



Daily symptom associations for urinary urgency and anxiety, depression and stress in women with overactive bladder

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Abstract

Introduction and hypothesis Women with overactive bladder (OAB) report psychological distress, anxiety and depression, but short-term associations between these symptoms are poorly studied. Our objectives were to study daily associations between OAB symptoms and psychological symptoms and test whether these associations were stable when reassessed after 3 months. We hypothesized that OAB symptoms are positively associated with anxiety and depression symptoms over a short-term (daily) basis.

Methods Female patients with OAB [bothersome urgency and/or urgency urinary incontinence (UUI)] assessed OAB and mood symptoms at baseline and 3 months using a 3-day bladder diary and visual analog scale (VAS) ratings (0–100 mm) for anxiety, depression and stress. Daily OAB and mood symptom associations were tested using Spearman correlations. Generalized estimating equation (GEE) models tested associations between daily urgency scores and each psychological rating adjusting for covariates, time and a time-symptom interaction term.

Results Participants ($n=69$) had mean (SD) age 63.3 (13.4) years. Baseline diary outcomes [median (IQR)/day] included day voids 8 (7–11), nocturia 0 (0–1), UUI episodes 1 (0–3) and urgency score 1.75 (1–2.25). Anxiety and depression diagnoses (dx) and treatment (tx) were common (anxiety dx 30.4%, tx 21.7%; depression dx 47.8%, tx 37.7%), but daily anxiety, depression and stress ratings were low [median (IQR) mm 10 (3–35), 5 (1–16), and 16 (4–39), respectively]. Daily urgency scores correlated with anxiety ($r=0.30$ – 0.40 , days 1–3, $p\leq 0.01$ for all), depression ($r=0.24$ – 0.35 , $p\leq 0.05$ all) and stress ($r=0.27$ – 0.34 , $p\leq 0.03$ all). GEE models indicated no significant change in these associations between baseline and 3 months, and OAB treatment did not impact the associations.

Conclusions Urgency scores were positively associated with same-day ratings of anxiety, depression and stress in OAB patients.

Keywords Overactive bladder · Urgency · Anxiety · Depression · Stress

Abbreviations

OAB	Overactive Bladder
UUI	Urgency urinary incontinence
ICIQ	International Consultation on Incontinence Questionnaire
GEE	Generalized estimating equations
VAS	Visual analog scale
SD	Standard deviation
IQR	Interquartile range
UDI	Urogenital Distress Inventory-long form
IIQ-7	Incontinence Impact Questionnaire-short form
GAD-7	General Anxiety Disorder-short form
PHQ-8	Personal Health Questionnaire Depression Scale
BMI	Body mass index

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Introduction

Urinary incontinence and overactive bladder (OAB) are associated with psychological distress, anxiety, and depressive symptoms [1–4]. Lai et al. found 30–50% of OAB patients reported anxiety and depression symptoms, and the severity of these symptoms positively correlated with OAB symptoms [5, 6]. Longitudinal studies of OAB and anxiety and depression support a bi-directional relationship between these disorders, suggesting a potential common mechanism is involved [1, 5–11]. While longitudinal studies have tested these associations over longer time intervals (several months to years), little is known about short-term associations between OAB and anxiety and depression symptoms. Furthermore, it is unknown whether treatment (of OAB or the mental health disorders) impacts these relationships. Dysfunctions in serotonergic systems and stress systems (hypothalamic-pituitary-adrenal axis and sympathetic-adrenal-medullary axis) have been proposed as possible pathophysiological mechanisms linking psychological and urinary disorders. For example, physical and emotional stress may play a role in the development and potential aggravation of lower urinary tract symptoms via changes in sympathetic and parasympathetic nervous system activity that lead to disruption of autonomic function [12]. Better understanding the relationships between OAB and psychological symptoms, along with additional mechanistic research, may lead to improved treatments for OAB in patients with mental health co-morbidities.

Thus, our primary aim was to investigate short-term (daily) associations between OAB and anxiety, depression, and stress symptoms over a 3-day period in treatment-seeking women with OAB; secondarily, we assessed whether these relationships were stable 3 months later. We hypothesized that OAB symptoms are positively associated with anxiety and depression symptoms over a short-term (daily) basis.

Materials and methods

This was a 3-month prospective, observational study of women with OAB performed at a tertiary care hospital. Urinary and mental health-related symptoms were assessed via questionnaires and a 3-day diary at baseline and 3 months later. The study was approved by the local institutional review board, and all participants provided informed consent.

