

Racial and ethnic disparities in LUTS prevalence may be related to preferences around the timing and position for toileting and/or social contextual factors that influence preferences and may provide an opportunity for interventions to prevent or improve disease.

1. Introduction

Toileting behaviors, i.e., behaviors related to bladder emptying, are increasingly recognized as important factors in bladder health and may contribute to the development or exacerbation of lower urinary tract symptoms (LUTS) in cisgender women (Wang and Palmer, 2010; Sjögren et al., 2017; Palmer et al., 2018). Certain toileting behaviors are of particular public health interest because of their potential effect on physiologic bladder function over time. Behaviors, including premature voiding (i.e., voiding “just in case”), delayed voiding (holding), altered toileting position from the “usual” sitting position, and straining to initiate or augment voiding, may impact bladder emptying.

Behaviors such as premature voiding and delayed voiding (i.e., holding) have been associated with urinary incontinence (Palmer and Newman, 2015; Willis-Gray et al., 2017). In a cross-sectional study of 6562 community-living adult women (Daily et al., 2019), overactive bladder symptoms were associated with premature voiding, delayed voiding, straining to void and position preference. Evidence suggests that women who limit use of restrooms when they are at work have a higher prevalence of LUTS (Reynolds et al., 2020).

Use of a hovering or crouching position, rather than a sitting position, is often employed by women to avoid contact with a public toilet seat due to concerns about cleanliness. These positions may impair the usual pelvic floor muscle and urinary sphincter relaxation resulting in alteration in the normal micturition reflex and incomplete bladder emptying (Moore et al., 1991) and are also associated with incontinence (Willis-Gray et al., 2017). Several studies found that toileting position did not affect uroflowmetry parameters (i.e., the speed of urine flow) in young healthy nulliparous women (Duêas-Garcia et al., 2019) or healthy female volunteers (Übsal and Cimentepe, 2004; Gupta et al., 2008). However, these studies lacked urodynamic measures of detrusor (bladder) smooth muscle

contractions or increases of abdominal pressure, which contribute to bladder emptying. Abdominal straining to initiate voiding has also been associated with bladder dysfunction (Pauwels et al., 2006; Willis-Gray et al., 2017) and may represent a behavior learned during toilet training or a behavior adopted to hasten the process of bladder emptying.

A scoping review of 25 studies on women's toileting behaviors summarized the evidence on prevalence, determinants, and outcomes (Wu et al., 2019). The majority of studies ($n = 17$; 68%) used the Toileting Behaviors: Women's Elimination Behaviors (TB-WEB) scale (Wang and Palmer, 2010, 2011), a validated theory-based questionnaire. Study populations included nurses and advanced practice providers, non-pregnant women working in academic medical centers, university students, full-time working women, and female patients in a urogynecology clinic. Relationships were found between toileting behaviors and LUTS (Wan et al., 2017), as well as between toileting positions and uroflowmetric parameters and post-void residual volumes (Wu et al., 2019; Reynolds et al., 2019). A recent large study with respondents recruited from a national research registry found that women who reported a bladder problem were more likely to report certain toileting behaviors, e.g., convenience voiding, delayed voiding, and strained voiding (Kowalik et al., 2019). However, significant gaps in knowledge remain. Few studies of the association between toileting behaviors and LUTS included older women or compared women of different age and race/ethnicity groups.

The Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium was established in 2015 with the primary aim to expand the scientific basis for the prevention of LUTS and promotion of bladder health in adolescent and adult women (Harlow et al., 2018). In developing the evidence base, an initial step was to study the perceptions and experiences of adolescent and adult women related to bladder health across the life span. Using focus group methodology, the PLUS Consortium conducted the Study of Habits, Attitudes, Realities, and Experiences (SHARE) among community-dwelling females across six age groups (Low et al., 2019; Hebert-Beirne et al., 2019). Participants in the SHARE study engaged in focus groups using an interview guide informed by the PLUS conceptual framework (Brady et al., 2018) to explore knowledge, attitudes, beliefs, and behaviors related to bladder health and the experience of LUTS. At the end of each focus group session, participants completed questionnaires to assess sociodemographic characteristics, toileting behaviors, and LUTS status.

Here, we analyze the questionnaire data on toileting behaviors and LUTS in a subsample of adult women to describe: (1) toileting behaviors and LUTS stratified by age group and race/ethnicity; and (2) the relationships between toileting behaviors and LUTS. We were guided by the PLUS conceptual framework that centers behavior and biology within levels of social ecology that are in turn shaped by distal factors rooted in a society's political, economic, and social structures, such as public policies that determine access to clean and safe toilets. These structural determinants shape the social context in which individuals engage in behaviors associated with the bladder. We hypothesized that (1) that toileting behaviors would vary by age and, given the variability in social context and lived experience, by race/ethnicity, understood as a social, not biologic construct, and (2) that toileting behaviors would be associated with storage and emptying LUTS.

2. Methods

2.1. Design and participants

Study researchers performed an analysis of quantitative data on toileting behaviors and LUTS collected from adult participants in the SHARE study. Conducted between July 2017 and April 2018, SHARE performed 44 focus groups with 360 adolescent and adult cisgender women. Details of the study design and research protocol were previously published (Low et al., 2019). Briefly, participants were recruited from seven PLUS Consortium centers located in Birmingham, AL, Chicago, IL, Ann Arbor, MI, Philadelphia, PA, San Diego, CA, St. Louis, MO, and New Haven, CT. The goal was to recruit a community sample that was racially and ethnically diverse and across a spectrum of education, socioeconomic, and geographic backgrounds (urban/rural and region of the country). In addition, intentional recruitment across a wide age range included adolescents and women over the age of 75 years, both of whom are traditionally under-represented in LUTS research. Recruitment was coordinated across centers to strategically determine the composition of each focus group and ensure overall study diversity. A variety of recruitment methods including flyers, on-line postings through social media, word of mouth, email announcements, and referral by community partners were used.

