Published in final edited form as:

Am J Obstet Gynecol. 2020 February ; 222(2): 163.e1–163.e8. doi:10.1016/j.ajog.2019.08.023.

The natural history of urinary incontinence subtypes in the Nurses' Health Studies

Vatche A Minassian, MD MPH¹, Kaitlin A Hagan, ScD MPH^{2,3}, Elisabeth Erikson, MD MPH^{4,5}, Andrea M Austin, PhD⁵, Donald Carmichael, M.Div.⁵, Julie PW Bynum, MD MPH^{5,6,7}, Francine Grodstein, ScD^{2,3}

¹Division of Urogynecology, Department of Obstetrics and Gynecology, Brigham and Women's Hospital, Boston, MA

²Channing Division of Network Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA

³Department of Epidemiology, Harvard School of Public Health, Boston, MA

⁴Department of Obstetrics and Gynecology at the Geisel School of Medicine at Dartmouth, Hanover, NH

⁵The Dartmouth Institute for Health Policy and Clinical Practice at the Geisel School of Medicine at Dartmouth, Lebanon, NH

⁶Department of Internal Medicine, University of Michigan Medical School, Ann Arbor, MI

⁷Institute for Health Policy and Innovation, University of Michigan, Ann Arbor MI

Abstract

Background: Urinary incontinence (UI) subtypes often differ by symptom severity and treatment profiles; in particular, mixed UI is generally associated with worse symptoms and less successful treatment. Yet, limited information exists on the natural history of different urinary incontinence (UI) subtypes, which could help better identify and treat patients prior to development of more intractable disease.

Objective: To evaluate the onset of UI subtypes, and transitions between subtypes over 8 years, using two large cohorts of middle-age and older women with incident UI.

Study Design: We identified 10,349 women with incident UI (stress, urgency, and mixed subtypes), from the Nurses' Health Study and Nurses' Health Study II, age 41–83 years, using repeated mailed questionnaires. We defined stress UI as leakage with coughing, sneezing, or activity; urgency UI as urine loss with a sudden feeling of bladder fullness or when a toilet was inaccessible; and mixed UI when women reported that stress and urgency symptoms occurred

Corresponding Author: Vatche Minassian, MD MPH, 75 Francis St, Boston, MA 02115, (617) 732-4838, vminassian@partners.org.

Publisher's Disclaimer: This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

equally. In subsequent questionnaires 4 and 8 years later, we continued to track symptom severity and subtypes. In addition, to obtain predicted probabilities of UI subtypes 4 years and 8 years after UI onset, we used multivariable-adjusted generalized estimated equations with a multinomial outcome.

Results: At UI onset in 2004-5, 56% of women reported stress UI symptoms, 23% reported urgency UI symptoms, and 21% reported mixed UI symptoms. Women with stress UI or urgency UI at onset were likely to report the same UI type 4 and 8 years later (Stress UI at onset: 70% and 60% reported stress UI at years 4 and 8, respectively; Urgency UI at onset: 68% and 64% reported urgency UI at years 4 and 8, respectively). Nonetheless, for both stress and urgency UI, women with more severe symptoms at onset were more likely to progress to mixed UI. Women with mixed UI at onset had more variation over time, although the largest subset continued to report mixed UI (45% reported mixed UI at year 4, 43% reported mixed UI at year 8). Few women across all UI subtypes reported resolution of symptoms over 4 to 8 years of follow-up (4-12%).

When considering the likelihood of remaining with or progressing to mixed UI over follow-up, according to age, body mass index and UI severity, we found that older and younger women had similar predicted probability of remaining with or progressing to mixed UI (e.g., women <60 years old at onset with severe mixed UI had a 54% (95% CI: 53, 55) probability of mixed UI 8 years later vs. 57% (95% CI: 56, 58) of women 70 years old with severe mixed UI at onset). Obese women were somewhat more likely to progress to mixed UI regardless of UI type at onset (e.g., women with BMI <25 kg/m² at onset with severe stress UI had a 30% predicted probability of mixed UI 8 years after onset vs. 36% of women with BMI of 30+ kg/m² at onset with severe stress UI).

Conclusions: Most women with incident stress and urgency UI continued to experience similar subtype symptoms over 8 years. However, obese women and those with more severe symptoms were more likely to remain with or progress to mixed UI.