Ambulatory, community-dwelling adult women seen in urogynecological or urology clinics in the past 1–2 months

with a clinical diagnosis of OAB, urgency urinary incontinence, urinary urgency, or frequency were identified using billing records and contacted via a recruitment letter followed by a telephone call after 7 business days. We made up to three contact attempts via telephone to reach the patient and left our contact information if the patient did not answer. Potential participants were screened using the Urogenital Distress Inventory (UDI) item #2 (“Do you experience a strong feeling of urgency to empty your bladder? If yes, how much does it bother you?”). Those who responded yes and were at least “slightly” bothered were eligible. We intended to study patients with idiopathic OAB. Therefore, exclusion criteria included genitourinary pathology, neurological diagnosis, pelvic organ prolapse beyond the hymen, current pessary, urinary retention (postvoid residual > 150 ml), bladder pain syndrome, genitourinary surgery within prior 3 months, urinary tract infection in past 6 weeks, and current/recent (within 3 months) pregnancy. Non-English speakers were also excluded.

Baseline questionnaires and bladder diary were collected via mail and chart abstraction identified: demographics; medical, surgical, and reproductive histories; medications; examination and evaluation results; current OAB treatment; and current anxiety or depression treatment. Clinical diagnoses for mental health disorders were identified by chart review and self-report. Baseline urinary and psychosocial symptoms were assessed with validated questionnaires.

The UDI (long form) evaluated symptoms of lower urinary tract dysfunction and associated bother (item responses 1 = not at all to 4 = greatly, scored 0–300; higher scores indicate more symptom bother) [13]. The Incontinence Impact Questionnaire short form (IIQ-7) assessed life impact and symptom distress of urinary incontinence and related conditions [item responses 0 (not at all) to 3 (greatly), scored 0–100; higher scores indicate more impact/distress] [14]. The General Anxiety Disorder short form (GAD-7) assessed anxiety with responses varying from 0 = not at all to 3 = nearly every day and score range 0–21. Scores > 10 suggest moderate or severe anxiety over the last 2 weeks [15]. The Personal Health Questionnaire Depression Scale (PHQ-8) assessed depression with item responses from 0 = not at all to 3 = nearly every day and score range 0–24. Values ≥ 10 indicate major depression over the last month [16]. The Perceived Stress Scale (PSS) assessed stress experienced over the last month. Item responses ranged from 0 = never to 4 = very often with scores ranging from 0 to 40; scores ≥ 14 suggest moderate stress [17].

Daily assessments of both urinary and mood symptoms were performed using the 3-day International Consultation on Incontinence Questionnaire (ICIQ) Bladder Diary, modified to assess anxiety, depression, and stress by adding a daily visual analog scale (VAS) rating for

What time did you get up for the day? 7:00 AM PM *Diary entries must begin after this time

Time of Urination or Leak	Did You Urinate In The Toilet?	Bladder Sensation (Urgency)					Did You Leak Urine?	If Yes →	Reason for Leakage <i>Please check only one main reason</i>		
		0	1	2	3	4					
7:15 <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes		X				<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes	→	<input type="checkbox"/> Urge	<input type="checkbox"/> Stress	<input type="checkbox"/> Other
9:00 <input checked="" type="checkbox"/> AM <input type="checkbox"/> PM	<input checked="" type="checkbox"/> No <input type="checkbox"/> Yes						<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	→	<input checked="" type="checkbox"/> Urge	<input type="checkbox"/> Stress	<input type="checkbox"/> Other

Example

Please indicate on the line below your overall level of anxiety today:
 Not at all anxious _____ X _____ Very anxious

What time did you go to bed for the night? 9:00 AM PM

Fig. 1 Bladder diary and visual analog scales. A completed, partial bladder diary with visual analog scale for anxiety is shown

each (Fig. 1) [18]. Bladder diary parameters included numbers of daytime and nighttime voids, urinary incontinence episodes (overall, urgency, stress, and other) and an urgency rating. Urgency was rated from 0 to 4 for each void, defined as 0 = “no sensation of needing to pass urine, but passed urine for social reasons,” 1 = “normal desire to pass urine and no urgency,” 2 = “urgency but it had passed away before you went to the toilet,” 3 = “urgency but managed to get to the toilet, still with urgency, but did not leak urine” and 4 = “urgency and could not get to the toilet in time so you leaked urine.” A daily urgency score was calculated by averaging ratings across voids [18]. In an OAB randomized trial using a similar diary-based 5-point urgency rating, the average urgency score improved by 0.3 points in participants who had successful treatment [19].

The VAS items used were based on previously validated and published items [20–23]. Participants were instructed to complete the VAS items at the end of each day (just before sleep) to rate the overall symptom for that day. They responded with a mark on a 100-mm line, with ratings later measured (0 to 100 mm). Each diary was graded from A–D: A = 100% or almost 100% complete, B = > 50% complete and interpretable, C = < 50% complete and interpretable and D = not interpretable.

