Association of menopausal status and hormone use with bladder health and lower urinary tract symptoms in US women: results from the RISE FOR HEALTH study

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Abstract

Objectives: Most previous studies of genitourinary symptoms associated with menopause focus on comparisons of postmenopausal to premenopausal women and less is known about bladder health during menopause. We evaluated associations of menopause status and hormone use with bladder health and lower urinary tract symptoms (LUTS).

Methods: Data were collected from May 2022 to December 2023 from a regionally representative cohort of community-dwelling adult women in the United States. Bladder health and LUTS were measured using validated questionnaires. Analyses included multivariable linear and logistic regression models.

Results: Of 3,423 eligible participants, 3,126 responded to menopause and hormone use questions. Of these, 1,226 were premenopausal, 260 perimenopausal, and 1,640 postmenopausal.

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Premenopausal women reported hormone use more often than perimenopausal or postmenopausal women (38.3% vs. 21.5%and 13.2%). Across multiple bladder health scales (BHS, range 0-100) and bladder function indices (BFI, range 0-100), perimenopause and postmenopause status were associated with worse scores compared with premenopause status. Perimenopausal women were more likely to report urgency UI [OR 2.27, (95% CI: 1.49-3.46)] and other LUTS compared to premenopausal women. Hormone use was associated with worse bladder health in postmenopausal women [postmenopause/hormone -6.0 Overall BHS, (95% CI: -9.8 to -2.2)] and BFI [postmenopause/hormone BFI -4.8, (95% CI: -7.4 to -2.2)].

Conclusions: Promotion of bladder health and LUTS prevention is important as women approach the menopause transition. Hormone use was infrequently reported in perimenopausal and postmenopausal women and was associated with worse bladder health postmenopause.

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he menopause transition is associated with systemic symptoms of hot flashes and night sweats. In addition, local genitourinary symptoms (GUS) of urinary urgency, frequency, and dysuria are common. However, most studies focus on comparisons of postmenopausal women to premenopausal women, and less is known about bladder health during the menopause transition, often referred to as perimenopause. Lower urinary tract symptoms (LUTS) of incontinence and urinary tract infections increase with age, affecting ~60% of US women.^{1,2} While the menopause transition is a normal part of aging, worldwide estimates of moderate to severe vasomotor symptoms range from 12% to 40% and for GUS from 13% to 87%.³⁻⁵ Hormone therapy is commonly prescribed, either systemically or locally, as treatment or prevention of these symptoms. However, evidence suggests that systemic hormones may be associated with higher rates of incontinence than placebo while local low dose therapy is associated with improvement in GUS and urinary tract infections.1

Because associations of menopausal status and hormone use with bladder health or disease are not well established, we sought to examine the relationships between menopausal status with and without hormone use on overall bladder health, and prevalence of LUTS among women enrolled in a US population-based study. We expected worse bladder health and more urinary symptoms among perimenopausal and postmenopausal women compared with premenopausal women. Based on prior studies suggesting hormone use is associated with increased prevalence of urinary incontinence, we hypothesized that hormone use would be associated with worse bladder health in perimenopausal and postmenopausal women compared with premenopausal and postmenopausal women compared with premenopausal women with or without hormone use.

METHODS

Study population and design

The RISE FOR HEALTH study, conducted by the Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium, is an ongoing regionally representative cohort study of US women to identify factors positively and negatively associated with bladder health and LUTS across the lifespan. Study design and procedures were published previously.⁶ Women residing in one of 50 counties surrounding nine university research centers were selected from a marketing database using simple and stratified probability sampling by age and race/ethnicity to achieve a regionally representative sample by these factors. Participants were invited to complete two 30-minute baseline surveys via a web portal; those who did not complete online surveys were mailed paper versions on

two separate occasions. Eligibility included (1) birth as female or identification as cis-woman; (2) age 18 years or above; and (3) the ability to complete the surveys independently in English or Spanish. Individuals consented by completing the initial baseline survey from May 2022 through December 2023. The University of Minnesota Institutional Review Board (IRB) served as the single IRB of record.