Keywords

Stress; urgency; and mixed urinary incontinence; natural history; progression; transition; severity

INTRODUCTION

Urinary incontinence (UI) is a physically and economically burdensome condition that is common among middle-aged and older women, with a prevalence ranging from 30-60%.¹ Prior data on prevalence of UI subtypes demonstrates that stress UI tends to be the most common among middle-aged women, while prevalence of urgency and mixed UI start relatively low and gradually increase after the fourth decade of life.^{2,3}

Mixed UI is associated with more severe symptoms, has worse impact on quality of life compared to stress UI or urgency UI,⁴⁻⁹ and is the most challenging subtype to treat. Yet, it is unknown whether mixed UI is a consequence of the natural progression of pure UI symptoms (i.e., stress or urgency) or if it develops independently without transitioning through stress or urgency UI. Knowledge of the natural history of UI subtypes is critical to prevention, clinical management, and informing discussions between patients and providers.

This information is also critical to the development of different management and treatment strategies along the continuum of disease.

In this analysis, we utilized data from the Nurses' Health Study I & II, two large prospective cohorts of middle-aged and older women, with repeated measures of UI collected from regular mailed questionnaires, to understand the trajectory of UI subtype symptoms in women with incident UI followed for 8 years.

METHODS

Study Population

The Nurses' Health Study (NHS) was initiated in 1976 when 121,700 female registered nurses ages 30-55 years responded to a mailed questionnaire about their medical history and lifestyle. Using similar methodology, the Nurses' Health Study II (NHS II) was initiated in 1989. The population included women between 25-42 years old; the upper age was selected to correspond with the lowest age in NHS. A total of 116,430 women were enrolled in NHS II. Both cohorts utilize identical methods for data collection and follow-up, including biennial mailed questionnaires to update health and lifestyle information. During each questionnaire cycle, full-length questionnaires are sent in initial mailings, followed by abbreviated questionnaires to maximize participation. The Institutional Review Board of Brigham and Women's Hospital approved both the Nurses' Health Study and Nurses' Health Study II.

Urinary Incontinence

To obtain information on UI, women were asked, "During the past 12 months, how often have you leaked or lost control of your urine?" Response choices were never, < 1/month, 1/month, 2-3/month, approximately 1/week, and almost every day. Women reporting any UI were then asked, "When you lose your urine, how much usually leaks?" Response options were a few drops, enough to wet your underwear, enough to wet your outer clothing, and enough to wet the floor. A reliability study among a subgroup of these nurses demonstrated high reproducibility of responses to these questions.¹⁰

UI subtype was ascertained from all women reporting UI on the questionnaires starting in 2004 (NHS) and 2005 (NHS II). We defined 'stress UI' as report of leakage occurring with coughing or sneezing, lifting things, laughing, or exercise. Urine loss with a sudden feeling of bladder fullness or when a toilet was inaccessible was considered 'urgency UI'. UI classifications were based on the participants' reports of their dominant symptoms. Women who reported that stress and urgency symptoms occurred equally were defined as cases of 'mixed UI'.

UI severity was measured by the Sandvik severity index. The Sandvik index is well-validated.¹¹ We calculated severity by multiplying the reported frequency of UI by the amount of leakage.¹¹ Frequency of UI was assigned a value from 1 to 4, with both <1/month and 1/month assigned a score of 1, and subsequently higher numbers indicating greater frequency. The amount of leakage was assigned a value of 1 for drops or 2 for more than drops. After multiplying scores for frequency and amount, women with a total score of 1 to

2 were classified as having slight UI severity, those with a score of 3 to 4 were classified as having moderate UI severity, and those with a score of 6 or more with severe UI.

For these analyses, we utilized similar follow-up for both cohorts to ensure comparability of findings; we identified new onset of UI in 2004 for the NHS cohort and 2005 for the NHS II cohort (i.e., after excluding women who reported having UI in the preceding time period, 2002 (NHS) and 2003 (NHS II)). We therefore defined new UI onset as women who had no UI in the survey prior to the baseline survey, acknowledging the fact that some women defined as new onset UI may have had history of UI in their distant past that had resolved. To track UI symptoms over time, we utilized data on UI subtype and UI severity every 4 years over 8 years of follow-up after this first report of symptoms, using information on UI from participants in NHS in 2008 and 2012 and in NHS II in 2009 and 2013.

