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Risk factors, urodynamic characteristics, and distress associated with nocturnal enuresis in overactive bladder -wet women

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Patients with overactive bladder syndrome-wet (OAB-wet) experience urgency urinary incontinence, particularly urinary frequency and nocturia. Nocturnal enuresis (NE) is less addressed among OAB-wet patients. The study evaluated the prevalence of NE, lower urinary tract symptoms (LUTS), urodynamic factors, and social factors in OAB-wet patient. Over three years, adult women with urgency urinary incontinence were enrolled. A comprehensive questionnaire, including baseline characteristics, LUTS, fatigue, stress, and partner relationship was completed by the participants. NE was defined as complaint of intermittent incontinence that occurs during the main sleep period. Urodynamics was performed on every patient to assess bladder function. Of 203 OAB-wet patients (age: 64.45 years), 46.4% had NE. Patients with NE had higher scores of intermittency, slow stream, straining, hesitancy, post micturition dribble, nocturia, and stress urinary incontinence than non-NE. NE patients had a more parity numbers, diuretic, hypnotic, and prokinetic use, and smoking. NE patients more likely reported fatigue, anxiety, and distress. Urodynamic studies revealed more detrusor overactivity, detrusor underactivity, and low bladder compliance in NE patients. In conclusion, OAB-wet women with NE had more detrusor overactivity, detrusor underactivity, and a lower compliance bladder on urodynamic studies than those without NE. NE impacts the patients' life in aggravating fatigues, anxiety, and distress in OAB-wet women.

Keywords Nocturnal enuresis, Overactive bladder, Women, Incontinence

The overactive bladder (OAB) is common with an estimated prevalence ranging from 12 to 17% in adults. The prevalence increases with age and is slightly higher among women than men. As suggested by the International Continence Society, OAB patients experience urge incontinence particularly with symptoms of urinary frequency and nocturia[1]. OAB can be classified into two main categories, OAB-wet and OAB-dry, based on the presence or absence of urgency urinary incontinence. Among women, the overall prevalence of dry OAB and wet OAB is similar (7.6% and 9.3%, respectively)[2]. Compared with dry OAB, wet OAB further hampers quality of life and associates with higher distress among women. The standard therapy for OAB is life style modification. Second-line therapies includes anticholinergics and beta-3 agonist. Individuals who do not respond positively to behavioral and medical treatments are subjected to the third-line therapies and may consider seeking evaluation from a specialist if they wish to explore further therapeutic options[3,4]. It is crucial to conduct a thorough assessment before subjecting patients to these treatments to ensure that their symptoms are not caused by other underlying medical conditions that necessitate different forms of treatment.

The definition of OAB does not include nocturnal enuresis (NE) that is predominantly recognized as a childhood disorder[5,6]. However, NE can be found among women with OAB. Previous reports show that NE is present in about 0.05% of the overall adult population[7], with 2.0% reported in overall female patients[8]. NE often leads to considerable social embarrassment and psychological distress, disrupted sleep, and impaired quality of life. NE may even worsen the already diminished quality of life in OAB-wet patients. However, the prevalence and risk factors of NE are seldom addressed among these patients. As such, the aim of this study is to evaluate the prevalence NE, lower urinary tract symptoms (LUTS), urodynamic factors, and social factors in OAB-wet patient. As these patients are indicated for urodynamic studies, the differences in urodynamic factors between NE and non-NE OAB-wet patient would be also explored.