Individuals were eligible for the SHARE study if they were age 11 years or older, self-reported assigned female sex at birth, had no physical or mental condition that would impede participation, spoke English or Spanish, and were able to read and provide written consent. Women with current known pregnancies were excluded due to the known effects of pregnancy on toileting behavior and LUTS (Handa et al., 2011). Participants were included without regard to LUTS status, which was only assessed following focus group participation to ensure a wide range of bladder experiences. Due to the small number of participants 18 years and under, and the lack of validation of the TB-WEB scale in this age group, we did not include them in the analysis. Therefore, this analysis was performed on data from the 316 adult female participants (age > 18 years) who completed the self-administered questionnaires.

The study was approved by the University of Pennsylvania Institutional Review Board (IRB), which served as the central review board for six of the seven centers and a local university IRB at the remaining site. All participants signed informed consent or assent forms and received \$50 gift cards for their participation.

2.2. Data collection procedures

Following the focus group sessions, which were planned to last up to 90 min, participants completed several self-administered questionnaires to characterize their sociodemographics, physical health conditions, toileting behaviors, and LUTS status. The questionnaires were available in English and Spanish.

2.3. Measures

Sociodemographics and Physical Health Conditions. Demographic variables included self-reported age, race/ethnicity, gender identity, sexual orientation, education, marital status, living location, employment status, household income, and health insurance status. Race/ethnicity and urban/rural classification were collected using the categories adopted by the U.S. Census Bureau. Data were collected on medical conditions (history of urinary tract infections, diabetes, asthma, and arthritis), pregnancy history, and parity (including mode of delivery). Body mass index (BMI) was calculated using self-reported weight and height.

Toileting behaviors Toileting behaviors were assessed using the Toileting Behaviors-Women's Elimination Behaviors Scale (TB-WEB) (Wang and Palmer, 2011; Palmer and Newman, 2015, 2010; Palmer et al., 2019; Angelini et al., 2020). The TB-WEB, validated in women, 18 years and older, is self-administered and consists of 26 items designed to measure women's voiding behaviors in public and home settings. Domains include: (1) place preference for voiding (at home or away, 4 items), (2) premature voiding (emptying the bladder in the absence of an urge to void, 5 items), (3) delayed voiding (waiting to void despite an urge to do so, 3 items), (4) straining to void (the use of abdominal musculature to void, 5 items), (5) position preference for voiding (when at home or away from home: sitting, hovering over, or crouching on a toilet, 8 items). A 5-point Likert rating scale (never, rarely, sometimes, often, or always) was used to indicate frequency of each behavior.

Lower urinary tract symptoms LUTS status was measured using the Lower Urinary Tract Symptom Tool (LUTS Tool) (Coyne et al., 2012). The LUTS Tool uses non-medical terminology and assesses the frequency and bother of 18 LUTS in the past week. All LUTS symptoms are rated on a 5-point Likert scale (never, rarely, sometimes, often, or almost always) except for daytime and nighttime urinations. Frequency of daytime urinations are categorized as 1–3 times a day, 4–7 times a day, 8–10 times a day, 11–13 times a day, or 14 or more times a day. Nighttime urinations are rated on a frequency scale ranging from none, 1 time a night, 2 times a night, 3 times a night, and 4 or more times a night. The frequency of urinary incontinence was rated as less than once a month, a few times a month, a few times a week, daily, or many times a day. If a symptom was scored as “rarely or more,” respondents were asked to rate how much bother was associated with the symptom using a 5-point Likert scale (not at all, a little bit, somewhat, quite a bit, and a great deal). Bother was assessed for any level of daytime urination frequency and for one time or more a night for nighttime urination frequency.

2.4. Data analysis

Descriptive statistics were used to summarize participants' toileting behaviors (TB-WEB individual item and domain scores) and LUTS status (LUTS types and individual item scores) by age group and race/ethnicity group. Chi-square statistics were used to test for age and race/ethnicity group differences. Participants were organized into six age categories: 18–25 years, 26–44 years, 45–54 years, 55–64 years, 65–74 years, 75+ years. Race/ethnicity variables were collapsed and analyzed as: White, Black, Hispanic, and Other (any race or ethnicity other than White, Black, or Hispanic). If an individual reported herself as White and Hispanic, this was categorized as Hispanic. Similarly, if a participant self-reported as Black and Hispanic, this was also categorized as Hispanic.

The TB-WEB domain scores (Place Preference, Premature Voiding, Delayed Voiding, Straining to Void) were calculated by taking the single highest score from among all the questions in each domain (Xu et al., 2018). The five response options for the TB-WEB domains were combined to form three categories, “Never/Rarely,” “Sometimes,” “Often/Always.” We separated Position Preference into two domains: Position Preference at Home and Position Preference Away from Home. For each domain (Home and Away from Home), there were four questions regarding preference for sitting, squatting, standing, or crouching. Position was categorized into sitting versus other (squatting, standing crouching) based on which position resulted in the highest value from the 5-point scale. If the highest value a person endorsed was the same for sitting as it was for another category, then the position preference was classified as “Mixed.”