Measurement of Demographic and Health Characteristics

We used data from the cohort questionnaires in 2004 (NHS) and 2005 (NHS II) to obtain information on demographic, health, and lifestyle factors, including age, race, height and weight, reproductive history, smoking, postmenopausal hormone use, and hysterectomy. Women reported the number of hours spent on various leisure activities (e.g., walking, running) during the past year on the 2004 questionnaire (NHS) and 2005 questionnaire (NHS II), and total energy expenditure was calculated in metabolic-equivalent task hours per week, which has been previously described in detail.²⁰ In addition, women reported diagnoses of stroke, myocardial infarction, and type 2 diabetes on every questionnaire.

Population for Analysis

Since our focus here is new-onset UI in 2004 (for NHS) or 2005 (in NHSII), we excluded women who did not have UI as well as women with prevalent UI at those time points. Thus, the study population from NHS included the 3,393 women with incident UI in 2004 who provided follow-up information in 2008 and 2012. Similarly, for Nurses' Health Study II, the study population included the 6,956 women with incident UI in 2005, who provided follow-up information on the subsequent questionnaires in 2009 and 2013. Overall then, the analyses presented are based on 10,349 women in NHS and NHSII with incident UI in 2004/2005 with an age range of 41-84 at baseline and 8 years older at follow-up.

Statistical Analysis

To evaluate changes in UI subtype over time, we calculated predicted probabilities and 95% confidence intervals using the beta estimates from multivariable multinomial regression models, using generalized estimating equations (GEEs) with an independent correlation structure; the predicted probabilities provide results with easier clinical interpretation than standard measures of association, such as relative risks. The GEEs, an extension of generalized linear models that account for correlated repeated measurements within individuals, allow for the analysis of the correlated data on UI over time, modeled while accounting for within-participant correlation. We included the following variables that impacted the model, measured at UI onset: UI severity (mild, moderate, severe), UI type (stress, urge mixed), age (50-<60, 60-<70, 70+), body mass index (<25 kg/m², 25-<30 kg/m², 30+ kg/m²), and physical activity (quartiles) to evaluate how these characteristics

may influence UI subtype 4 years and 8 years after UI onset. Although the models accounted for all the variables mentioned, for ease of presentation in the results, we chose to focus on contrasts in age (ie, <60 years and 70+ years) as well as in BMI categories (ie, <25 and 30+ kg/m²), commonly-measured factors in clinical practice. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC). Ethics approval was obtained from the institutional review board.

RESULTS

Among the 10,349 women with incident UI in 2004/2005 from NHS and NHSII, 56% had stress UI, 23% had urgency UI, and 21% had mixed UI at onset. As shown in Table 1, women with urgency UI or mixed UI at onset were older (mean age: stress UI=54.6 years, urgency UI=60.0 years, mixed UI=57.7 years) and had a somewhat higher BMI (mean BMI: stress UI= 27.6 kg/m², urgency UI=28.8 kg/m², mixed UI= 28.4 kg/m²) compared to women with stress UI at onset. Women with urgency UI or mixed UI at onset also reported more severe UI symptoms at UI onset, compared to women with stress UI (severe symptoms: stress UI= 14%, urgency UI=19%, mixed UI=24%) (Table 1).

In Table 2, we examined the progression of UI subtype and severity both at 4 as well as at 8 years of follow-up. Women with stress UI or urgency UI at onset were likely to report the same UI subtype over follow-up. For example, among women with mild or moderate stress UI at onset (n=4,915), 70% reported stress UI 4 years later and 60% reported stress UI 8 years later. Although similar patterns were observed with severe stress UI, women with severe stress UI at onset (n=848) reported more progression to mixed UI over follow-up compared to women with mild/moderate stress UI at onset. For example, 13% of women with mild or moderate stress UI at onset reported mixed UI 4 years later; in contrast, among women with severe stress UI, 19% reported mixed UI 4 years later. More women with mild/moderate (versus severe) stress UI reported resolution of UI over follow-up; among those with mild/moderate symptoms at onset, 12% and 17% reported no symptoms 4 and 8 years later, respectively, while these figures were 6% and 12% for those with severe symptoms of stress UI at onset.