The present analysis includes individuals who participated in the baseline survey and provided complete information on their age, self-reported menopausal status and hormone use.

Bladder health assessment

Bladder health was assessed using the validated PLUS Bladder Health Scales (BHS) and Bladder Function Indices (BFI).⁷ There are 10 scales covering global bladder health, holding, urination, social-occupational, physical activity, intimacy, travel, emotion, perception, and freedom. An adaptive behavior adjustment (ABA) is utilized to account for self-reported coping behaviors that affect individual variations between symptom severity and quality of life. The ABA includes use of absorbent products and toilet mapping.⁸ BFI consists of 6 items assessing dysbiosis (eg, urinary tract infection), frequency, sensation, continence, comfort, and emptying. These items were developed and evaluated as indices to assess periodicity, resilience, interference, and relative change in functions.

Scoring for the 10 BHS, 6 BFI, and ABA requires that > 50% of the items within a scale be completed. The ABA value is the sum of behavior items and confidence indicators associated with each behavior. Adjusted BHS scores were used for analyses and range from 0 to 100, with zero representing the most unhealthy and 100 representing optimal health.⁷ The 6 individual BFIs were scored as the sum of index items within a domain, from 0 to 100, with higher values indicating better bladder function for that particular BFI domain. A total BFI score was created by taking the mean of the 6 individual BFI scores. The different domains of the BHS and BFI are reported as means \pm SDs (possible range, 0-100).

LUTS assessment

LUTS were assessed using the 10-item symptoms of Lower Urinary Tract Dysfunction Research Network Symptom Index (LURN SI-10), which is a brief validated instrument that measures the frequency of 10 clinically significant LUTS including storage, voiding/emptying, and pain with bladder filling within the preceding 7 days.⁹ Most items are assessed on scales from 0 ("never") to 4 ("every time"), except for daytime (≤ 3 , 4-7, 8-10, ≥ 11 times/day) and nighttime (none, 1, 2-3, > 3 times/night) urination frequency. For this analysis, we dichotomized symptoms based upon women reporting individual LUTS at least 50% or more of the time in the preceding 7 days, or daytime frequency ≥ 10 times/day, or nighttime frequency ≥ 3 times/night.

Menopause status

Menopause status was based on the question, Are you premenopausal (have not gone through menopause/ the change of life), perimenopausal (going through menopause), postmenopausal [have gone through menopause (no period in 12 or more months) or had both of your ovaries removed].

Current hormone use

Hormone use was determined based on responses to questions assessing current vaginal estrogen and systemic menopausal hormone therapy. Among premenopausal and perimenopausal participants, hormone use also included reporting current use of oral contraceptives, vaginal estrogen ring, hormonal intrauterine device, or hormone-containing patch. Women reporting the use of a copper intrauterine device, diaphragm for contraception, or vaginal gel, in addition to reporting none of the hormone products previously described, were identified as non-hormone users.

Covariates

Covariates were selected based on their potential influence on the association between menopause and bladder function. Covariates included parity/delivery status, current pregnancy, body mass index, number of medical comorbidities, educational attainment, marital status, and income. Based on clinical interest in whether hormone use might modify the association between menopause and bladder function, we also evaluated sociodemographic factors such as income and employment status that could affect access to hormone therapy options. Age is reported to describe the cohort; however, age was not included in multivariable models based on the significant correlation between age and menopausal status.¹⁰

Statistical analysis

Descriptive statistics were used to compare sociodemographic and clinical characteristics across groups defined by self-reported menopausal status (ie, premenopausal, perimenopausal, and postmenopausal).