Three months after enrollment, participants completed the mailed questionnaires and diary a second time. In addition, participants were queried about changes to OAB treatment and any new diagnoses or treatment for mental health conditions.

Participant characteristics were summarized and compared between those with and without baseline anxiety and depression (based on questionnaire results). Comparisons between categorical variables used chi-squared or Fisher’s exact test. Comparisons between normally and non-normally distributed continuous variables used Student’s *t* and Wilcoxon rank sum tests, respectively. Correlations were tested between daily OAB parameters and psychological symptoms using Spearman’s rank coefficient.

Generalized estimating equations (GEE) were used to test the association between urgency scores (primary dependent variable) and psychological symptoms (VAS ratings, primary independent variable). Separate models were fit using VAS anxiety, depression, and stress as predictors while accounting for repeated measurements on participants. Our modeling procedure specified a compound symmetric correlation matrix for repeated measures on participant. Other covariates including age, body mass index (BMI), self-reported health, anxiety or depression treatment, and changes in OAB treatment were included to adjust for potential confounding. These were selected because of a known association with OAB or a potential impact on OAB and/or psychological symptoms during follow-up.

Additional modeling was conducted, adding a time (baseline vs. 3 month) main effect and its interaction with psychological symptom (anxiety, depression, or stress). The interaction assesses whether the relationship between urgency and psychological symptoms vary over time. Treatment and its interaction with psychological symptoms were similarly

assessed with GEE modeling, testing whether these relationships were altered by treatment status. We were not powered to produce definitive results related to treatment and consider these analyses hypothesis-generating.

Prior published data estimate a correlation of 0.37 between anxiety and urgency [5, 6], which using Spearman's correlation requires a sample of 57 subjects to ensure at least 80% power when testing at the $\alpha=0.05$ level. We assumed an intra-class correlation of zero for simplicity and to provide a conservative estimate. To account for missing data and/or loss to follow-up, we increased the enrollment goal by 20%. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC). A p value of <0.05 was considered significant.

Results

Of 2392 outpatient records screened for eligibility between September 2018 and June 2019, 347 patients (14.5%) met inclusion criteria and were contacted (Fig. 2). Of these, 252 declined or were ineligible. Analysis was performed on 69 participants who completed a baseline questionnaire and diary. Sixty-six completed a 3-month follow-up at median (range) of 99 (94–115) days. Those patients who declined to participate or were lost to follow-up prior to baseline data collection ($n=278$) were similar to enrolled participants except they were younger (mean \pm SD 57.5 ± 15.2 vs. 62.6 ± 13.3 years, $p<0.01$) and more frequently had a diagnosis of nocturia (29.5% vs. 15.9%, $p=0.023$) (data not shown).

Participant characteristics are presented in Table 1. The average age was 63 years. Eighty-four percent rated their general health as at least good, but more than half were taking four or more medications. Overactive bladder was treated with medications and other treatments in 42% and 47.8%, respectively. Anxiety had been diagnosed in 21 (30.4%), with 71.4% of those participants reporting anxiety treatment [including medication 13 (18.8%) and behavioral treatment 6 (8.7%)]. Nearly half of women carried a diagnosis of depression (33, 47.8%), and 78.8% of them reported depression treatment [including medication 25 (36.2%) and behavioral treatment 6 (8.7%)]. Baseline characteristics were similar between those with and without current psychological symptoms, including anxiety (GAD score ≥ 10) and depression (PHQ-8 ≥ 10) (Table 1), except women with anxiety were more likely to be African-American and to use timed voiding for OAB treatment ($p=0.01$).

At 3 months, 51.5% reported an OAB treatment change, including 10.6% with a change in OAB medication (new medication or dose change) and 43.9% reporting other treatment changes (Table 2). Among those, three (4.5%) women advanced to treatment for refractory OAB