Three categories of LUTS were identified and defined as: storage, emptying, and pain/discomfort. Storage LUTS included symptoms of voiding frequency, urgency, and leakage. Emptying LUTS included symptoms of the feeling of incomplete emptying, post-void dribble, hesitancy, flow, straining, weak stream, and splitting or spraying; and one question regarding pain/discomfort in the bladder area. Participants were classified as having “Any LUTS” if they reported “Sometimes” or “Always” (versus “Rarely” or “Never”) for any of the symptoms. We additionally considered LUTS bother as determined by LUTS that occurred at least “sometimes” and participant rating of bother from that LUTS indicated as “somewhat” or more. Distributions of individual symptoms, with and without bother, within the three LUTS types are reported by age group and race/ethnicity group.

The relationship between individual behaviors within TB-WEB domains and LUTS types for any LUTS or LUTS with bother were evaluated by calculating odds ratios using generalized linear models adjusting for age group, BMI category (0–24.9, 25–29.9, and 30+), race/ethnicity (Black, White, Hispanic, and Other) and history of UTI vs. none. Robust variance estimation was used for confidence intervals and P-values. All analyses were performed using R v3.6.1. A significance level of $p < 0.05$ was used.

3. Results

3.1. Sociodemographics

The mean age of participants was 50.2 years (range 18–93 years) and all six age groups were well represented (Table 1). Participants were predominantly single, divorced or separated (66.1%), lived in a house or apartment (89.9%), made less than \$75,000 annually (74.4%), attended some college (64.2%), and were employed or a student (51.9%). We achieved strong representation across

Table 1
Sample characteristics.

	Overall	LUTS Status No LUTS	Any LUTS
N	316	60	256
Age: Mean (SD)	50.2 (19.3)	45.2 (18.8)	51.3 (19.3)
Age: Median (IQR)	51 (32–65)	46 (27.5–57.5)	55 (33–66)
Age group			
18–25 years old	51 (16.1)	13 (21.7)	38 (14.8)
26–44 years old	72 (22.8)	16 (26.7)	56 (21.9)
45–54 years old	43 (13.6)	13 (21.7)	30 (11.7)
55–64 years old	61 (19.3)	5 (8.3)	56 (21.9)
65–74 years old	57 (18.0)	7 (11.7)	50 (19.5)
75+ years old	32 (10.1)	6 (10.0)	26 (10.2)
Gender identity	316 (100)	60 (100)	256 (100)
Female/woman			
Race/ethnicity			
White	104 (32.9)	26 (43.3)	78 (30.5)
Black	93 (29.4)	12 (20.0)	81 (31.6)
Hispanic	108 (34.2)	18 (30.0)	90 (35.2)
Other	11 (3.5)	4 (6.7)	7 (2.7)
Sexual attraction			
Heterosexual/straight	279 (88.3)	55 (91.7)	224 (87.5)
Non-heterosexual	19 (6.0)	3 (5.0)	16 (6.2)
Missing	18 (5.7)	2 (3.3)	16 (6.2)
Marital status			
Single/divorced/separated	209 (66.1)	42 (70.0)	167 (65.2)
Now married	106 (33.5)	18 (30.0)	88 (34.4)
Missing	1 (0.3)	0 (0.0)	1 (0.4)
Employment status			
Employed/student	164 (51.9)	39 (65.0)	125 (48.8)
Not employed/not student	147 (46.5)	21 (35.0)	126 (49.2)
Missing	5 (1.6)	0 (0.0)	5 (2.0)
Household income			
<\$75,000	235 (74.4)	41 (68.3)	194 (75.8)
>\$75,000	44 (13.9)	10 (16.7)	34 (13.3)
Missing	37 (11.7)	9 (15.0)	28 (10.9)
Highest level of education			
GED/high school diploma	113 (35.8)	13 (21.7)	100 (39.1)
Some college credit, or more	203 (64.2)	47 (78.3)	156 (60.9%)
Living location			
Mobile home	18 (5.7)	4 (6.7)	14 (5.5)
House	157 (49.7)	26 (43.3)	131 (51.2)
Apartment	127 (40.2)	27 (44.9)	100 (39.0)
Boat, RV, van, etc.	2 (0.6)	0 (0.0)	2 (0.8)
Other (e.g., homeless/shelter)	11 (3.5)	3 (5.0%)	8 (3.1)
Missing	1 (0.3)	0 (0.0)	1 (0.4)
Urban/Rural Classification			
Rural	45 (14.2)	9 (15.0)	36 (14.1)
Suburban	56 (17.7)	13 (21.7)	43 (16.8)
Urban	215 (68.0)	38 (63.3)	177 (69.1)
Body mass index			
<–24.9	88 (27.8)	23 (38.3)	65 (25.4)
25–29.9	98 (31.0)	21 (35.0)	77 (30.1)
30+	120 (38.0)	15 (25.0)	105 (41.0)
Missing	10 (3.2)	1 (1.7)	9 (3.5)
Medical History			
History of Urinary tract infection	181 (57.3)	31 (51.7)	150 (58.6)
Missing	5 (1.6)	0 (0.0)	5 (2.0)
Diabetes	64 (20.3)	3 (5.0)	61 (23.8)
Missing	8 (2.5)	2 (3.3)	6 (2.3)
Asthma	61 (19.3)	6 (10.0)	55 (21.5)
Missing	6 (1.9)	2 (3.3)	4 (1.6)
Arthritis	105 (33.2)	12 (20.0)	93 (36.3)
Missing	11 (3.5)	2 (3.3)	9 (3.5)
Ever been pregnant	224 (70.9)	36 (60.0)	188 (73.4)
Mean number of pregnancies (range)	2 (0–9)	1.7 (0–7)	2.1 (0–9)