Separate models regressed BHS and BFI scores on hormone use, stratified by menopausal status. Forest plots of BHS and BFI adjusted mean scores were generated to demonstrate the range of responses by hormone use within menopausal status categories. To describe the distribution of clinically significant LUTS, we reported the proportion of individuals reporting symptoms "about half the time or more." Daytime and nighttime voiding frequencies were reported based on ordinal categories to differentiate normal frequencies from frequencies that are often associated with increased bother. Linear regression was used for the BHS and BFI, the total LURN SI-10 measures with adjustment for covariates, and logistic regression was used for the individual symptoms. Multivariable models regressed individual LUTS and the global LURN SI-10 score on menopausal status groups among the total sample. For these analyses, premenopausal women served as the reference group.

RESULTS

Within our analytic sample of 3,126 women, 1,226 were identified as premenopausal, 260 as perimenopausal, and 1,640 were classified as postmenopausal (Table 1). Distributions by age appropriately reflected these menopausal status categories. As shown in Table 1, our sample comprised 361 (11.5%) Black women, 174 (5.6%) Asian women, 425 (13.6%) Hispanic women, 1.984 (63.5%) White women, and 182 (5.8%) women of mixed race, race not stated or responses in a combined category including n=9 women who reported American Indian or Alaska Native, n = 12 who reported Middle Eastern or North African, n = 4 women who reported Native Hawaiian or Other Pacific Islander, and three free text responses of Ashkenazic, Middle East, and North African. Premenopausal women were more highly educated, less likely to be married, and more likely to be nulliparous. Postmenopausal women were less likely to be employed, more likely to be divorced, separated, or widowed, and reported greater history of hysterectomy and other comorbidities. There were no meaningful differences in self-reported general health by menopausal status. In addition, no meaningful differences in household income, region of residence, or body mass index were seen by menopausal status. Any use of hormones was more prevalent among premenopausal women, with 38.3% reporting use while 21.5% of perimenopausal and 13.2% of postmenopausal women reported current hormone use.

Examining Bladder Health Scales, we noted little difference in bladder health scores across all the scales by use of hormones in premenopausal women (Fig. 1). However, in both perimenopausal and postmenopausal women, the use of hormones was associated with lower bladder health scores across virtually all scales. When we assessed associations between hormone use and BFI, we again saw no difference in scores by hormone use among premenopausal women (Fig. 2). However, among postmenopausal women, hormone use was associated with lower scores across all BFI relative to nonusers. Among perimenopausal women, hormone use was associated with lower scores in the domains of frequency, sensation, and emptying among hormone users relative to nonhormone users.

As shown in Table 2, BHS and BFI scores did not differ by hormone use among premenopausal women. The magnitude of the BHS mean score differences between hormone users and nonusers in perimenopausal women ranged from 3 to 8 points on a 100-point bladder health scale but was statistically significant only for the urination scale. The overall difference was a 5.3-point lower score. Hormone use versus nonuse in postmenopausal women was associated with mean BHS score differences ranging from 5 to 6 points lower and virtually all differences were statistically significant. Among perimenopausal women, hormone use versus nonuse was associated with a trend toward lower mean BFI, including a 9-point lower functional index score for emptying, a 7-point lower score for frequency, and 5.5-point lower score for sensation (Table 2); however, only the frequency index reached