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Materials and methods

A retrospective review of medical charts was conducted at a tertiary medical center over three years. This study included adult women aged 19 years and older who experienced urgency urinary incontinence (≥ 1 time per week for at least 3 months) that was refractory to the standard therapies including lifestyle modification, anticholinergic agents, and selective beta-3 adrenoreceptor agonists. Before urodynamic tests, patients were asked to complete a self-administered questionnaire including baseline characteristics (age, body weight, height, waist circumference), LUTS, comorbidity, current medication usage, life style factors (exercise habit, sleeping patterns, alcohol consumption, smoking, job related stress levels), and the impacts of LUTS on fatigue, associated stress, and partner relationships (Supplementary S1). This comprehensive questionnaire was developed by selecting and summarizing questions from several established questionnaires, including OAB-SS, OAB-q, ICIQ-FLUTS, and the King's Health Questionnaire[9–12]. It was tailored to focus on key points of interest, presented in a Likert scale format. Each LUTS (increased daytime frequency, urgency, feeling of incomplete emptying, intermittency, slow stream, straining, hesitancy, post micturition dribble, pelvic pain, nocturia, and stress urinary incontinence, and nocturnal enuresis) was rated on a Likert scale from 0 (never) to 5 (every day). The quality of life associated with urinary symptoms was rated from 0 (delighted) to 6 (terrible). NE was defined as complaint of intermittent incontinence that occurs during the main sleep period[13]. All patients experienced any severity of NE in the past three months were included in the NE group. The questionnaire for the NE section was rated on a Likert scale, with the following scoring system: 0 for never, 1 for seldom, 2 for one episode of NE per month, 3 for one episode of NE per week, 4 for one episode of NE every two to three days, and 5 for more than one episode of NE per day. Based on the severity of NE, patients were further classified into mild (scores of 1 to 3) and severe (scores 4 to 5). The physical activity level, alcohol consumption habits, and smoking were rated in frequency from 0 (never) to 2 (regular, or more than 1 pack per week in case of smoking). Quality of sleep was rated from 1 (very poor) to 5 (very good). Job related stress levels was rated from 0 (no stress) to 3 (very stressful). The impacts of LUTS on fatigue, life style, psychological status (anxiety, social distress), family, and partner relationships were rated from 0 (no impact) to 4 (very great impact). Urodynamic studies included a free uroflowmetry before and after pressure flow study. Patients who were pregnant and had untreated urinary tract infections, active malignancies, congenital neurological anomaly (cerebral palsy, spinal bifida), spinal cord injury and abnormal urological anatomy were excluded. This study was performed in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the National Taiwan University Hospital (202102073RINC). All research was performed in accordance with relevant guidelines and regulations. The need for consent to participate was waived by the Institutional Review Board of the National Taiwan University Hospital.

Patients without history of neurological disease history including neurological surgery, head trauma, Alzheimer disease, Parkinson's disease, and any degenerative neurological history were further classified as idiopathic OAB group. A subgroup analysis was conducted. The LUTS presented, impact to their normal life, and the urodynamic study were analyzed.

Data were reported in mean ± standard deviation and analyzed by commercial statistical software MedCalc® Statistical Software version 22.014 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2023). Demographic and clinical parameters were compared using an analysis of variance (ANOVA) for continuous demographic variables and Kruskal-Wallis test for ordinal data. Post-hoc comparison was conducted using Conover test. Multivariate regression was used to evaluate the potential risk factors of NE. A p-value of less than 0.05 was considered statistically significant.

Results

Of the 203 refractory OAB-wet participants (mean age 64.45) included in our study, 89 (46.4%) women reported NE. The most common LUTS symptoms that complained by the patient were urinary incontinence (33.5%) and increased daytime frequency (29.5%), followed by urgency (18.2%) and stress urinary incontinence (18.2%). However, none of these patients complained about NE initially. 92.6% of the patients had childbirth experiences, and 83.7% of the patients were in their post-menopause. 21.6% of the patients experienced a very poor quality of sleep. 53.2% of participants in the study shared that their urinary symptoms significantly deteriorated their quality of life (rated "terrible"). The urodynamic findings of these OAB patients revealed that 19.3% of the patients had detrusor underactivity, 42.1% detrusor overactivity, 38.1% BOO, and 42.6% poor bladder compliance. The mean BOOI was 17.89 (SD = 24.57) and mean BCI was 79.80 (SD = 32.42) in these patients.