Among women with mild or moderate urgency UI at onset (n=1,973, Table 2), 68% reported urgency UI 4 years later and 63% reported urgency UI after 8 years of follow-up. Similar patterns were also observed among women reporting severe urgency UI at onset. However, women with severe urgency UI at onset (n=450) reported more progression to mixed UI over follow-up, compared to women with mild or moderate urgency UI. For example, 15% of women with mild or moderate urgency UI at onset reported mixed UI 4 years later. Among women with severe urgency UI, 23% reported mixed UI 4 years later. Even fewer women with urgency UI than stress UI at onset reported resolution of UI over follow-up; among those with mild/moderate urgency UI, 8% and 13% reported no symptoms after 4 and 8 years, respectively, and these figures were 5% and 4% among those with severe urgency UI at onset.

Women with mixed UI symptoms at onset (Table 2) tended to have more variation in the trajectory of their symptoms over follow-up, although the largest group continued to have

mixed UI. For example, among women reporting mild or moderate mixed UI (n=1,636), 42% reported mixed UI, 25% reported stress UI and 25% reported urgency UI 4 years later. Similar trends were also observed after 8 years. Women with severe mixed UI (n=527) were more likely to continue to report mixed UI symptoms over follow-up compared to women with mild or moderate mixed UI (56% of women with severe mixed UI at onset reported mixed UI, 18% reported stress UI and 22% reported urgency UI) 4 years after onset. Similar trends were also observed 8 years after UI onset. Remission of UI symptoms was low; among those with mild/moderate mixed UI, 8% and 11% reported no symptoms after 4 and 8 years, respectively, and these figures were 4% and 6% among those with severe mixed UI at onset.

When we examined severity of UI symptoms over 4 and 8 years of follow-up (Table 2), we found that women with urgency UI or mixed UI were more likely to report severe UI symptoms over follow-up compared to women with stress UI at onset. Only 12% of women with mild or moderate stress UI reported severe UI symptoms 8 years later. Among women with severe stress UI, 38% reported severe symptoms at year 8. In comparison, among women with mild or moderate urgency UI, 22% reported severe UI symptoms 8 years later. Among women with severe urgency UI at onset, most persisted with severe UI over follow-up (50% and 59%, respectively at 4 and 8 years of follow-up). Similarly, among women with mild/moderate mixed UI, 20% reported severe symptoms 8 years later. Among women with severe mixed UI at onset, 57% persistent severe symptoms at year 4 and 55% at year 8.

We next modeled different patient profiles based on age and body mass index to predict patterns of UI symptom progression among these groups (Table 3). Among women <60 years (N=7183) and women 70+ years (N=1696), the predicted probabilities of progressing from urgency to mixed UI were modest; for example, women less than 60 years old at UI onset with mild or moderate urgency UI had a 17% (95% CI: 17, 18) probability of mixed UI 8 years after onset; among women 70 years or older with mild or moderate urgency UI, this probability was 16% (95% CI: 16, 17). On the other hand, women less than 60 years old with severe stress UI at onset had a 23% (95% CI: 23, 24) predicted probability of mixed UI 8 years later; for women 70 years or older, this probability was 33% (95% CI: 32-33).

We also considered different patient profiles based on BMI at UI onset (Table 4). We found that women with a BMI of less than 25 kg/m² (N=4365) with mild or moderate stress UI at onset had a 21% (95% CI: 20, 21) predicted probability of mixed UI 8 years later; this probability was 25% (95% CI: 25, 26) for women with a BMI of 30 kg/m² or more (N=2587). Similar patterns were also observed for urgency UI. Finally, among women with mild or moderate mixed UI, women with BMI of less than 25 kg/m² at UI onset had a 47% (95% CI: 46, 48) predicted probability of mixed UI 8 years later; this probability was 52% (95% CI: 52, 53) for women with a BMI of 30 kg/m² or more at UI onset.

DISCUSSION

Principal Findings

In this cohort of women between the ages of 41-84 years, incident stress UI (56%) was most prevalent followed by urgency UI (23%) and mixed UI (21%). Overall, we observed that the

prevalence of pure UI subtypes (as opposed to mixed UI) was generally more stable over 4 and 8 years among both younger and older women with incident UI at baseline. About 2/3 of women with incident stress or urgency UI continued to experience persistent stress or urgency symptoms over 8 years. Women with incident mixed UI symptoms at baseline had more variation in UI symptoms over follow-up with 2/5 reporting persistent mixed UI symptoms at follow-up.