Note: Numbers reported as number (percentage) unless otherwise noted. LUTS=lower urinary tract symptoms; SD=standard deviation; IQR=interquartile range.

three racial/ethnic groups with White women representing 32.9% ($n = 104$), Black women representing 29.4% ($n = 94$), and Hispanic women representing 34.2% ($n = 108$) of the sample. Less than one-fifth of participants ($n = 60$; 19.0%) rarely or never experienced any LUTS. Compared to women who did not have LUTS, those who reported any LUTS were significantly older (mean age 51.3 versus 45.2 years); more likely to identify as Black (31.6% versus 20.0%) or Hispanic (35.2% versus 30.0%). (See Supplemental Table 1 for detailed demographics).

3.2. Prevalence of toileting behaviors across age and race/ethnicity groups

The distribution of TB-WEB domain scores across age groups is presented in Table 2 (see Supplemental Table 2 for responses on individual items). A significant effect for age was found for the Delay Voiding domain ($p < 0.001$), with 76.5% of the youngest age group (18–25 years) and only 21.9% of the oldest group (75+ years) reporting they delayed voiding often or always. In addition, reports of Premature Voiding were lowest in the youngest age group (9.8%), peaked at 41% for those between ages 55–64 years and was also high in the two oldest age groups, 65–74 years and 75+ years (31.6% and 34.4%, respectively). There were no significant differences by age group for Place Preference ($p = 0.073$), Straining ($p = 0.750$), or Home and Away Position Preferences ($p = 0.418$, 0.120, respectively).

Racial/ethnic differences were found for three domains of the TB-WEB scale: Place Preference, Premature Voiding, and Away Position Preference (Table 3 for domains; Supplemental Table 3 for individual items). Although most White women endorsed a preference for voiding at home rather than away from home (90.4% reporting often/always), this percentage was lower than that for Black (98.9%), Hispanic (93.5%) and other racial/ethnic groups (100%; $p = 0.041$). White women were also less likely to void in the absence of a “need to urinate,” with 21.2% endorsing this behavior (often/always) compared to 37.6% of Black women and 33.3% of Hispanic women ($p = 0.048$).

Regarding voiding position, significantly more White women (47.1%) expressed a preference for sitting to void when away from home compared to Black (17.2%; $p < 0.001$) and Hispanic women (25.0%), whereas more Black (69.9%) and Hispanic (58.3%) women preferred to crouch, squat, or stand to void when away from home compared to White women (41.3%; $p < 0.001$).

3.3. Prevalence of LUTS across age groups and race/ethnicity groups

The distribution of LUTS types by age and race/ethnicity groups are presented in Tables 4 and 5 (see Supplemental Tables 4 and 5 for responses on individual LUTS items). Reports of having any storage LUTS increased across age groups from 51% in the youngest

Table 2
Frequencies of toileting behaviors domains by age.

	Age Group						P-Value
	18–25 years old	26–44 years old	45–54 years old	55–64 years old	65–74 years old	75+ years old	
N	51	72	43	61	57	32	
Place Preference							
Never/Rarely	2 (3.9)	1 (1.4)	0 (0.0)	1 (1.6)	0 (0.0)	0 (0.0)	0.073
Sometimes	5 (9.8)	0 (0.0)	0 (0.0)	2 (3.3)	1 (1.8)	1 (3.1)	
Often/Always	44 (86.3)	70 (97.2)	42 (97.7)	58 (95.1)	54 (94.7)	30 (93.8)	
Missing	0 (0.0)	1 (1.4)	1 (2.3)	0 (0.0)	2 (3.5)	1 (3.1)	
Premature Voiding							
Never/Rarely	16 (31.4)	23 (31.9)	16 (37.2)	15 (24.6)	18 (31.6)	11 (34.4)	0.022
Sometimes	30 (58.8)	29 (40.3)	12 (27.9)	19 (31.1)	21 (36.8)	8 (25.0)	
Often/Always	5 (9.8)	20 (27.8)	15 (34.9)	25 (41.0)	18 (31.6)	11 (34.4)	
Missing	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.3)	0 (0.0)	2 (6.2)	
Delay Voiding							
Never/Rarely	1 (2.0)	13 (18.1)	8 (18.6)	10 (16.4)	5 (8.8)	6 (18.8)	<0.001
Sometimes	11 (21.6)	19 (26.4)	21 (48.8)	30 (49.2)	31 (54.4)	16 (50.0)	
Often/Always	39 (76.5)	38 (52.8)	13 (30.2)	19 (31.1)	21 (36.8)	7 (21.9)	
Missing	0 (0.0)	2 (2.8)	1 (2.3)	2 (3.3)	0 (0.0)	3 (9.4)	
Straining							
Never/Rarely	19 (37.3)	34 (47.2)	22 (51.2)	30 (49.2)	26 (45.6)	18 (56.2)	0.750
Sometimes	18 (35.3)	22 (30.6)	11 (25.6)	22 (36.1)	16 (28.1)	7 (21.9)	
Often/Always	14 (27.5)	15 (20.8)	10 (23.3)	9 (14.8)	15 (26.3)	7 (21.9)	
Missing	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Home Position Preference							
Sitting	50 (98.0)	68 (94.4)	40 (93.0)	58 (95.1)	54 (94.7)	32 (100.0)	0.418
Crouch/Squat/Stand	1 (2.0)	2 (2.8)	2 (4.7)	0 (0.0)	0 (0.0)	0 (0.0)	
Mixed	0 (0.0)	2 (2.8)	1 (2.3)	3 (4.9)	3 (5.3)	0 (0.0)	
Away Position Preference							
Sitting	21 (41.2)	18 (25.0)	11 (25.6)	16 (26.2)	23 (40.4)	8 (25.0)	0.120
Crouch/Squat/Stand	25 (49.0)	40 (55.6)	28 (65.1)	31 (50.8)	30 (52.6)	20 (62.5)	
Mixed	5 (9.8)	14 (19.4)	4 (9.3)	14 (23.0)	4 (7.0)	4 (12.5)	