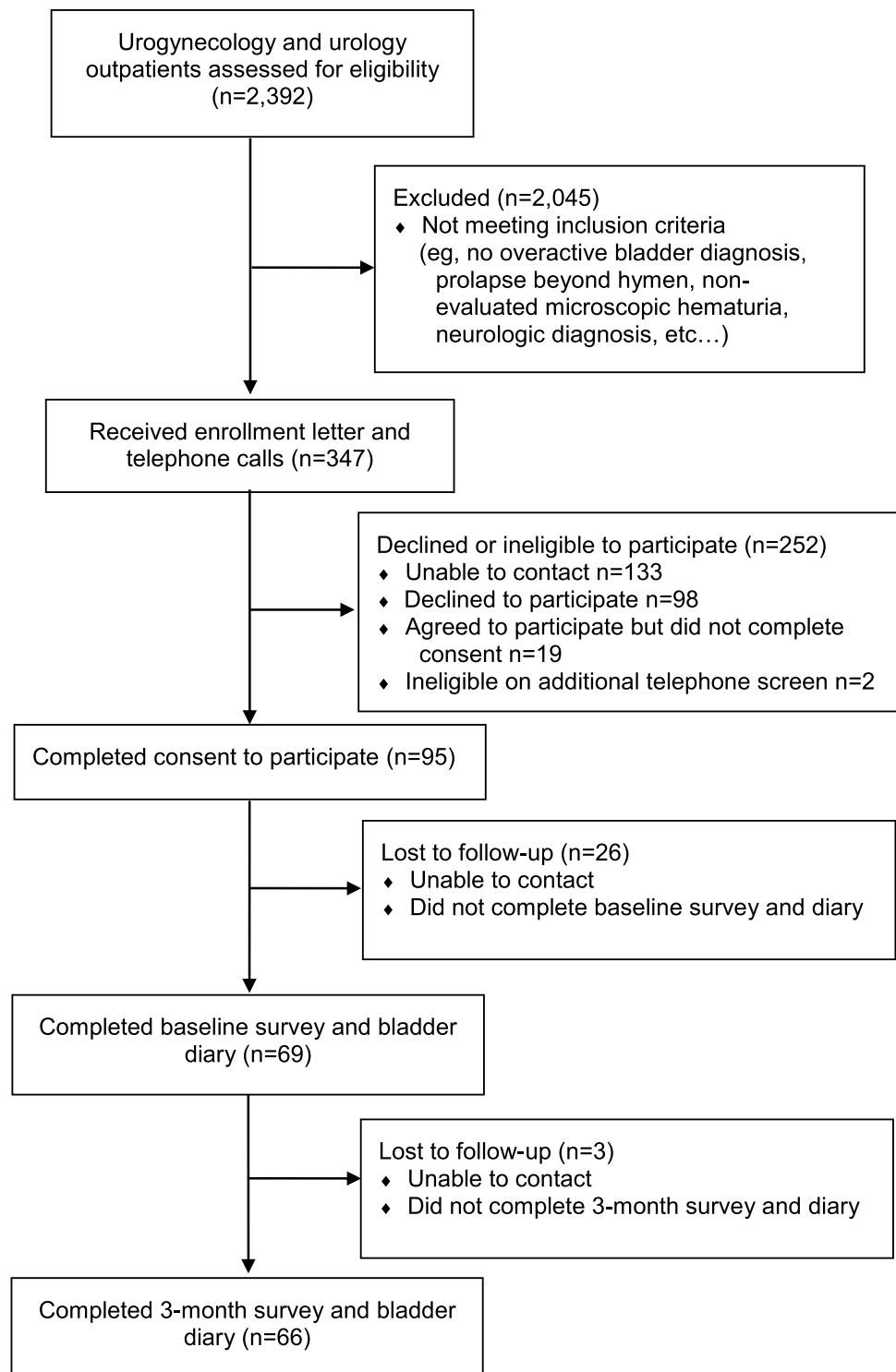
(sacroneuromodulation and intradetrusor onabotulinum-toxinA treatment). Changes in OAB treatment were similar in participants with and without anxiety and depression symptoms. Only three participants reported new mental health diagnoses and treatment (2 anxiety, 1 depression). At 3 months, urinary symptom bother and functional impact were improved (UDI 189 vs. 163, $p=0.002$ and IIQ-7 29 vs. 21, $p=0.04$), but no changes were noted in anxiety, depression, and stress scores (Table 3).

More than 95% of diaries were 100% complete at baseline and 3 months [66 (95.7%) and 65 (98.5%), respectively, $p=0.19$]. Only those data with 100% completion or data that were interpretable were included. The median day and night voids were 8 and 0, respectively, with no change from baseline to 3 months. The median urinary incontinence episodes per day was 1, and this improved slightly after 3 months [median (IQR) 1 (0–3) vs. 1 (0–2), $p=0.02$]. Median urgency scores were 1.75 and 1.67 at baseline and 3 months, respectively ($p=0.46$). Daily baseline ratings for anxiety, depression, and stress were low [median (IQR) mm 10 (3–35), 5 (1–16) and 16 (4–39)] and not statistically different between baseline and 3 months ($p=0.46$, $p=0.99$, $p=0.11$, respectively). The diary-based mood ratings and urgency scores correlated as expected with questionnaires (Spearman correlations, baseline: GAD-7 vs. VAS Anxiety, $r=0.51$ ($p<0.0001$); PHQ-8 vs. VAS Depression, $r=0.61$ ($p<0.0001$); PSS vs. VAS Stress, $r=0.35$ ($p=0.0033$); UDI vs. urgency score, $r=0.40$ ($p=0.0008$)).