Results

When we examined severity of UI symptoms over 4 and 8 years of follow-up, we found that women with urgency UI or mixed UI were more likely to report severe UI symptoms over follow-up compared to women with stress UI at onset. Furthermore, women with severe UI at onset were more likely to transition to mixed UI over time. These findings together suggest at least two possible pathways for new onset mixed UI, one that develops *de novo* from no UI as exemplified by the 2,163 incident mixed UI cases in our cohort, and another that develops as women with more severe UI transition from stress or urgency UI to mixed UI over a period of 4-8 years.

Moreover, when we considered different patient profiles based on age and body mass index categories, we found that women over 70 years old with stress UI at onset, and obese women of any UI subtype had a higher predicted probability of remaining with or progressing to mixed UI. This effect of age on the UI natural history suggests that for older women, a driver of new onset mixed UI as it transitions from one subtype to the other may be stress UI. Since obesity is a modifiable risk factor and it appears to be a marker for persistent mixed UI, women with high BMI could be identified early during their disease and targeted with weight loss programs to prevent the transition to mixed UI.

Clinical and Research Implications

In previous studies, mixed UI has been associated with more severe symptoms, similar to our findings here, and worse impact on quality of life compared to stress UI or urgency UI.⁴⁻⁹ The underlying cause of mixed UI is poorly understood and the etiology of mixed UI has been largely unknown,^{12,13} although in our previous work, and in other studies, the incidence and prevalence of mixed UI increases over time into late adulthood.^{2,3,14} In the current analysis, we found there to be two phenotypes for mixed UI: 1) women who have mixed UI symptom onset and 2) a smaller number of women who transition to mixed UI after having stress or urgency UI symptoms at onset. Women with worse initial symptoms, older women with stress UI, and obese women were more likely to progress to mixed UI. Based on these findings, it may be important in future research to develop and test different strategies to address these differing trajectories to mixed UI phenotypes.

Strengths and Limitations

A major strength of our study is the multiple repeated measures of UI and UI subtype over time among both younger and older women. Our study also has several limitations. First, UI information was self-reported; however we have previously demonstrated high reliability of self-reported incontinence symptoms among these women,¹⁰ and other studies have demonstrated high validity of self-reported incontinence compared to clinical assessment.¹⁵

Additionally, our assessment of UI symptoms via mailed questionnaire helps to reduce embarrassment that might otherwise cause underreporting of UI among women. Secondly, our study population is relatively homogenous, consisting of nurses who are predominantly white, which may limit generalizability to minorities (in whom UI prevalence and incidence appear to be different); at the same time, we would expect accurate reporting of symptoms and health status in this population of nurses, which likely strengthens the internal validity of our findings. Moreover, although our participants are health professionals, and may be forced to delay voiding due to their work demands (eg, “nurses’ bladder”), in previous research on UI in this cohort, we have consistently found that UI prevalence, incidence, and risk factors are similar to those in other populations, and thus findings here are likely generalizable to White women.¹⁶ Although UI remission rates were generally low, it is possible within each of our 4-year follow-up periods that there was both remission and re-initiation of symptoms. Lastly, the majority of women in our cohort do not seek treatment and the observed changes in UI subtype prevalence estimates over time cannot be attributed to treatment seeking behavior.¹⁷

Conclusions

To summarize, the majority of women in our cohort with incident UI continued to experience the same subtype of UI over time with more variation observed in women with mixed UI. Older women with incident stress UI, obese women and those with severe symptoms at onset were more likely to transition into or persist within mixed UI. These data could help clinicians to better target women with worse initial symptoms, and obese women, in discussing treatment strategies to reduce likelihood of progressing to mixed UI. Future studies are needed to better characterize the mixed UI phenotypes and associated risk factors both for mixed UI incidence as well as for progression to mixed UI from other subtypes, with the goal of better understanding the natural history of UI and preventing mixed UI.

Acknowledgments

Funding: The research in this publication was supported by the National Institutes of Health (Grants UM1 CA186107, UM1 CA176726, R01 DK105050). Dr. Erekson was supported by The Dartmouth Clinical and Translational Science Institute, under award number KL2TR001088 from the National Center for Advancing Translational Sciences (NCATS) of the National Institutes of Health (NIH).