Note: Numbers reported as frequency (percentage). Domain scores are calculated as the highest response to the questions within a domain as shown in supplemental Tables. P-values are observed from a Chi-square test.

Table 3
Frequencies of toileting behavior domains by race/ethnicity.

	Race White	Black	Hispanic	Other	P-Value
N	104	93	108	11	
Place Preference					
Never/Rarely	4 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0.041
Sometimes	6 (5.8)	1 (1.1)	2 (1.9)	0 (0.0)	
Often/Always	94 (90.4)	92 (98.9)	101 (93.5)	11 (100.0)	
Missing	0 (0.0)	0 (0.0)	5 (4.6)	0 (0.0)	
Premature Voiding					
Never/Rarely	35 (33.7)	24 (25.8)	37 (34.3)	3 (27.3)	0.048
Sometimes	46 (44.2)	33 (35.5)	33 (30.6)	7 (63.6)	
Often/Always	22 (21.2)	35 (37.6)	36 (33.3)	1 (9.1)	
Missing	1 (1.0)	1 (1.1)	2 (1.9)	0 (0.0)	
Delay Voiding					
Never/Rarely	15 (14.4)	12 (12.9)	16 (14.8)	0 (0.0)	0.157
Sometimes	32 (30.8)	44 (47.3)	47 (43.5)	5 (45.5)	
Often/Always	55 (52.9)	36 (38.7)	40 (37.0)	6 (54.5)	
Missing	2 (1.9)	1 (1.1)	5 (4.6)	0 (0.0)	
Straining					
Never/Rarely	46 (44.2)	42 (45.2)	54 (50.0)	7 (63.6)	0.553
Sometimes	33 (31.7)	34 (36.6)	27 (25.0)	2 (18.2)	
Often/Always	25 (24.0)	17 (18.3)	26 (24.1)	2 (18.2)	
Missing	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	
Home Position Preference					
Sitting	101 (97.1)	88 (94.6)	102 (94.4)	11 (100.0)	0.946
Crouch/Squat/Stand	1 (1.0)	2 (2.2)	2 (1.9)	0 (0.0)	
Mixed	2 (1.9)	3 (3.2)	4 (3.7)	0 (0.0)	
Away Position Preference					
Sitting	49 (47.1)	16 (17.2)	27 (25.0)	5 (45.5)	<0.001
Crouch/Squat/Stand	43 (41.3)	65 (69.9)	63 (58.3)	3 (27.3)	
Mixed	12 (11.5)	12 (12.9)	18 (16.7)	3 (27.3)	

Note: Numbers reported as frequency (percentage). *P*-values are observed from a Chi-square test.

group (18–25 years) to 87.7% in the 65–74-year group and 81.2% in the oldest group ($p < 0.001$; Table 3). Reports of any storage LUTS with bother also increased with age ($p = 0.001$). A similar pattern was observed for any LUTS ($p = 0.039$) and any LUTS with bother ($p = 0.027$).

The majority of participants in each age group reported at least one emptying LUTS, but without significant group differences ($p = 0.56$). However, emptying LUTS with bother was significantly associated with age group ($p = 0.009$). The highest prevalence was reported in the 45–54-year-old group (46.5%) and was lowest (13.7%) in the youngest group. Bladder pain or discomfort did not differ significantly by age group ($p = 0.385$ for pain, $p = 0.243$ for bothersome pain).

Reports of having any LUTS with bother ($p = 0.041$) and having any storage LUTS ($p = 0.001$) and storage LUTS with bother ($p = 0.003$) differed significantly across race/ethnicity groups (Table 4). A higher proportion of Black women (84.9%) and Hispanic women (75.9%) reported any storage LUTS compared to White women (59.6%). Black women reported a higher prevalence of any

Table 4
Frequencies of lower urinary tract symptom type with and without bother by age.