Urgency scores correlated with same-day anxiety, depression, and stress ratings (anxiety $r=0.30$ – 0.40 , days 1–3, $p\leq 0.01$ for all; depression $r=0.24$ – 0.35 , $p\leq 0.05$ all; stress $r=0.27$ – 0.34 , $p\leq 0.03$ all; Supplemental Table 1). Other diary parameters had a minimal association with mood ratings. A graphic review of these associations did not suggest any threshold effect for urgency or mood symptoms.

In GEE models adjusted for self-rated health, the associations between urgency and mood ratings remained significant (Table 4), particularly for anxiety. For each 10-mm increase in anxiety, baseline urgency scores increased by 0.10 (95% CI 0.03–0.17). The association at 3 months was similar. The interaction effect was not significant ($p=0.55$), indicating a similar relationship between urgency and anxiety at baseline and 3 months. Self-rated health was also (and more strongly) associated with urgency scores. Women who reported they had good, very good, or excellent health compared to those reporting fair or poor health had lower urgency scores [mean difference -0.50 (95% CI -0.84 , -0.16)]. Other covariates were not significantly associated with urgency scores, including mental health treatment and change in OAB treatment between baseline and 3 months.

Similar results were seen in models testing the associations between urgency scores and depression and stress ratings, with positive associations between urgency and the

Fig. 2 Participant flow diagram: enrollment and study completion

mood ratings at baseline (Table 4). While the associations between urgency and depression and stress ratings were not significant at 3 months, the interaction test was also not significant ($p=0.17$ and 0.10 for depression and stress, respectively), suggesting no significant difference between baseline and 3-month results.

We reversed the GEE models to consider the association with urgency as the independent variable and anxiety, depression, or stress as the dependent outcome. Overall, we noticed similar findings: for example, for each 1-unit increase in urgency score, the VAS for anxiety increased by 46% (95% CI 117–182%; Supplemental Table 2).