The patients' demographic data were shown in Table 1. In the NE group, 37.1% of the patient had mild NE, and 62.9% had severe NE. Among non-NE and NE (mild and severe) OAB-wet patients, no significant difference was found in age (63.29 years vs. 64.48 years vs. 66.80 years, $p = 0.293$), body mass index (24.85 vs. 22.99 vs. 24.80, $p = 0.059$), waist-hip ratio (0.8553 vs. 0.8613 vs. 0.8618, $p = 0.872$), and menopause status (80.53% vs. 90.91% vs. 87.50%, $p = 0.259$). A significant correlation between the severity of NE and birth numbers was observed ($p = 0.006$). Patients with lower leg edema were found to have a significant correlation with NE (10.60% vs. 9.10% vs. 30.40%, $p = 0.002$). Although constipation was also found to be positively related to NE, it did not reach statistical significance (31.80% vs. 46.90% vs. 49.10%, $p = 0.067$). More NE patients reported diuretics and prokinetics usage ($p = 0.012$ and $p = 0.008$). No significant associations were found for exercise habits, life pressure, alcohol consumption, smoking, or family history with NE. Multivariate analysis showed a significant relationship between NE and the numbers of giving birth ($p = 0.002$), smoking habits ($p = 0.012$), diuretics usage ($p = 0.029$), sleeping pills ($p = 0.012$), and prokinetics usage ($p = 0.002$) (Table 3).

The LUTS experienced by patients and the impacts to their daily life were demonstrated in Table 2. Comparable scores in increased daytime frequency, urgency, feeling of incomplete emptying, and pelvic pain were observed between non-NE and NE groups. However, NE patients had higher scores in intermittency ($p < 0.001$), slow stream ($p = 0.002$), straining ($p < 0.001$), hesitancy ($p < 0.001$), post micturition dribble ($p = 0.015$), nocturia

	No NE ($n=114$)	Mild NE ($n=33$)	Severe NE ($n=56$)	p	Post-hoc		
					No NE - mild NE	No NE - severe NE	Mild NE - severe NE
Age	63.29	64.48	66.80	0.293			
BMI	24.85	22.99	24.80	0.059			
Waist	83.15	82.08	84.49	0.498			
Hipline	102.45	95.27	97.91	0.347			
Waist-hip ratio	0.86	0.86	0.86	0.872			
Menopause	80.53%	90.91%	87.50%	0.259			
Number of parity	3.32	3.21	4.29	0.006		*	*
CS hx	7.50%	9.40%	9.10%	0.910			
NSD hx	86.00%	93.70%	92.70%	0.282			
Sleep hours	5.97	6.00	6.32	0.308			
Sleep quality	2.42	2.15	2.49	0.265			
Exercise	1.06	0.88	0.70	0.344			
Life pressure	0.96	0.97	1.24	0.293			
UTI hx	51.40%	66.70%	52.80%	0.297			
Constipation	31.80%	46.90%	49.10%	0.067			
Alcohol	0.11	0.24	0.15	0.531			
Smoking	0.05	0.11	0.13	0.369			
Family history	11.30%	22.60%	16.30%	0.271			
Underline dx							
DM	19.50%	21.20%	23.20%	0.851			
HTN	38.10%	48.50%	42.90%	0.537			
Heart	22.10%	18.20%	25.00%	0.756			
Lung	6.20%	6.10%	12.50%	0.330			
ESRD	2.70%	6.10%	7.10%	0.368			
Liver	8.80%	3.00%	7.10%	0.532			
Neuro	16.80%	30.30%	25.00%	0.183			
PSY	15.00%	27.30%	10.70%	0.112			
Lipid	25.70%	27.30%	23.20%	0.903			
Leg edema	10.60%	9.10%	30.40%	0.002		*	*
GYN	19.50%	21.20%	19.60%	0.975			
Current drug							
Diuretics	9.70%	12.10%	26.80%	0.012		*	
Sleeping pills	23.90%	33.30%	21.40%	0.433			
Anti-anxiety	15.90%	27.30%	14.30%	0.249			
Heart Drug	39.80%	33.30%	37.50%	0.772			
Prokinetics	18.60%	39.40%	37.50%	0.008		*	
Pain killer	12.40%	27.30%	10.70%	0.067			
Asthma	4.40%	9.10%	3.60%	0.475			
Hermone	8.80%	6.10%	3.60%	0.432			