LUTS Type	Overall	Age Group						P-Value
		18–25 years old	26–44 years old	45–54 years old	55–64 years old	65–74 years old	75+ years old	
N	316	51	72	43	61	57	32	
Any Storage LUTS	230 (72.8)	26 (51.0)	49 (68.1)	28 (65.1)	51 (83.6)	50 (87.7)	26 (81.2)	<0.001
Any Storage LUTS w/bother	152 (48.1)	12 (23.5)	30 (41.7)	24 (55.8)	35 (57.4)	35 (61.4)	16 (50.0)	0.001
Any Emptying LUTS	197 (62.3)	34 (66.7)	43 (59.7)	23 (53.5)	43 (70.5)	35 (61.4)	19 (59.4)	0.561
Any Emptying LUTS w/bother	95 (30.1)	7 (13.7)	21 (29.2)	20 (46.5)	24 (39.3)	15 (26.3)	8 (25.0)	0.009
Pain/discomfort in bladder area	65 (20.6)	10 (19.6)	16 (22.2)	11 (25.6)	16 (26.2)	9 (15.8)	3 (9.4)	0.385
Pain/discomfort in bladder area w/Bother	42 (13.3)	5 (9.8)	9 (12.5)	8 (18.6)	12 (19.7)	7 (12.3)	1 (3.1)	0.243
Any LUTS	256 (81.0)	38 (74.5)	56 (77.8)	30 (69.8)	56 (91.8)	50 (87.7)	26 (81.2)	0.039
Any LUTS w/bother	166 (52.5)	18 (35.3)	33 (45.8)	26 (60.5)	38 (62.3)	35 (61.4)	16 (50.0)	0.027

Note: Numbers reported as frequency (percentage). *P*-values are observed from a Chi-square test. LUTS= lower urinary tract symptoms.

Table 5
Frequencies of lower urinary tract symptom type by race/ethnicity.

LUTS Type	Overall	Race Group				P-Value
		White	Black	Hispanic	Other	
N	316	104	93	108	11	
Any Storage LUTS	230 (72.8)	62 (59.6)	79 (84.9)	82 (75.9)	7 (63.6)	0.001
Any Storage LUTS w/Bother	152 (48.1)	46 (44.2)	59 (63.4)	44 (40.7)	3 (27.3)	0.003
Any Emptying LUTS	197 (62.3)	66 (63.5)	63 (67.7)	64 (59.3)	4 (36.4)	0.186
Any Emptying LUTS w/Bother	95 (30.1)	27 (26.0)	30 (32.3)	36 (33.3)	2 (18.2)	0.506
Pain/discomfort in bladder area	65 (20.6)	17 (16.3)	18 (19.4)	29 (26.9)	1 (9.1)	0.194
Pain/discomfort in bladder area w/Bother	42 (13.3)	11 (10.6)	11 (11.8)	19 (17.6)	1 (9.1)	0.433
Any LUTS	256 (81.0)	78 (75.0)	81 (87.1)	90 (83.3)	7 (63.6)	0.065
Any LUTS w/Bother	166 (52.5)	51 (49.0)	60 (64.5)	51 (47.2)	4 (36.4)	0.041

Note: Numbers reported as frequency (percentage). P-values were observed from a Chi-square test. LUTS=lower urinary tract symptoms.

storage LUTS with bother (63.4%) than Hispanic (40.7%) and White women (44.2%). There were no significant differences in reports of any LUTS, emptying LUTS or pain/discomfort in bladder area LUTS or LUTS with bother in these two categories by race/ethnicity group.

3.4. Associations between toileting behaviors and lower urinary tract symptoms

In the generalized linear models to examine relationships between TB-WEB domains and LUTS type with bother adjusting for age, BMI, history of UTI, and race/ethnicity categories, four domains were significantly associated with LUTS: Premature Voiding, Delayed Voiding, Straining, and Away Position Preference (Supplemental Table 6). Premature Voiding was associated with any bothersome LUTS (OR 2.5, 95% CI= 1.3–4.8; $p = 0.005$) and with any bothersome storage LUTS (OR 2.9, 95% CI= 1.5–5.5; $p = 0.002$). Participants who reported premature voiding often/always had 2.9 times higher odds of bothersome storage symptoms and 2.5 times higher odds to have any bothersome LUTS relative to participants who reported Premature Voiding as never/rarely.

Women who reported delayed voiding often/always had 2.8 times higher odds to report bothersome emptying symptoms (95% CI= 1.1–6.6; $p = 0.024$) relative to women who reported delaying voiding rarely/never. Those who reported straining to void often/always had 2.0 times higher odds of bothersome storage symptoms (95% CI= 1.0–3.7; $p = 0.037$), 3.7 times higher odds of bothersome emptying symptoms (95% CI= 1.9–7.3; $p < 0.001$), and 2.3 times higher odds of any bothersome LUTS (95% CI= 1.2–4.3; $p = 0.008$) relative to women who reported straining to void never/rarely. Similarly, women who reported straining to void sometimes had 2.1 times higher odds of bothersome storage symptoms (95% CI= 1.2–3.8; $p = 0.013$), 2.8 times higher odds of bothersome emptying symptoms (95% CI= 1.5–5.4; $p = 0.001$), and 1.9 times higher odds of any bothersome LUTS (95% CI= 1.1–3.4; $p = 0.030$) relative to those women who reported straining to void never/rarely.

Women who endorsed a preference for crouching, squatting, or standing, when away from home, had 2.5 times higher odds of reporting bothersome emptying symptoms (95% CI= 1.3–4.8; $p = 0.008$) and 1.8 times higher odds of reporting any bothersome LUTS (95% CI= 1.0–3.2; $p = 0.038$) relative to women who endorsed a preference for sitting when away from home. Due to nearly uniform endorsement of sitting position preference at home, there was not sufficient variability in preferences for testing associations with LUTS. Place preference for voiding was not significantly associated with LUTS.

4. Discussion

In this sample of adult women from the SHARE study, we report new findings related to women's toileting behaviors across age and race/ethnicity groups. As hypothesized, we found significant differences in toileting behaviors and LUTS across age and race/ethnicity, as well as some important relationships between specific toileting behavior domains and types of LUTS.