Table 1 Demographics and participant characteristics

Participant characteristics	Overall	Anxiety*			Depression**		
		Yes (10)	No (59)	<i>p</i> value	Yes (12)	No (57)	<i>P</i> value
Age (years)	63.3 (13.4)	61.1 (18.9)	63.7 (12.4)	0.57	65.1 (15.3)	62.9 (13.0)	0.67
Body mass index (kg/m ²)	31.2 (7.5)	31.1 (8.9)	31.2 (7.3)	0.91	33.2 (7.1)	30.8 (7.6)	0.24
Race/ethnicity							
Black/African American	2 (2.9%)	2 (20%)	0 (0%)	0.02	1 (8.3%)	1 (1.8%)	0.44
Hispanic/Latino	0 (0%)	0 (0%)	0 (0%)		0 (0%)	0 (0%)	
White Non-Hispanic	66 (95.7%)	8 (80%)	58 (98.3%)		11 (91.7%)	55 (96.5%)	
Other	1 (1.5%)	0 (0%)	1 (1.7%)		0 (0%)	1 (1.8%)	
Education							
Less than high school	3 (4.4%)	1 (10%)	2 (3.4%)	0.15	1 (8.3%)	2 (3.5%)	0.79
Completed high school/GED	10 (14.5%)	3 (30%)	7 (11.9%)		2 (16.7%)	8 (14.0%)	
Some college	26 (37.7%)	4 (40%)	22 (37.3%)		4 (33.3%)	22 (38.6%)	
Completed 4 years of college or more	30 (43.5%)	2 (20%)	28 (47.5%)		5 (41.7%)	25 (43.9%)	
Marital status							
Single	6 (8.7%)	2 (20%)	4 (6.8%)	0.44	2 (16.7%)	4 (7.0%)	0.63
Married	48 (69.6%)	6 (60%)	42 (71.2%)		8 (66.7%)	40 (70.2%)	
Widowed	4 (5.8%)	1 (10%)	3 (5.1%)		1 (8.3%)	3 (5.3%)	
Divorced	10 (14.5%)	1 (10%)	9 (15.3%)		1 (8.3%)	9 (15.8%)	
Separated	1 (1.5%)	0 (0%)	1 (1.7%)		0 (0%)	1 (1.8%)	
Parity	2 (2–3)	2 (0–3)	2 (2–3)	0.30	2 (0–3)	4 (2–5)	0.52
Sexually active	33 (47.8%)	5 (50%)	28 (47.5%)	> 0.99	5 (41.7%)	28 (49.1%)	0.76
Self-rated general health							
Excellent	1 (1.5%)	0 (0%)	1 (1.7%)	0.34	0 (0%)	1 (1.8%)	0.11
Very good	26 (37.7%)	3 (30%)	23 (39.0%)		2 (16.7%)	24 (42.1%)	
Good	31 (44.9%)	5 (50%)	26 (44.1%)		6 (50%)	25 (43.9%)	
Fair	10 (14.5%)	1 (10%)	9 (15.3%)		3 (25%)	7 (12.3%)	
Poor	1 (1.5%)	1 (10%)	0 (0%)		1 (8.3%)	0 (0%)	
Number of medications (excluding vitamins and supplements)							
None	1 (1.5%)	0 (0%)	1 (1.7%)	0.54	0 (0%)	1 (1.8%)	0.99
One	9 (13.0%)	0 (0%)	9 (15.3%)		1 (8.3%)	8 (14.0%)	
Two	7 (10.1%)	2 (20%)	5 (8.5%)		1 (8.3%)	6 (10.5%)	
Three	8 (11.6%)	1 (10%)	7 (11.9%)		1 (8.3%)	7 (12.3%)	
Four	13 (18.8%)	1 (10%)	12 (20.3%)		3 (25%)	10 (17.5%)	
Five or more	31 (44.9%)	6 (60%)	25 (42.4%)		6 (50%)	25 (43.9%)	
Vaginal estrogen	23 (33.3%)	5 (50%)	18 (30.5%)	0.28	6 (50%)	17 (29.8%)	0.20
Overactive bladder medication	29 (42.0%)	5 (50%)	24 (40.7%)	0.73	6 (50%)	23 (40.3%)	0.54
Oxybutynin	14 (20.3%)	3 (30%)	11 (18.6%)	0.41	3 (25%)	11 (19.3%)	0.70
Tolterodine	2 (2.9%)	0 (0%)	2 (3.4%)	> 0.99	0 (0%)	2 (3.5%)	> 0.99
Solifenacin	4 (5.8%)	1 (10%)	3 (5.1%)	0.47	1 (8.3%)	3 (5.3%)	0.54
Fesoterodine	2 (2.9%)	0 (0%)	2 (3.4%)	> 0.99	1 (8.3%)	1 (1.8%)	0.32
Mirabegron	9 (13.0%)	1 (10%)	8 (13.6%)	> 0.99	1 (8.3%)	8 (14.0%)	> 0.99
Other	0 (0%)	0 (0%)	0 (0%)	–	0 (0%)	0 (0%)	–
Overactive bladder- other treatment	33 (47.8%)	6 (60%)	27 (45.8%)	0.50	6 (50%)	27 (47.4%)	> 0.99
Timed voiding	4 (5.8%)	3 (30%)	1 (1.7%)	0.01	2 (16.7%)	2 (3.5%)	0.14
Pelvic floor physical therapy	14 (20.3%)	3 (30%)	11 (18.6%)	0.41	1 (8.3%)	12 (22.8%)	0.44
Posterior tibial nerve stimulation	2 (2.9%)	0 (0%)	2 (3.4%)	> 0.99	0 (0%)	2 (3.5%)	> 0.99
Sacral nerve implant	10 (14.5%)	2 (20%)	8 (13.6%)	0.63	3 (25%)	7 (12.3%)	0.36
Other	1 (1.5%)	0 (0%)	1 (1.7%)	> 0.99	1 (8.3%)	0 (0%)	0.17
Anxiety disorder	21 (30.4%)	5 (50%)	16 (27.1%)	0.16	6 (50%)	15 (26.3%)	0.17

Table 1 (continued)

Participant characteristics	Overall	Anxiety*			Depression**		
		Yes (10)	No (59)	<i>p</i> value	Yes (12)	No (57)	<i>P</i> value
Treatment for anxiety	15 (21.7%)	4 (40%)	11 (18.6%)	> 0.99	5 (41.7%)	10 (17.5%)	0.62
Depression disorder	33 (47.8%)	5 (50%)	28 (47.5%)	> 0.99	9 (75%)	24 (42.1%)	0.06
Treatment for depression	26 (37.7%)	4 (40%)	22 (37.3%)	> 0.99	8 (66.7%)	18 (31.6%)	0.64
Pelvic organ prolapse-quantification stage							
0–1	36 (52.2%)	7 (70%)	29 (49.2%)	0.31	9 (75%)	27 (47.4%)	0.11
2	33 (47.8%)	3 (30%)	30 (50.8%)		3 (25%)	30 (52.6%)	
Post-void residual, ml	20 (0–50)	30 (20–49)	19 (0–69)	0.38	30 (5–49.5)	20 (0–50)	0.61

Data presented as *n* (%), mean (standard deviation) or median (interquartile range). *P* values calculated using chi-squared, Fisher's exact, Student's *t* or Wilcoxon rank sum tests