Table 1. Patients' demographic data. *NE* nocturnal enuresis, *BMI* body mass index, *hx* history, *CS* cesarean section, *NSD* normal spontaneous delivery, *UTI* urinary tract infection, *DM* diabetes mellitus, *HTN* hypertension, *ESRD* end-stage renal disease, *Neuro* neurology, *PSY* psychiatry, *GYN* gynecology.

($p=0.007$), and stress urinary incontinence ($p<0.001$). In addition, there was a positive correlation between the severity of NE and LUTS. Intermittency and stress urinary continence were also significantly related to NE in multivariate analysis ($p<0.001$ and $p=0.003$; Table 3). Compared with non-NE patients, NE patients had less energy ($p=0.001$), fewer exercise habits ($p=0.005$), less fluid intake ($p<0.001$), less frequent of travel ($p=0.005$), higher level of anxiety or pressure ($p=0.001$), and higher social distress ($p<0.001$). Both increased levels of anxiety or pressure and social distress were also found to be correlated with the severity of NE. However, NE did not significantly affect the family life ($p=0.082$) or sex life and partner relationship ($p=0.169$).

In uroflowmetry study, as shown in Table 4, both voided volume and maximal flow rate demonstrated a significant decrease in NE groups (224.74 ml vs. 241.44 ml vs. 155.74 ml, $p=0.010$; 20.93 ml/s vs. 17.12 ml/s vs. 11.65 ml/s, $p<0.001$). In urodynamic studies, a significant decrease in maximal capacity of bladder (284.58 ml. vs. 309.97 ml vs. 239.80 ml, $p=0.009$) was found in NE patients. A comparable result of PdetQmax (34.58 cmH20 vs. 38 cmH2O vs. 35.5 cmH2O, $p=0.669$) was found. A significant higher BOOI (13.63 vs. 20.45 vs. 23.22,

	No NE ($n=114$)	Mild NE ($n=33$)	Severe NE ($n=56$)	p	Post-hoc		
					No NE - mild NE	No NE - severe NE	Mild NE - severe NE
Symptoms							
Increased daytime frequency	3.48	3.06	3.89	0.109			
Urgency	4.18	3.76	4.22	0.543			
Feeling of incomplete emptying	3.05	3.53	3.85	0.058			
Intermittency	2.29	3.03	3.81	0.000		*	
Slow stream	2.34	3.32	3.39	0.002		*	
Straining	1.98	2.58	3.41	0.000		*	
Hesitancy	1.53	2.59	2.89	0.000	*	*	
Post micturition dribble	2.12	2.29	3.15	0.015		*	
Pelvic pain	2.07	2.32	2.65	0.214			
Nocturia > = 3	2.42	2.48	3.16	0.007		*	
SUI	2.97	3.15	4.45	0.000		*	*
Impact to daily life							
Lack of energy	1.70	1.77	2.54	0.001		*	
Less exercise	1.98	1.70	2.69	0.005		*	*
Less fluid intake	1.89	1.55	2.77	0.000		*	*
Less travel	2.24	2.15	3.00	0.005		*	*
Anxiety	1.68	2.13	2.57	0.001		*	
Distress	1.56	2.00	2.58	0.000		*	
Affect to family life	1.75	1.94	2.31	0.082			
Affect to sexual life	0.97	1.03	1.45	0.169			

Table 2. Lower urinary tract symptoms presented by the patients and the impact to their daily life. *NE* nocturnal enuresis, *SUI* stress urinary incontinence.