REFERENCES

1. Landefeld CS, Bowers BJ, Feld AD, et al. National Institutes of Health state-of-the-science conference statement: prevention of fecal and urinary incontinence in adults. *Annals of internal medicine*. 2008;148(6):449–458. [PubMed: 18268289]
2. Jahanlu D, Hunskaar S. Type and severity of new-onset urinary incontinence in middle-aged women: the Hordaland Women's Cohort. *Neurourology and urodynamics*. 2011;30(1):87–92. [PubMed: 20860018]
3. Hannestad YS, Rortveit G, Sandvik H, Hunskaar S, Norwegian EsEoItCoN-T. A community-based epidemiological survey of female urinary incontinence: the Norwegian EPINCONT study. *Epidemiology of Incontinence in the County of Nord-Trondelag. Journal of clinical epidemiology*. 2000;53(11):1150–1157. [PubMed: 11106889]
4. Felde G, Bjelland I, Hunskaar S. Anxiety and depression associated with incontinence in middle-aged women: a large Norwegian cross-sectional study. *International urogynecology journal*. 2012;23(3):299–306. [PubMed: 22068320]

5. Melville JL, Walker E, Katon W, Lentz G, Miller J, Fenner D. Prevalence of comorbid psychiatric illness and its impact on symptom perception, quality of life, and functional status in women with urinary incontinence. *American journal of obstetrics and gynecology*. 2002;187(1):80–87. [PubMed: 12114892]
6. Minassian VA, Devore E, Hagan K, Grodstein F. Severity of urinary incontinence and effect on quality of life in women by incontinence type. *Obstetrics and gynecology*. 2013;121(5):1083–1090. [PubMed: 23635747]
7. Melville JL, Fan MY, Rau H, Nygaard IE, Katon WJ. Major depression and urinary incontinence in women: temporal associations in an epidemiologic sample. *American journal of obstetrics and gynecology*. 2009;201(5):490 e491–497. [PubMed: 19716547]
8. Asoglu MR, Selcuk S, Cam C, Cogendez E, Karateke A. Effects of urinary incontinence subtypes on women's quality of life (including sexual life) and psychosocial state. *Eur J Obstet Gynecol Reprod Biol*. 2014;176:187–190. [PubMed: 24630299]
9. Coyne KS, Zhou Z, Thompson C, Versi E. The impact on health-related quality of life of stress, urge and mixed urinary incontinence. *BJU Int*. 2003;92(7):731–735. [PubMed: 14616456]
10. Grodstein F, Fretts R, Lifford K, Resnick N, Curhan G. Association of age, race, and obstetric history with urinary symptoms among women in the Nurses' Health Study. *American journal of obstetrics and gynecology*. 2003;189(2):428–434. [PubMed: 14520212]
11. Sandvik H, Hunskaar S, Seim A, Hermstad R, Vanvik A, Bratt H. Validation of a severity index in female urinary incontinence and its implementation in an epidemiological survey. *Journal of epidemiology and community health*. 1993;47(6):497–499. [PubMed: 8120507]
12. Bandukwala NQ, Gousse AE. Mixed urinary incontinence: what first? *Curr Urol Rep*. 2015;16(3):9. [PubMed: 25677232]
13. Minassian VA, Bazi T, Stewart WF. Clinical epidemiological insights into urinary incontinence. *International urogynecology journal*. 2017;28(5):687–696. [PubMed: 28321473]
14. Lifford KL, Townsend MK, Curhan GC, Resnick NM, Grodstein F. The epidemiology of urinary incontinence in older women: incidence, progression, and remission. *J Am Geriatr Soc*. 2008;56:1191–8. [PubMed: 18492035]
15. Bradley CS, Brown JS, Van Den Eeden SK, Schembri M, Ragins A, Thom DH. Urinary incontinence self-report questions: reproducibility and agreement with bladder diary. *International urogynecology journal*. 2011;22(12):1565–1571. [PubMed: 21796472]
16. Hagan KA, Erekson E, Austin A, Minassian VA, Townsend MK, Bynum JP, Grodstein F. A Prospective Study of the Natural History of Urinary Incontinence in Women. *Am J Obstet Gynecol*. 2018 218(5):502.e1–502.e8 [PubMed: 29425839]
17. Erekson E, Hagan KA, Austin A, Donald Carmichael MD, Minassian VA, Grodstein F, Bynum JP. Outpatient Evaluation and Management Visits for Urinary Incontinence in Older Women. *J Urol*. 2019 . PMID: 30865568

CONDENSATION

Most women with incident stress, urgency and mixed urinary incontinence continue to experience similar subtype symptoms over 8 years with varying degrees.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

AJOG at a GLANCE**Why was the study conducted?**

- To evaluate the onset of stress, urgency and mixed urinary incontinence and transitions between subtypes over 8 years.