*Anxiety defined as Generalized Anxiety Disorder-short form (GAD-7) score ≥ 10

**Depression defined as Personal Health Questionnaire Depression Scale (PHQ-8) score ≥ 10

Table 2 Changes in OAB treatment at 3 months vs. baseline

Results	Overall	Anxiety*			Depression**		
		Yes (10)	No (59)	<i>P</i> value	Yes (12)	No (57)	<i>P</i> value
Medication							
Treatment change	7 (10.6%)	1 (12.5%)	6 (10.3%)	> 0.99	1 (9.1%)	6 (10.9%)	> 0.99
No treatment change	59 (89.4%)	7 (87.5%)	52 (89.7%)		10 (90.9%)	49 (89.1%)	
Other treatments							
Treatment change	29 (43.9%)	6 (75.0%)	23 (39.7%)	0.12	6 (54.5%)	23 (41.8%)	0.52
No treatment change	37 (56.1%)	2 (25.0%)	35 (60.3%)		5 (45.5%)	32 (58.2%)	
Combined medication or other treatment							
Treatment change	34 (51.5%)	6 (75.0%)	28 (48.3%)	0.25	7 (63.6%)	27 (49.1%)	0.38
No treatment change	32 (48.5%)	2 (25.0%)	30 (51.7%)		4 (36.4%)	28 (50.9%)	

Data reported as *n* (%). *P* values calculated using chi-squared or Fisher's exact test

Discussion

Our study demonstrated that urinary urgency scores in women with OAB were positively associated with same-day ratings of anxiety, depression, and stress assessed over a 3-day period. This relationship was not impacted by age, BMI, OAB treatment changes, and mental health treatment. The association between urgency and anxiety was consistent when measured 3 months later. The relationships between urgency and depression and between urgency and stress appeared to be attenuated after 3 months, although a statistically significant change in these relationships between baseline and 3 months was not observed.

Prior clinical and epidemiologic studies have also found that depression and anxiety are associated with OAB [1, 2, 5, 6, 24, 25]. Vrijens et al. [11] systematically reviewed longitudinal associations between OAB and mental health symptoms across 43 studies with > 80,000 subjects, reporting significant and bidirectional

associations (OAB subjects at increased risk for developing anxiety and depression and depressed and anxious subjects at increased risk for OAB). Similar to our findings, the strength of the association between OAB and anxiety appears to be more robust than for other affective symptoms [8, 11]. The follow-up in the longitudinal studies in this systematic review all occurred at ≥ 6 months, in contrast to the daily associations we studied.

The presence of a bidirectional association between mental health symptoms (particularly anxiety) and OAB in previous longitudinal studies supports that a common biological mechanism may underlie these associations in some cases. The cross-sectional associations seen in our study cannot provide evidence for a common mechanism, but their stability suggests the symptoms of these chronic disorders are linked, regardless of current treatment status and symptom severity. Dysfunctions in serotonergic systems and stress systems (hypothalamic-pituitary-adrenal axis and sympathetic-adrenal-medullary axis) have been proposed as possible pathophysiological mechanisms linking psychological and urinary disorders [12, 26–30]. However, these

Table 3 Baseline and 3-month questionnaire and diary results

	Baseline	3 months	P value
Generalized Anxiety Disorder-7 (GAD-7)	4 (1–7)	2 (1–6)	0.31
Patient Health Questionnaire Depression (PHQ-8)	4 (1–7)	3 (1–7)	0.98
Perceived Stress Scale (PSS)	20 (17–22)	20 (18–22)	0.81
Urogenital Distress Inventory-long form (UDI)	189 (150–233)	163 (120–209)	< 0.01
Incontinence Impact Questionnaire-7 (IIQ-7)	29 (14–52)	21 (10–43)	0.04
Daytime voids	8 (7–11)	8 (7–10)	0.79
Nighttime voids	0 (0–1)	0 (0–1)	0.52
Total leaks (per day)	1 (0–3)	1 (0–2)	0.02
Urgency leaks	1 (0–2)	0 (0–2)	0.18
Stress leaks	0 (0–0)	0 (0–0)	0.12
Other leaks	0 (0–0)	0 (0–0)	0.23
Urgency score*	1.75 (1.10–2.38)	1.67 (1.09–2.25)	0.46
Urgency score ≥ 3 **	27 (13.4%)	16 (8.4%)	0.15
VAS-Anxiety	10 (3–35)	11 (3–27)	0.46
VAS-Depression	5 (1–16)	5 (1–13)	0.99
VAS-Stress	16 (4–39)	12 (3–31)	0.11
Diary completion			0.188
100% complete or almost 100%	66 (95.7%)	65 (98.5%)	
> 50% complete and data are interpretable	2 (2.9%)	1 (1.5%)	
< 50% complete and data are interpretable	1 (1.5%)	0	
< 50% complete and data are uninterpretable	0	0	