	Coefficient	SE	t	p
Risk factors				
Births	0.113	0.034	3.300	0.002
Smoking	1.106	0.372	2.975	0.012
Diuretics	0.403	0.179	2.254	0.029
Sleeping pills	−0.431	0.161	−2.672	0.012
Prokinetics	0.509	0.153	3.329	0.002
LUTS				
Intermittency	0.117	0.031	3.757	0.000
SUI	0.101	0.033	3.032	0.003

Table 3. Multiple regression of risk factors of NE and the LUTS presented by NE patients. *SE* standard error, *LUTS* lower urinary tract symptoms, *SUI* stress urinary incontinence.

$p=0.042$) and lower BCI (86.95 vs. 86 vs. 66.20, $p=0.001$) were found in the NE group. The NE patients also showed higher detrusor overactivity (35.40% vs. 42.40% vs. 55.40%, $p=0.048$), detrusor underactivity (15.00% vs. 15.20% vs. 30.40%, $p=0.049$), and low bladder compliance (32.70% vs. 36.40% vs. 66.10%, $p<0.001$), with each finding showing a linear relationship with the severity of NE.

A total of 159 patients were classified as idiopathic OAB group. Subgroup analysis revealed a significant positive relationship between NE severity and LUTS including feeling of incomplete emptying ($p=0.013$), intermittency ($p<0.001$), slow stream ($p=0.003$), straining ($p=0.001$), hesitancy ($p<0.001$), post micturition dribble ($p=0.044$), nocturia ($p=0.007$), and stress urinary incontinence ($p<0.001$; Table 5). Additionally, these patients also experienced a higher level of lacking energy ($p=0.005$), less fluid intake ($p=0.004$), less frequent of travel ($p=0.018$), higher level of anxiety or pressure ($p<0.001$), and higher social distress ($p<0.001$). Uroflometry also showed a decrease in voided volume ($p=0.012$) and maximal flow rate ($p<0.001$) in NE patient (Table 6). A decrease in maximal capacity of the bladder was found ($p=0.034$) in NE patient during the urodynamic study. A progressive trend of increasing BOOI ($p=0.029$) and decreasing BCI ($p=0.003$) was found in NE patients. Particularly, a significant difference was found between non-NE group and severe NE group. They reported significant higher prevalence of poor bladder compliance ($p<0.001$) but comparable results in DO ($p=0.332$) and DU ($p=0.135$).

	No NE ($n=114$)	Mild NE ($n=33$)	Severe NE ($n=56$)	p	Post-hoc		
					No NE - mild NE	No NE - severe NE	Mild NE - severe NE
vv, 1st UFM	132.40	92.39	76.57	0.036		*	
vv, 2nd UFM	224.74	241.44	155.74	0.010		*	*
Qmax, 1st UFM	13.15	9.92	9.32	0.090			
Qmax, 2nd UFM	20.93	17.12	11.65	0.000		*	*
First sensation	145.87	164.14	161.81	0.323			
Max capacity	284.58	309.97	239.80	0.009		*	*
PdetQmax	34.58	38.00	35.50	0.669			
Qmax, PFS	10.51	9.00	6.14	0.000		*	
vv, PFS	135.78	136.64	78.20	0.518			
Poor compliance	0.33	0.36	0.66	0.000		*	*
BOO	0.43	0.46	0.25	0.057			
DO	0.35	0.42	0.55	0.048		*	
DU	0.15	0.15	0.30	0.049		*	
BOOI	13.63	20.45	23.22	0.042		*	
BCI	86.95	86.00	66.20	0.001		*	*

Table 4. Result of urodynamic study. *NE* nocturnal enuresis, *vv* voided volume, *UFM* uroflowmetry, *Qmax* maximal flow rate, *PdetQmax* detrusor pressure at maximal flow rate, *PFS* pressure flow study, *BOO* bladder outlet obstruction, *DO* detrusor overactivity, *DU* detrusor underactivity, *BOOI* bladder outlet obstruction index, *BCI* bladder contractility index.