What are the key findings?

- About 2/3 of women with either stress or urgency urinary incontinence continue to have similar symptoms at 4 and 8 years.
- About 2/5 of women with mixed urinary incontinence continue to have similar symptoms at 4 and 8 years.
- Obese women and those with more severe symptoms are more likely to remain with or progress to mixed incontinence.

What does this study add to what is already known?

- Although most women who develop urinary incontinence continue to have similar symptoms over time, some women transition into other subtypes.
- Few women (4-12%) report resolution of urinary incontinence symptoms over time.
- Mixed urinary incontinence may develop from transition of stress or urgency to mixed incontinence or from denovo onset of mixed symptoms.

Table 1.Age-adjusted characteristics of women (age 41-84 years) at baseline UI onset in the Nurses' Health Studies¹

	Stress UI (n=5763)	Urgency UI (n=2423)	Mixed UI (n=2163)	p-value ²
Mean Age (SD), yrs ³	54.6 (8.9)	60.0 (10.6)	57.7 (10.1)	<0.01
White Race, %	98	97	97	0.20
Mean BMI (SD), kg/m ²	27.6 (6.0)	28.2 (6.8)	28.4 (6.6)	<0.01
Parity, %				<0.01
0	12	15	12	
1-2	49	47	47	
3+	39	38	41	
Smoking, %				<0.01
Never	60	59	58	
Past	33	34	35	
Current	7	7	7	
Mean Physical Activity (SD), METs/week	22.7 (28.0)	21.4 (27.1)	21.1 (25.5)	<0.01
Hysterectomy, %	14	18	17	0.14
Diabetes, %	6	7	7	<0.01
History of vascular disease, % ⁴	3	3	4	<0.01
Postmenopausal hormone use, %				<0.01
Never	20	22	21	
Past	27	32	33	
Current	18	17	16	
Premenopausal (not eligible for hormone therapy)	35	29	31	
Baseline UI severity, % ⁵				<0.01
Mild	44	34	31	
Moderate	42	47	45	
Severe	14	19	24	

Values are means (SD) or percentages and are standardized to the age distribution of the study population.

¹Characteristics measured in 2004 for Nurses' Health Study participants. Characteristics measured in 2005 for Nurses' Health Study II participants.

²P-value calculated using ANOVA for continuous variable and χ^2 for categorical variables.

³Value is not age-adjusted

⁴History of vascular disease includes MI or stroke.

⁵Severity measured by the Sandvik Severity Index.

Crude percentages for progression of UI subtype and severity from onset through 4 and 8 years of follow-up for women age 41-84 years, in the Nurses' Health Studies.

Table 2.

Subtype & Severity at UI onset*	Subtype at Year 4 (%)			Subtype at Year 8 (%)			Severity at Year 4 (%)			Severity at Year 8 (%)		
	No UI	Stress	Urge	Mixed	No UI	Stress	Urge	Mixed	No UI	Mild/Mod	Severe	Severe
Stress (n=5763)												
Mild/Mod (n=4,915)	12	70	5	13	17	60	7	16	12	78	10	12
Severe (n=848)	6	70	5	19	12	61	6	21	6	55	39	38
Urgency (n=2423)												
Mild/Mod (n=1,973)	8	9	68	15	13	7	63	17	8	76	16	22
Severe (n=450)	5	4	68	23	4	5	67	24	5	45	50	59
Mixed (n=2163)												
Mild/Mod (n=1,636)	8	25	25	42	11	21	28	40	8	77	15	20
Severe (n=527)	4	18	22	56	6	18	24	52	4	39	57	55

* Incident UI cases at baseline

Table 3.

Predicted probabilities (95% confidence intervals) of UI symptoms after 8 years of follow-up among women in Nurses' Health Studies according to age at UI onset.