	Premenopause N (%) N = $1,226$	N (%) N = 260	Postmenopause N (%) N = $1,640$			
Age group						
18-25	325 (26.5)	1 (0.38)	2 (0.12)			
26-44	732 (59 7)	17 (6 5)	14 (0.85)			
45-59	169 (13.8)	203 (78.1)	352 (21.5)			
60+	0	30 (15.0)	1 272 (77.6)			
	0	53 (15.0)	1,272 (77.0)			
Arian	77 (6 2)	15 (5 9)	82 (5.0)			
Asian	// (6.3)	15 (5.8)	82 (5.0)			
Black or African American	117 (9.5)	50 (19.2)	194 (11.8)			
White	693 (56.5)	150 (57.7)	1,141 (69.6)			
Hispanic	247 (20.2)	32 (12.3)	146 (8.9)			
Other race ^b or multiple races	67 (5.5)	5 (1.9)	32 (2.0)			
Unknown	25 (2.0)	8 (3.1)	45 (2.7)			
ducation						
< High School Graduate	94 (77)	29 (11 2)	265 (16.2)			
Some College/Votech/Associate degree	164 (13.4)	43 (16 5)	301(184)			
Bashalar'a damaa	512 (41.9)	72 (29.1)	422 (25.9)			
Canduate Degree	215 (25.7)	73 (28.1)	425 (25.8)			
Graduate Degree	515 (25.7)	/2 (2/./)	395 (24.1)			
Missing	6 (0.49)	3 (1.2)	24 (1.5)			
larital status						
Married	463 (37.8)	163 (62.7)	927 (56.5)			
Divorced/separated/widowed	52 (4.2)	52 (19.6)	503 (30.7)			
Unmarried w/partner	119 (9.7)	9 (3.5)	47 (2.9)			
Single	556 (45.4)	29 (11.2)	116 (7.1)			
Other	4 (0.33)	1 (0.38)	23(14)			
Missing	4 (0.33)	1 (0.38)	23(1.4)			
wissing	4 (0.55)	1 (0.58)	25 (1.4)			
	550 ((1.0)	160 (61.5)	102 (21.5)			
(1) Full-time employed	/59 (61.9)	160 (61.5)	402 (24.5)			
(2) Part-time employed	199 (16.2)	36 (13.9)	177 (10.8)			
(3) Unemployed/retired/student/other or missing	6 (0.49)	28 (10.8)	864 (52.7)			
ousehold income						
< 25,000	101 (8.2)	19 (7.3)	175 (10.7)			
25.000-49.999	181 (14.8)	28 (10.8)	250 (15.2)			
50 000-74 999	150 (12.2)	32 (12 3)	205 (12 5)			
75,000,00,000	153 (12.2)	35 (12.5)	182 (11.1)			
100,000,140,000	212 (17.4)	33 (13.3)	227 (12.8)			
150,000-149,999	213 (17.4)	37 (14.2)	227 (13.8)			
150,000 or more	221 (18.0)	68 (26.2)	225 (13.7)			
DK/not reported	207 (16.9)	41 (15.8)	376 (22.9)			
ody mass index (BMI)						
Underweight (<18.5 kg/m ²)	30 (2.5)	4 (1.5)	29 (1.8)			
Healthy weight (18.5 to $< 25 \text{ kg/m}^2$)	474 (38.7)	82 (31.5)	534 (32.6)			
Overweight (25 to $< 30 \text{ kg/m}^2$)	289 (23.6)	70 (26.9)	439 (26.8)			
Obese $(30 \pm kg/m^2)$	389 (31 7)	86 (33.1)	517 (31 5)			
Unknown	44 (3.6)	18 (6 0)	121 (7 A)			
onknown	++ (3.0)	10 (0.9)	121 (7.4)			
arity/delivery		105 (11.2)				
Nulliparous	7/1 (62.9)	107 (41.2)	535 (32.6)			
l vaginal parity	82 (6.7)	22 (8.5)	134 (8.2)			
2 vaginal parity (or 1 vaginal delivery /1 C-section	149 (12.2)	49 (18.9)	389 (23.7)			
delivery)						
3 vaginal parity or more (at least 1 vaginal delivery)	112 (9.1)	41 (15.8)	352 (21.5)			
C-section only deliveries	108 (8 8)	39 (15 0)	164 (10.0)			
ny hysterectomy	100 (0.0)	55 (15.0)	101 (10.0)			
Vac	31 (2.5)	18 (19 5)	145 (27.1)			
105	51 (2.3)	40 (18.3)	445 (27.1)			
Eneral nearth status	155 (12.0)	20 (11 5)	101 (11.0)			
Excellent/very good	155 (12.6)	30 (11.5)	181 (11.0)			
Good	417 (34.0)	98 (37.7)	596 (36.3)			
Fair	111 (9.1)	22 (8.5)	185 (11.3)			
Poor	15 (1.2)	2 (0.77)	18 (1.1)			
omorbidities (%) ^c	. /		× /			
0	520 (42 4)	87 (33 5)	261 (15.9)			
1	265 (21.6)	43 (16 5)	201 (13.7)			
2	203 (21.0)	55 (21.2)	520 (19.5) 202 (19.5)			
2 2	255 (20.8)	33 (21.2)	303 (18.5)			
3	99 (8.1)	29 (11.2)	246 (15.0)			
÷.	86 (7.0)	46 (17.7)	509 (31.0)			
ny current hormone use	469 (38.3)	56 (21.5)	216 (13.2)			
ny current/previous bladder specific treatment ^d	34 (2.8)	19 (7.3)	174 (10.6)			