	No NE ($n=94$)	Mild NE ($n=23$)	Severe NE ($n=42$)	p	Post-hoc		
					No NE - mild NE	No NE - severe NE	Mild NE - severe NE
Symptoms							
Increased daytime frequency	3.55	3.17	4.14	0.094			
Urgency	4.17	3.70	4.39	0.239			
Feeling of incomplete emptying	2.96	3.70	4.07	0.013		*	
Intermittency	2.23	3.00	3.98	0.000		*	*
Slow stream	2.23	3.30	3.48	0.003	*	*	
Straining	1.87	2.77	3.38	0.001		*	
Hesitancy	1.44	2.39	3.12	0.000	*	*	
Post micturition dribble	2.18	2.48	3.14	0.044		*	
Pelvic pain	2.02	2.87	2.71	0.072			
Nocturia > = 3	2.47	2.57	3.31	0.007		*	
SUI	2.92	3.30	4.50	0.000		*	*
Impact to daily life							
Lack of energy	1.66	1.91	2.50	0.005		*	
Less exercise	2.01	1.65	2.50	0.075			
Less fluid intake	1.97	1.65	2.81	0.004		*	*
Less travel	2.26	2.04	2.98	0.018		*	*
Anxiety	1.66	2.30	2.69	0.000		*	
Distress	1.46	2.09	2.71	0.000		*	
Affect to family life	1.76	2.00	2.25	0.191			
Affect to sexual life	1.09	1.09	1.32	0.618			

Table 5. Subgroup analysis of the patients without underlying of neurological disease. Lower urinary tract symptoms presented by these patients and the impact to their daily life. *NE* nocturnal enuresis, *SUI* stress urinary incontinence.

Discussion

This is the largest study to date discussing NE in adult women with OAB-wet symptoms, followed up with urodynamic studies, in this population. Contrary with pediatric cases, adult NE is often unreported due to stigma, leading to underdiagnosis. In our study, not a single participant identified NE as their main complaint. NE causes sleep disturbance and social distress, and impacts job performance and quality of life[8,14]. However, unlike urgency or urinary incontinence, the stigma associated with NE can lead to significant embarrassment

	No NE ($n=94$)	Mild NE ($n=23$)	Severe NE ($n=42$)	p	Post-hoc		
					No NE - mild NE	No NE - severe NE	Mild NE - severe NE
vv, 1st UFM	131.98	92.10	77.90	0.070			
vv, 2nd UFM	238.06	256.25	157.89	0.012		*	*
Qmax, 1st UFM	13.10	9.30	8.38	0.046		*	
Qmax, 2nd UFM	21.90	18.84	11.23	0.000		*	*
First sensation	147.07	165.52	159.24	0.471			
Max capacity	289.70	317.83	244.45	0.034		*	*
PdetQmax	33.50	34.27	36.65	0.740			
Qmax, PFS	10.76	9.53	5.70	0.000		*	
vv, PFS	140.32	135.48	70.50	0.340			
Poor compliance	0.31	0.35	0.71	0.000		*	*
BOO	0.41	0.57	0.26	0.051			
DO	0.37	0.44	0.50	0.332			
DU	0.15	0.13	0.29	0.135			
BOOI	12.05	15.20	25.24	0.029		*	
BCI	87.13	81.93	65.16	0.003		*	

Table 6. Result of urodynamic study in subgroup analysis of the patients without underlying of neurological disease. *NE* nocturnal enuresis, *vv* voided volume, *UFM* uroflowmetry, *Qmax* maximal flow rate, *PdetQmax* detrusor pressure at maximal flow rate, *PFS* pressure flow study, *BOO* bladder outlet obstruction, *DO* detrusor overactivity, *DU* detrusor underactivity, *BOOI* bladder outlet obstruction index, *BCI* bladder contractility index.

among adult patients, who may deliberately skip disclosing symptoms of NE and choose not to seek any treatment. While examining patients' demographic data, we identified leg edema, diuretics, and prokinetics as significant risk factors in NE patients. The impact on life is also profound, with individuals experiencing energy depletion, increased anxiety, and social distress. Moreover, urodynamic studies revealed that NE patients had reduced maximum flow rate, low bladder compliance, and more detrusor overactivity.