*Urgency was rated from 0 to 4 for each void, defined as 0 = “no sensation of needing to pass urine, but passed urine for social reasons,” 1 = “normal desire to pass urine and no urgency,” 2 = “urgency but it had passed away before you went to the toilet,” 3 = “urgency but managed to get to the toilet, still with urgency, but did not leak urine,” and 4 = “urgency and could not get to the toilet in time so you leaked urine.” The urgency score was calculated for each day by averaging ratings across all voids

***n* (%) of participants whose median urgency score was ≥ 3

Data presented as median (interquartile range) or *n* (%). *P* values calculated using Wilcoxon signed rank or chi-squared tests

relationships are complex and likely impacted by other environmental, behavioral and social factors. Whereas consistent positive associations were confirmed between urgency and mood symptoms in our study, we also note that the impact of daily mood symptoms on urgency was smaller than the impact of overall self-rated health, a known OAB risk factor. Despite this, our results support the hypothesis that mental health symptom treatment could positively impact OAB symptoms. This must be tested with future research.

Strengths of our study include the prospective study design and validated tools to collect real-time, daily information about OAB and mood. Limitations were that we enrolled a “treated” OAB cohort with milder symptoms than anticipated, possibly limiting our ability to study associations between some OAB symptoms and mood ratings. Similarly, while many participants reported diagnoses of depression and anxiety, more severely affected patients may be less likely to participate in research. The number of participants with changes in mental health treatment during our study was very low, so we were unable to determine whether changes in mental health treatments impact the relationship

between urgency and mood symptoms. We also had a non-racially diverse study population.

Last, our primary outcomes and predictors were self-reported or rated variables, which may be subject to recall or other bias. However, the ICIQ diary urgency score is a validated rating system calculated using urgency ratings that patients assigned after each void. Urgency (our primary outcome) is the hallmark symptom for OAB and is generally assessed via patient report. Minimal important differences have not been established for this urgency score, but evidence suggests small changes may be meaningful [19]. Similarly, the VAS mood ratings were subjective ratings. Although previously validated for the condition they represent, our results suggested similar trends for each, and it is possible they represent measures of global psychological distress rather than different psychological constructs.

Our findings demonstrate that the well-known longer-term associations between OAB and psychological conditions are also present when assessed on a more granular daily basis. In particular, we identified positive and consistent associations between same-day urgency and anxiety.

Table 4 Generalized estimating equation models for urgency scores (range 0–4; dependent outcome) by anxiety, depression and stress visual analog scale ratings (range 0–100 mm)

Anxiety	Urgency score mean estimate*	95% CI	P value
Anxiety (10-mm increase), baseline	0.10	0.03, 0.17	< 0.01
Anxiety (10-mm increase), 3 month	0.07	0.01, 0.14	0.03
Anxiety (10-mm increase), 3 month vs. baseline**	−0.03	−0.12, 0.06	0.55
Self-rated health***	−0.50	−0.84, −0.16	< 0.01
Depression	Urgency score mean estimate*	95% CI	P value
Depression (10-mm increase), baseline	0.13	0.04, 0.23	< 0.01
Depression (10-mm increase), 3 month	0.04	−0.07, 0.15	0.50
Depression (10-mm increase), 3 month vs. baseline**	−0.09	−0.21, 0.04	0.17
Self-rated health***	−0.51	−0.86, −0.15	< 0.01
Stress	Urgency score mean estimate*	95% CI	P value
Stress (10-mm increase), baseline	0.10	0.03, 0.17	< 0.01
Stress (10-mm increase), 3 month	0.02	−0.05, 0.10	0.61
Stress (10 mm increase), 3 month vs. baseline**	−0.08	−0.17, 0.01	0.10
Self-rated health***	−0.52	−0.88, −0.17	< 0.01

*Mean estimated change in urgency score for each 10-mm increase in anxiety, depression or stress (e.g., urgency score will increase by 0.100 for each 10-mm increase in anxiety), adjusted for other listed variables

**Mean estimated difference between the urgency score estimates at baseline and 3 months for each 10-mm increase in anxiety, depression or stress, adjusted for other listed variables

***Self-rated health categorized as excellent, very good and good vs. fair and poor (reference)

Additional research is needed to better understand the mechanisms behind these associations and to improve OAB treatment in patients with concurrent mental health problems.

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Author's contribution AA Mehr: Protocol/project development, recruited participants, data collection/analysis, manuscript writing/editing.

KJ Kreder: Protocol/project development, manuscript editing.

SK Lutgendorf: Protocol/project development, manuscript editing.

PT Eyck: Data management, data analysis, manuscript editing.

ES Greimann: Recruited participants, data collection, manuscript editing.

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Declarations

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