DK, don't know.

^aExcludes 3 women missing age, 266 women missing menopausal status, and 28 women missing hormone use.

^hOther race category includes the following responses that were combined for this table: American Indian or Alaska Native n = 9; Middle Eastern or North African n = 12, Native Hawaiian or Other Pacific Islander n = 4; Free text responses of Ashkenazic, Middle East, North African

⁶Comorbidities include: diabetes, hypertension, congestive heart failure, chronic obstructive pulmonary disease, osteoarthritis, inflammatory arthritis, sleep apnea, kidney failure, depression, anxiety, and neurologic disease. Neurologic disease was yes/no for any of the following: cerebral palsy, Parkinson disease, multiple sclerosis, spinal stenosis, spinal disc disease, spinal nerve damage, sciatica, stroke, and spina bifda.

bladder symptoms.



FIG. 1. Adjusted^a mean scores among Bladder Health Scale and Subscales among users and nonusers of hormones stratified by menopausal status. ^aAdjusted for parity/delivery status (reference is nulliparous), currently pregnant, body mass index, comorbidity count (0, 1, 2, 3, 4+), education (4 categories), marital status (5 categories), and income (7 categories).

statistical significance. Among postmenopausal women, hormone use versus nonuse was associated with significantly lower scores across all BFI, except sensation, with a range from 5.1 to 6.2-point lower scores. Supplementary Tables 1 and 2, Supplemental Digital Content 1, http://links.lww.com/MENO/B360 show the numerical data corresponding with Figures 1 and 2 related to bladder health and bladder function among hormone users and nonusers stratified by menopausal status.

Table 3 shows the association of menopausal status with LURN SI-10 symptoms. Perimenopausal women were 1.5-2.3 times more likely to experience urgency, urgency urinary incontinence, stress urinary incontinence, or urological pain 50% or more of the time in the preceding 7 days compared with premenopausal women. The 95% CIs across all risk estimates showed statistical significance. Furthermore, perimenopausal women were 2.3 times more likely to void 3 or more times per night (95% CI: 1.2-4.5) compared with premenopausal women. Among postmenopausal women, there was a trend toward increased prevalence of urgency urinary incontinence (OR = 1.3, 95% CI: 0.9-1.8), and a significantly greater prevalence of voiding more than 3 times per night (OR = 1.9, 95% CI: 1.2-3.2) compared with premenopausal women.

We assessed the distribution of the same LURN SI-10 symptoms among hormone users and nonusers within menopausal status groups (Table 4). The prevalence of LURN symptoms in the preceding 7 days 50% or more of the time, or excessive daytime and nighttime voiding, did not vary by hormone use among premenopausal or postmenopausal women. However, among perimenopausal and postmenopausal women, the prevalence of urgency, urgency UI, and stress urinary incontinence symptoms occurring 50% or more of the time in the preceding 7 days was reported more often among hormone users; however, no within-group comparisons reached statistical significance.



FIG. 2. Adjusted^a mean scores among Bladder Function Indices among users and nonusers of hormones stratified by menopausal status. ^aAdjusted for parity/delivery status (reference is nulliparous), currently pregnant, body mass index, comorbidity count (0, 1, 2, 3, 4+), education (4 categories), marital status (5 categories), and income (7 categories).