A significant association between BMI and NE has been reported by Song et al. although the association was not found in our study. It may be because our study only enrolled OAB-wet women for analysis of risk factor. Several studies have recognized constipation as a risk factor of OAB and urinary incontinence among women[15,16]. Pediatric bedwetting is also accompanied by constipation[17]. Our study showed that constipation had a non-significant association with NE ($p=0.067$). The impact of constipation on NE may be hampered by prokinetics usage as prokinetics use was positively associated with NE ($p=0.002$). Evidence has demonstrated a strong significant relationship between urinary incontinence and number of deliveries[18]. A higher risk of pelvic floor disorder and overactive bladder could also be found in women after childbirth[19–21]. Although the mean age of our sample was higher compared with the mean age in the previous study, given the evidence of a strong relationship between NE and pelvic floor dysfunction[22], the number of deliveries is therefore a significant factor of NE.

The analysis of comorbid conditions in our cohort revealed a non-significant association with a wide landscape of underlying diagnoses, including hypertension, diabetes mellitus, chronic kidney diseases, neurological diseases, and psychological diseases. However, NE patients.

showed an increasing prevalence in patients with leg edema and the diuretics usage. Previous research has found that nocturia could be reported in patients with hypertension and heart failure who received diuretic therapy due to oedema or leg edema[23]. The increased urine production induced by diuretics may lead to urinary incontinence[24], with a documentation by an odds ratio of 1.44 (95% CI: 0.96–2.17) in women patients[25]. Therefore, these factors might potentially contribute to NE as we could notice in our study.

Our analysis showed a strong association between various LUTS and NE. Women with OAB-wet had more severity in LUTS then non-NE patients, both in voiding and storage symptoms. A similar result was reported by Song et al., where nocturia, increased daytime frequency, and urinary incontinence could be found in adult men with NE[26]. An epidemiological data among Hong Kong enuretic adults showed a significant prevalence of urinary symptoms, including frequency, imperative urgency, and urgency incontinence, compared with a control group[8]. Our study recruited adult women with an older age (mean age of more than 60 years), mostly at menopausal status (> 80% in all groups). The symptoms of LUTS could be different with other epidemiological data due to age and menopause status[27–29]. However, we found a higher prevalence of slow stream ($p=0.002$), intermittency ($p<0.001$), hesitancy ($p<0.001$), and stress urinary incontinence ($p<0.001$) in the NE group. Therefore, NE is associated with a more severe deterioration of bladder function, and a more pronounced incoordination between the bladder muscles and the pelvic floor musculature.

The results of our study were in line with previous studies that increasing in severity of LUTS could detrimentally impact patient's daily living and overall quality of life across multiple dimensions. Decreasing in sleep quality, concerns about hygiene due to urinary leakage, the financial burden of additional incontinence supplies, and the adverse effects on sexual function, have been identified as probable factors[30]. A markedly

higher prevalence of anxiety, depression, chronic fatigue, and low self-esteem have also been reported among adults with NE[31].