<i>N=7183</i>		<i>At Year 8</i>			
<i><60 years old at UI onset</i>		Predicted Probability* of UI Symptoms			
<i>Subtype/Severity at Onset</i>		No UI	Stress	Urgency	Mixed
<i>Stress</i>					
<i>Mild/Moderate</i>		17 (15, 19)	62 (60, 63)	6 (6, 6)	16 (15, 16)
<i>Severe</i>		9 (8, 11)	61 (60, 61)	6 (6, 7)	23 (23, 24)
<i>Urgency</i>					
<i>Mild/Moderate</i>		13 (11, 15)	7 (7, 7)	63 (62, 65)	17 (17, 18)
<i>Severe</i>		7 (5, 8)	7 (6, 7)	63 (62, 64)	24 (23, 24)
<i>Mixed</i>					
<i>Mild/Moderate</i>		11 (9, 13)	21 (21, 22)	25 (24, 26)	43 (42, 44)
<i>Severe</i>		5 (4, 6)	18 (17, 18)	23 (22, 23)	54 (54, 55)
<i>70 years old at UI onset</i>		Predicted Probability* of UI Symptoms			
<i>N=1696</i>		<i>At Year 8</i>			
<i>Subtype/Severity at Onset</i>		No UI	Stress	Urgency	Mixed
<i>Stress</i>					
<i>Mild/Moderate</i>		14 (12, 18)	52 (51, 53)	11 (10, 11)	23 (22, 24)
<i>Severe</i>		8 (6, 10)	49 (48, 49)	11 (10, 11)	33 (32, 33)
<i>Urgency</i>					
<i>Mild/Moderate</i>		7 (6, 9)	4 (4, 4)	73 (71, 74)	16 (16, 17)
<i>Severe</i>		4 (3, 5)	4 (3, 4)	71 (70, 72)	22 (22, 22)
<i>Mixed</i>					
<i>Mild/Moderate</i>		7 (6, 9)	13 (13, 14)	33 (32, 33)	47 (46, 48)
<i>Severe</i>		3 (2, 4)	11 (11, 11)	29 (28, 29)	57 (56, 57)

* Predicted probabilities calculated setting body mass index at 25-30 kg/m² and physical activity at 13.8-29.5 METs/week.

Predicted probabilities of UI symptoms after 8 years of follow-up among women in Nurses' Health Studies according to body mass index at UI onset.

Table 4.

<i>BMI <25 kg/m² at UI onset</i>		Predicted Probability* of UI Symptoms		
<i>N=4365</i>		<i>At Year 8</i>		
<i>Subtype/Severity at Onset</i>	<i>No UI</i>	<i>Stress</i>	<i>Urgency</i>	<i>Mixed</i>
<i>Stress</i>				
<i>Mild/Moderate</i>	14 (11, 16)	57 (56, 59)	9 (8, 9)	21 (20, 21)
<i>Severe</i>	7 (6, 9)	54 (53, 54)	9 (8, 9)	30 (29, 31)
<i>Urgency</i>				
<i>Mild/Moderate</i>	8 (6, 10)	5 (5, 5)	70 (68, 71)	18 (17, 18)
<i>Severe</i>	4 (3, 5)	5 (4, 5)	68 (67, 69)	24 (23, 24)
<i>Mixed</i>				
<i>Mild/Moderate</i>	7 (6, 9)	16 (16, 16)	29 (28, 30)	47 (46, 48)
<i>Severe</i>	3 (2, 4)	13 (13, 13)	26 (25, 26)	58 (57, 58)
<i>BMI 30+ kg/m² at UI onset</i>		Predicted Probability* of UI Symptoms		
<i>N=2587</i>		<i>At Year 8</i>		
<i>Subtype/Severity at Onset</i>	<i>No UI</i>	<i>Stress</i>	<i>Urgency</i>	<i>Mixed</i>
<i>Stress</i>				
<i>Mild/Moderate</i>	12 (10, 15)	53 (52, 54)	9 (8, 10)	25 (25, 26)
<i>Severe</i>	7 (5, 8)	49 (48, 49)	9 (9, 10)	36 (35, 36)
<i>Urgency</i>				
<i>Mild/Moderate</i>	7 (5, 8)	4 (4, 5)	69 (68, 70)	20 (20, 20)
<i>Severe</i>	3 (2, 4)	4 (4, 4)	66 (65, 67)	27 (26, 27)
<i>Mixed</i>				
<i>Mild/Moderate</i>	6 (5, 7)	14 (14, 14)	28 (27, 29)	52 (52, 53)
<i>Severe</i>	3 (2, 4)	11 (11, 11)	24 (24, 25)	62 (62, 63)

* Predicted probabilities calculated setting age at 60-70 years and physical activity at 13.8-29.5 METs/week.