	Premenopausal (N = 1,226)		Perimenopau	sal (N = 260)	Postmenopausal (N = 1,640)		
	No current hormonal use n = 757	Current hormonal use n = 469	No current hormonal use n = 204	Current hormonal use n = 56	No current hormonal use n = 1,424	Current hormonal use n = 216	
Covariates	Least square mean difference (95% CI)		Least square mean difference (95% CI)		Least square mean difference (95% CI)		
Bladder Health Scales							
1 Overall bladder health	0.2 (-2.4 to 2.9)		-5.3 (-13.4 to 2.8)		-6.0 (-9.8 to -2.2)		
2 Holding	2.4 (-0.5 to 5.3)		-4.2 (-13.1 to 4.7)		-4.4 (-8.5 to -0.3)		
3 Urination	2.6(-0.1 to 5.2)		-8.1 (-16.0 to -0.3)		-5.8(-9.6 to -2.1)		
4 Social/occupational	2.1 (-0.	2.1 $(-0.7 \text{ to } 4.7)$		-5.9(-14.9 to 3.1)		-4.5(-8.5 to -0.4)	
5 Physical activity	1.5 (-1.	5 to 4.5)	-4.7 (-14.0 to 4.6)		-4.4 (-8.8 to 0.1)		
6 Intimacy	1.7 (-1.	1 to 4.6)	-5.4 (-14.6 to 3.9)		-5.9 (-10.1 to -1.7)		
7 Travel	0.7 (-2.	2 to 3.7)	-5.9 (-14.8 to 3.0)		-4.6 (-8.8 to -0.4)		
8 Emotion	1.8 (-1.	2 to 4.7)	-4.3 (-13.8 to 5.1)		-5.6 (-9.8 to -1.4)		
9 Perception	2.0(-1.0 to 5.1)		-7.5 (-16.7 to 1.7)		-5.5 (-9.6 to -1.3)		
10 Freedom	1.8 (-1.	1.8 (-1.0 to 4.6)		2.4 to 5.6)	-5.0 (-9.1 to -0.9)		
Bladder Function Indices							
Total Average Score	-0.1 (-2	.1 to 1.9)	-3.4 (-9	.1 to 2.4)	-4.8 (-7.4	4 to -2.2)	
Comfort	0.4 (-2.	0.4 (-2.5 to 3.3)		1.0 (-7.4 to 9.4)		-5.1 (-8.7 to -1.5)	
Frequency	-1.3 (-4	.3 to 1.8)	-6.9 (-1:	5.3 to 1.4)	-5.4 (-9.2	2 to -1.5)	
Sensation	0.5 (-2.	0.5 (-2.4 to 3.5)		-5.5 (-13.5 to 2.5)		0 to 0.3)	
Emptying	0.3 (-2.	0.3 (-2.8 to 3.4)		-9.3 (-17.7 to -1.0)		3 to -1.7)	
Continence	-0.3 (-3	.1 to 2.5)	0.3 (-7.	4 to 8.0)	-3.6 (-6.9	9 to -0.3)	
Bios/UTI history	-0.4 (-2	.9 to 2.1)	-2.0 (-9	.3 to 5.3)	-6.2 (-9.0) to -3.4)	

TABLE 2. Adjusted^{*a*} mean score differences^{*b*} for all Bladder Health Scales and Bladder Function Indices between users and nonusers of hormones stratified by menopausal status.

UTI, urinary tract infection.

^aAdjusted for parity/delivery status (reference is nulliparous), currently pregnant, body mass index, comorbidity count (0, 1, 2, 3, 4+), education (4 categories), marital status (5 categories), and income (7 categories).