A urodynamic study is currently recommended by the NICE guidelines in assessing refractory OAB[32]. Women with OAB has been reported to have 33% of DO in diagnosis with urodynamic study, while only 2.4% have DU[33]. Another study has found that 27% of BOO could be diagnosed in OAB women via urodynamics[34]. Change of bladder compliance could also be noticed in 43.1% of patients with idiopathic OAB[35]. Further investigation such as urodynamic study might change the therapeutic strategy in managing patients with refractory OAB. In patients with severe NE, a poorer flow, higher PVR, and decreasing in bladder compliance have also been reported[36]. A significant decreasing in functional volume and Qmax was found among NE patients in our study. Given the high prevalence of pelvic floor dysfunction in those patients[22,37], voiding dysfunction could be expected in urodynamic study. The decrease in bladder compliance may significantly impair the bladder's storage capacity, compelling patients to urinate more frequently during the night or, in more severe cases, resulting in NE. The results of the current study are in line with previous studies. We found that NE patients had a lower BCI and higher BOOI than non-NE patients. Lower BCI in NE patients indicates a poorer bladder voiding function, resulting in a decreased Qmax and a higher PVR, giving a more significant symptoms in nocturia and incomplete voiding. In addition, lower BOOI in non-NE patients also indicated urgency urinary incontinence suffered by OAB-wet patients. A higher prevalence of DO has been reported in NE patients[30,36]. Higher DO in NE patients could be related to a more severity in pelvic floor discoordination, resulting in an involuntary voiding during the main sleep period at night.

Idiopathic OAB refers to a persistent urinary tract symptom condition, characterized by an unknown specific pathophysiology. Conversely, neurogenic OAB is a bladder dysfunction often observed in individuals with neurologic diseases, such as multiple sclerosis, spinal cord injury, or Parkinson's disease[1,38,39]. By limiting the sample to idiopathic wet-OAB women, as in our subgroup analysis, we found that patients shared similar LUTS and impacts on life as the overall wet-OAB women with NE. The urodynamic parameters showed significant differences with the NE group, specifically in decreased voided volume, maximal flow rate, and lower maximal capacity of the bladder. However, we did not find a significant increasing DO and DU in idiopathic NE group, though it showed a progressive trend in percentage. A strong association between neurogenic disease and NE episodes has also been found by Song et al. in adult men[26]. After excluding the patients with neurologic underlying, a slightly decreasing in percentage of patients with severe NE were found in our study, and conversely, similar percentage in the non-NE and mild NE groups.

There are several limitations in this study. As our cohort was exclusively comprised of patients with OAB-wet, there is an inherent limitation regarding the generalizability of the NE symptoms and UDS findings to a broader population. Our study's reliance on patient-reported outcomes, collected via questionnaires to delineate symptoms, inherently carries the potential for subjective bias, possibly leading to variances in the reported data. Additionally, the absence of data concerning the history of childhood NE in our study limits our ability to distinguish between persistent childhood cases and adult-onset NE cases. The etiologies underlying these two groups may differ, hence limiting our understanding of the pathophysiological mechanisms. Therefore, future research should take the history of childhood NE into consideration in studying NE. Finally, the number of patients we included was relatively low. However, both subjective parameters (symptom scores) and objective parameters (urodynamic studies) were collected in our study, that help clinicians further elucidate the risk factors and urodynamic findings in NE among the OAB-wet patients.

Conclusion

Our study found that women with OAB-wet during main sleep period had more severe LUTS (both voiding and storage symptoms) then non-NE patients. Number of parity, leg edema, and diuretic use are the risk factors of NE. OAB-wet women with NE had more detrusor overactivity, lower compliance bladder, poorer flow, and lower maximal bladder capacity on urodynamic studies than those without NE. Further studies should focus on the pathophysiology of NE, and also aim to identify the biomarkers or neurotransmitters that influence this particular disease.

Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Author contributions

S.C. and J.C. have made contributions to the conception, study design, and the acquisition. K.N. did the analysis, interpretation of data, and drafted the manuscript. S.C. and K.N. have revised and edited the manuscript. All authors have reviewed the manuscript and approved the submitted version.

Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of the National Taiwan University Hospital, with approval number 202102073RINC. The need for consent to participate was waived by the Institutional Review

Board of the National Taiwan University Hospital.

Additional information

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