As expected, toileting behaviors varied across age groups. Premature voiding was lowest in the younger women and increased with age, peaking at age 55–64 years and remaining high thereafter. This is consistent with the inverse relationship between age and delayed voiding, which was reported by the majority of women in the youngest two age groups and decreased across age group to only 22% in the oldest group. These relationships may reflect women's response to the growing incidence and burden of LUTS with age. Women may be managing symptoms such as urgency and urinary incontinence by voiding before they have any sense of urge to anticipate or mitigate urgency and avoid loss of control. While our data are cross-sectional, and therefore do not infer causality, the relationships are biologically plausible. It is also possible that the learned behavior or assumption that premature voiding is a positive health habit increases over the life course.

These relationships are also consistent with our findings of an overall increase in LUTS with age, which is not novel. Half of the youngest women, and over 80% of those age ≥ 65 years, reported at least one LUTS symptom. This high prevalence of symptoms is greater than was expected for a community recruited, nonclinical sample. This may be attributable to symptomatic women being more likely to volunteer to participate in a focus group study due to their own LUTS experience and interest in the topic, as well as participants had a heightened awareness of their bladder which prompted recall of symptoms.

Analyses revealed a pattern of findings in toileting behaviors and LUTS that differed by race/ethnicity. Our interest in the examination of the data by race/ethnicity draws not only from socially constructed categories of race/ethnicity as risk factors for LUTS

(Pew Research Center, 2015; Smedley 1998), but also the potential role of racism as a mechanism by which racial categorizations have biological and behavioral consequences (Fullilove, 1998; LaVeist, 2000; Boyd et al., 2020; Umek and Fischer, 2020). We found that although all women preferred to void at home, a greater proportion of Black and Hispanic women reported this preference compared to White women. Black and Hispanic women also preferred to assume non-sitting positions when voiding away from home.

These behaviors may signify differential exposure to suboptimal toileting environments (e.g. controlled access to toilets, and/or toileting conditions that are unsafe or unsanitary) by race/ethnicity, possibly due to historical structural racism that is known to produce racially segregated neighborhoods (Rothstein, 2017; Logan et al., 2004) and barriers to bathroom access, privacy, unclean facilities, and safety concerns outside the home (Stafford and Marmot, 2003; Anderson et al., 2003). Suboptimal toileting environment or access may be an underappreciated social determinant of health that helps explain the complex pathways through which racial health inequities are produced (Norton et al., 2016) and affect bladder health. There may also be differences in health beliefs related to using toilets away from home that differ across age groups and race/ethnicity.

Our findings are consistent with a large cross-sectional cohort survey conducted with a volunteer sample of US adult women to assess the association of limiting use of the restroom in the work setting with LUTS (Reynolds et al., 2020). Investigators noted that women in the group who limited restroom use had larger proportions who described themselves as Black, other or multiple races or Hispanic; however, further analysis by race was not conducted. In the group that limited restroom use during work, most cited concerns about cleanliness of public toilets and that they regularly avoided public toilet use as their primary reasons for restricting use of the restroom during work hours. The study findings align with our suggestion that a suboptimal toileting environment may contribute to changes in toileting behaviors as an adaptive response (Camenga et al., 2019). Differences in toileting behaviors and poor access to optimal toilet environments may play a role in the higher prevalence of storage LUTS reported by Black and Hispanic women in this study.

In addition to the associations of toileting behaviors and LUTS with age and race/ethnicity, our analyses showed relationships between toileting behaviors and LUTS. Premature voiding, delayed voiding, straining, and voiding position when away from home were all associated with increased reporting of LUTS symptoms. Our findings confirm and extend earlier research on the significant relationships between toileting behaviors and LUTS reported in Chinese female nurses (Wan et al., 2017) and US women (Willis-Gray et al., 2017). In both studies, premature voiding, delayed voiding, and straining with voiding were significantly associated with LUTS or urinary incontinence. In the current study, we also found that toileting position away from home was significantly related to any LUTS with bother.

In a cross-sectional study such as this, we cannot determine whether toileting behaviors led to LUTS or whether the behaviors reflect ways to manage LUTS. Although we cannot confirm the direction of causal relationships, it is plausible that chronic delayed voiding over time could stretch the bladder beyond its optimal capacity, resulting in bladder dysfunction and LUTS. Further, the implications of crouching/squatting or standing to void among women are not completely understood; but these positions may inhibit pelvic floor relaxation, such that voiding dynamics are altered, contributing to LUTS over time. Exploring other factors that, such as employment status, class and housing security that influence voiding position may reveal modifiable behaviors and environmental factors that can be addressed through public health interventions.

5. Strengths and limitations

Strengths of the study include its community-based recruitment strategy, a diverse participant sample across both sociodemographic factors and LUTS status, use of a validated instrument to measure toileting behaviors, and a standardized assessment of storage, emptying, and pain/discomfort symptoms.

The study has several limitations. First, we used a cross sectional design where causality and the direction of the relationships between toileting behaviors and LUTS cannot be confirmed. However, the findings suggest hypotheses about causal relationships that could be tested in future longitudinal studies of risk and protective factors for bladder health in women. Second, findings reflect the toileting behaviors and LUTS of the SHARE focus group participants recruited through the PLUS Consortium's clinical research centers, who may not be representative of all women. Our findings cannot be generalized to a particular population because our sampling and recruitment process was based on a consecutive series of volunteers. Third, completion of the toileting behavior and LUTS instruments occurred after the focus group discussion, which may have influenced recall of toileting behaviors and LUTS. Finally, analyses were limited by small cell sizes for some age and race/ethnicity groups and for those with no LUTS. Despite these limitations, this study provides unique insights into toileting behaviors and its relationship to LUTS in diverse women.