^bNegative values indicate lower bladder health

DISCUSSION

Among women in this cross-sectional analysis of the RISE FOR HEALTH study, we found associations between bladder health, bladder function, and LUTS according to menopausal status and hormone use. Our data show that perimenopausal and postmenopausal women reported worse bladder health and bladder function scores compared with premenopausal women and perimenopausal women were more likely to report multiple LUTS compared with premenopausal women. Additionally, among perimenopausal and postmenopausal women, current use of hormones was associated with reporting worse bladder health and bladder function as well as more LUTS.

In the RISE FOR HEALTH cross-sectional analysis, perimenopausal status was more consistently associated with LUTS relative to premenopausal women than postmenopausal status relative to premenopausal women. At least two longitudinal cohort studies have reported similar findings. Compared with premenopausal women in the Study of Women Across the Nation (SWAN), early perimenopausal women were 30% more likely, and late perimenopausal women were 50% more likely to develop monthly or more frequent incontinence.¹¹ In contrast,

FABLE 3. Association between menopausal status and LUTS.								
	Premenopausal N = 1,226		Perimenopausal N = 260		Postmenopausal N = 1,640			
LURN symptoms \geq 50% of time	n (%)	Reference	n (%)	OR ^a (95% CI)	n (%)	OR ^a (95% CI)		
Urgency	181 (14.9)	1.0	60 (23.3)	1.50 (1.05-2.14)	346 (21.4)	1.03 (0.80-1.34)		
Urgency UI	81 (6.7)	1.0	46 (17.8)	2.27 (1.49-3.46)	239 (14.8)	1.31 (0.95-1.81)		
Stress UI	69 (5.7)	1.0	39 (15.1)	2.00 (1.28-3.13)	152 (9.4)	0.88 (0.61-1.26)		
Pain	50 (4.1)	1.0	21 (8.2)	1.91 (1.06-3.45)	37 (2.3)	0.39 (0.22-0.67)		
Daytime voiding ≥ 10 times/day	49 (4.1)	1.0	19 (7.7)	1.72 (0.96-3.11)	72 (4.8)	0.97 (0.60-1.55)		
Nighttime voiding ≥ 3 times/night	29 (2.4)	1.0	16 (6.2)	2.29 (1.16-4.51)	106 (6.5)	1.94 (1.15-3.26)		

LURN, lower urinary tract research network; LUTS, lower urinary tract symptoms; UI, urinary incontinence.

^aAdjusted for parity/delivery status (reference is nulliparous), currently pregnant, body mass index, comorbidity count (0, 1, 2, 3, 4+), education (4 categories), marital status (5 categories), and income (7 categories).

LURN symptoms \geq 50% of the time in the last 7 d	n (%)					
	Premenopausal N = 1,226		Perimenopausal N = 260		Postmenopausal N = 1,640	
	No hormone $n = 757$	Any hormone n = 469	No hormone n = 204	Any hormone n = 56	No hormone $n = 1,424$	Any hormone n = 216
Urgency	111 (14.8)	70 (15.0)	42 (19.6)	18 (32.1)	304 (21.7)	42 (19.6)
Urgency UI	52 (6.9)	29 (6.2)	33 (16.3)	13 (23.2)	214 (15.3)	25 (11.6)
Stress UI	47 (6.2)	22 (4.7)	28 (13.9)	11 (19.6)	130 (9.3)	22 (10.3)
Pain	35 (4.7)	15 (3.2)	16 (7.9)	5 (9.1)	31 (2.2)	6 (2.8)
LURN voiding					. ,	
Daytime voiding ≥ 10 times/day	34 (4.6)	15 (3.3)	14 (7.3)	5 (9.3)	63 (4.8)	9 (4.5)
Nighttime voiding ≥ 3 times/night	17 (2.3)	12 (2.6)	11 (5.4)	5 (8.9)	87 (6.2)	19 (8.8)

TABLE 4. Distribution of LUTS among women who did and did not use hormones stratified by menopausal status.^a

LURN, lower urinary tract research network; UI, urinary incontinence.

^aNo comparisons are statistically significant within each hormone status group.

postmenopausal women were approximately half as likely to develop this degree of incontinence.¹¹ In the British National Survey of Health and Development (NSHD) cohort, women who became perimenopausal ("pre-peri") or those experiencing perimenopause for > 1 year ("peri-peri") were more likely to have symptoms of stress urinary incontinence than were postmenopausal women.¹⁰ Menopause transition status was not associated with urgent urinary incontinence. Although this lends support to the idea that perimenopausal status may pose a distinct period of risk for the experience of LUTS, at least two longitudinal cohort studies have found no association between menopausal status and development of urinary incontinence.^{12,13}

Other cross-sectional studies have found urinary incontinence or LUTS to be more broadly prevalent among postmenopausal than perimenopausal women, more prevalent among perimenopausal than postmenopausal women, or not different between perimenopausal and postmenopausal women.¹³⁻¹⁹ Additional research is needed to understand the differences in urinary incontinence and LUTS between perimenopausal and postmenopausal women.

The role of hormone therapy in mitigating LUTS remains controversial. While studies have shown that systemic hormone therapy could exacerbate urinary symptoms, especially urinary incontinence, localized vaginal estrogen therapies have shown promise in alleviating overactive bladder symptoms and other genitourinary symptoms of menopause.¹ Legendre et al²⁰ supported this view by suggesting that different administration routes of estrogen can have contrasting effects on urinary incontinence, emphasizing the necessity for personalized treatment strategies. Results from the RISE FOR HEALTH study are crosssectional and thus causality cannot be determined. Women with a greater burden of LUTS or worse bladder health may be more likely to use hormone therapy as a potential treatment; however, it is notable that less than a third of women in the RISE FOR HEALTH study reported current hormone use.

While the current literature provides valuable insights, several gaps remain. Notably, the impact of specific risk factors across the lifespan, such as obesity, smoking, and physical activity, on the development of LUTS and reduced bladder health during menopause requires further exploration. Moreover, longitudinal studies could enhance our understanding of how urinary symptoms evolve over the menopause transition, rather than relying solely on cross-sectional data. Only a small number of cohort studies have followed a cohort of women across the menopause transition and determined the impact on LUTS, such as the Study of Women's Health Across the Nation. Recruitment strategies focused on enrolling a cohort of women that is representative of the broader US population also facilitates evaluation of factors that may differentially affect women experiencing health disparities.^{11-13,21}

Strengths of the current study include its sample of adult women representative of the regional demography that reflects much of the US population. The cohort also includes many women in the perimenopausal period, permitting robust estimates of bladder health and LUTS among women in different stages of the menopause transition. A validated questionnaire to assess urinary symptoms and the use of a brief self-reported menopausal status question permit a novel assessment of how these conditions may relate to bladder health across the lifespan of adult women. A limitation of the current evaluation includes the cross-sectional design, which does not permit an assessment of causality. Data collection for a longitudinal phase of the RISE FOR HEALTH study is in progress. It is possible that selfreported hormone use and menopausal status could lead to misclassification. The analysis of hormone data includes only current use, which does not provide an assessment of whether former use is associated with urinary symptoms or bladder health. The lack of statistical significance across the bladder health scales by hormone use in perimenopausal women is likely due to sample size issues related to the number of perimenopausal women in our sample. The minimum important difference between the BHS and BFI has not been established so we are not able to determine whether statistically significant associations between hormone users and nonusers are clinically meaningful.

CONCLUSIONS

The association between menopausal status and bladder health and function is complex and multifaceted. Based on our findings, efforts to promote bladder health and prevent LUTS should target women before the menopausal period. More focus on premenopausal and perimenopausal women may be warranted for symptom assessment, screening in primary care, and prevention interventions. While it is not possible to determine the directionality of the association between hormone use and bladder health and LUTS, these results do not support routine recommendations for hormone use in the perimenopausal and postmenopausal periods. Future research should continue to investigate the nuances of this relationship, enabling more effective prevention and management strategies for women with and without LUTS before and during menopause.

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