6. Implications for future research

Future studies are needed on access to public toilets as a social determinant of health. Substantial research has provided evidence of racial differences in access to safe, walkable public space (Powell et al., 2006), and resources such as supermarkets, but little is known about racial inequities in access to safe public toilets (Moore and Diez Roux, 2006). In addition, research is to explore potential sociocultural influences, neighborhood context (Gasteyer et al., 2016), learned behavior, access to variations in the built environment and potential concerns about safety of public toilet seats.

Qualitative research is needed to explore racial/ethnic differences found in this study. Systemic racism and discrimination towards women of color may play a role in women's toileting experiences and behaviors when away from home. Transdisciplinary research exploring the intersection of racism and toileting behaviors is important to better understand the mechanisms underlying these associations.

Longitudinal research is also needed to understand the trajectory of LUTS across the lifespan and the nature of the relationship between toileting behaviors and LUTS. Improved understanding of the role of age-related changes and medical comorbidities, as well as the effect of older adults' social context that may drive certain toileting behaviors is also needed to inform future interventions.

7. Conclusions

This study provides evidence that toileting behaviors and LUTS vary across age and race/ethnicity groups and that there are strong relationships between specific toileting behavior domains and LUTS. Further research is necessary to understand the underpinnings of racial disparities and the mechanisms by which toileting behaviors might influence the development of LUTS over time. This work is important for the development of future public health interventions to encourage healthy toileting behaviors and equitable access to toileting environments that support bladder health. Nurses play an important role as advocates for policies for toilet access and optimal environments to ensure toileting parity for women.

Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium

Current Research Centers and Investigators

Loyola University Chicago - Maywood, IL

Multi-Principal Investigators: Linda Brubaker, MD; Elizabeth R. Mueller, MD, MSME

Investigators: Marian Acevedo-Alvarez, MD; Colleen M. Fitzgerald, MD, MS; Cecilia T. Hardacker, MSN, RN, CNL; Jeni Hebert-Beirne, PhD, MPH; Missy Lavender, MBA; David A. Shoham, PhD, MSPH.

Northwestern University – Chicago, IL

Multi-Principal Investigators: Kimberly Sue Kenton, MD; James W. Griffith, PhD; Melissa Simon, MD, MPH; Investigator: Patricia I. Moreno, PhD.

University of Alabama at Birmingham - Birmingham, AL

Principal Investigator: Alayne D. Markland, DO, MSc

Investigators: Tamera Coyne-Beasley, MD, MPH, FAAP, FSAHM; Kathryn L. Burgio, PhD; Cora E. Lewis, MD, MSPH; Gerald McGwin, Jr., MS, PhD; Camille P. Vaughan, MD, MS; Beverly Rosa Williams, PhD.

University of California San Diego - La Jolla, CA

Principal Investigator: Emily S. Lukacz, MD

Investigators: Sheila Gahagan, MD, MPH; D. Yvette LaCoursiere, MD, MPH; Jesse Nodora, DrPH.

University of Michigan - Ann Arbor, MI

Principal Investigator: Janis M. Miller, PhD, APRN, FAAN

Investigators: Lawrence Chin-I An, MD; Lisa Kane Low, PhD, CNM, FACNM, FAAN.

University of Minnesota - Minneapolis MN

Multi-Principal Investigators: Bernard L. Harlow, PhD; Kyle D. Rudser, PhD

Investigators: Sonya S. Brady, PhD; Haitao Chu, MD, PhD; John Connett, PhD; Melissa L. Constantine, PhD, MPAff; Cynthia S. Fok, MD, MPH; Todd Rockwood, PhD.

University of Pennsylvania – Philadelphia, PA

Multi-Principal Investigators: Diane K. Newman, DNP FAAN; Ariana L. Smith, MD; Investigators: Amanda Berry, PhD, CRNP; C. Neill Epperson, MD; Heather Klusaritz, PhD, MSW; Kathryn H. Schmitz, PhD, MPH, FACSM, FTOS; Ann E. Stapleton, MD; Terri Lipman PhD; Jean F. Wyman, PhD.

Washington University in St. Louis - Saint Louis, MO

Principal Investigator: Siobhan Sutcliffe, PhD, ScM, MHS; Investigators: Aimee S. James, PhD, MPH; Jerry L. Lowder, MD, MSc; Melanie R. Meister, MD, MSCI.

Yale University - New Haven, CT

Principal Investigator: Leslie M. Rickey, MD, MPH; Investigators: Marie A. Brault, PhD (Dec. 2020); Deepa R. Camenga, MD, MHS; Shayna D. Cunningham, PhD.

Steering Committee Chair: Linda Brubaker, MD. Past Steering Committee Chair: Mary H. Palmer, PhD, RN; University of North Carolina, Chapel Hill, NC. (2017–2020)

NIH Program Office: National Institute of Diabetes and Digestive and Kidney Diseases, Division of Kidney, Urologic, and Hematologic Diseases, Bethesda, MD.

NIH Project Scientist: Julia Barthold, M.D. Past NIH Project Scientist: Tamara Bavendam MD, MS (2017- 2020)

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Declaration of Competing Interest

None.

Supplementary materials

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