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Association between Menopausal Transition Stages and Developing Urinary Incontinence

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Abstract

Objective—To estimate whether menopause transition stage is independently associated with the development of incontinence symptoms.

Methods—We conducted a longitudinal analysis, using discrete proportional hazards models, of women who were continent at baseline in the Study of Women's Health Across the Nation (SWAN), a multi-center, multi-racial/ethnic prospective cohort study of community-dwelling mid-life women transitioning through menopause. At baseline and each of the 6 annual visits, SWAN elicited frequency and type of incontinence in a self-administered questionnaire and classified menopausal stage from menstrual bleeding patterns.

Results—Compared to being in premenopause, being in the early peri-menopause (incidence 17.8 per 100 woman years) made it 1.34 times and being in the late peri-menopause (incidence 14.5 per 100 woman years) made it 1.52 times more likely for women to develop monthly or more frequent incontinence. In contrast, women in postmenopause (incidence 8.2 per 100 woman years) were approximately half as likely to develop this degree of incontinence. This pattern of association across the menopausal transition was similar for stress and urge incontinence. However, menopausal stage was not associated with developing more frequent incontinence (leaking several times per week or more). Worsening anxiety symptoms, a high baseline BMI, weight gain and new onset diabetes were associated with developing more frequent incontinence.

Conclusions—Menopausal transition stage was associated with developing monthly or more frequent but not weekly or more frequent incontinence, suggesting that only infrequent incontinence symptoms were attributable to the peri-menopause. Since modifiable factors such as anxiety, weight gain, and diabetes were associated with developing more frequent incontinence,

determining whether healthy life changes and treating medical problems can prevent incontinence is a priority.

INTRODUCTION

Urinary incontinence is a common problem in middle-aged and older women associated with decreased quality of life (1). Prevalence estimates in mid-life women range from about 5% for severe to 60% for mild incontinence (2, 3). Because prevalent incontinence has been associated with postmenopausal status by clinicians and in epidemiological studies (4), it is often considered a symptom attributable to the change from the reproductive estrogen levels of pre-menopause to the lower estrogen levels of postmenopause as occurs across the menopausal transition (5).

The menopause transition is a series of stages of variable length from pre-, early peri- and late peri- to postmenopause defined by changes in menstrual and hormonal patterns. Results from cross-sectional epidemiological studies show an increase in prevalence of incontinence among women between the ages of 45 and 55 years, an age range that coincides with the menopause transition (2). Some studies have found no association between the menopausal transition and the risk for developing incontinence, (6) but this association remains uncertain.

In a previous set of analyses, we showed that the *worsening* of incontinence was not associated with menopausal transition stage in women with incontinence (7). Our main objective in the present analyses was to estimate whether menopause transition stages were independently associated with the *development* of any, stress or urge urinary incontinence symptoms in women who were continent at baseline. We also considered whether other modifiable factors that change over time, such as changes in weight and medical conditions, affected the development of incontinence.

METHODS

We analyzed data from 1529 women enrolled in the Study of Women's Health Across the Nation (SWAN) who reported no incontinence at baseline and followed them through 6 annual follow-up visits (1995–2002) (Figure 1). SWAN is a multi-center, multiethnic, prospective study of the menopause transition (8) funded by the National Institute of Aging (NIA). Seven clinical sites (Boston, Massachusetts; Chicago, Illinois; the Detroit area, Michigan; Los Angeles, California; Newark, New Jersey; Pittsburgh, Pennsylvania; and Oakland, California) recruited a total cohort of 3302 women. Eligibility criteria for entry into the SWAN cohort were age 42–52 years and self-identification as one of five racial/ethnic groups (African American, Hispanic, Chinese, Japanese, Caucasian). Exclusion criteria included inability to speak English, Spanish, Japanese, or Cantonese, no menstrual period in greater than 3 months before enrollment, hysterectomy and/or bilateral oophorectomy prior to enrollment, and current pregnancy, lactation, or hormone use. The institutional review boards at all sites approved SWAN, and all women gave informed consent to participate.

A self-administered questionnaire assessed incontinence at baseline and at each follow-up visit. Based on response to the question: “In the past year/since your last study visit, have you ever leaked even a small amount of urine involuntarily?”, we classified frequency of incontinence as “almost daily/daily” (daily), “several days per week” (weekly), “less than one day per week” (monthly), “less than once a month” or “none.” We defined any incontinence as incontinence occurring at least monthly. We considered incontinence occurring less than once a month as clinically insignificant and subject to higher

misclassification and thus combined this category with “no incontinence.” We categorized type of incontinence as “stress” if participants reported leakage with “coughing, laughing, sneezing, jogging, jumping, with physical activity or picking up an object from the floor” or as “urge” if participants reported leakage “when you have the urge to void and can’t reach the toilet fast enough.” We defined “any” incontinence as either stress or urge symptoms. Women who reported new onset incontinence at any of the 6 annual follow-up visits were compared to women who did not develop incontinence over the same time frame.

SWAN classified menopausal status annually from menstrual bleeding patterns. Pre-menopause was less than three months of amenorrhea and no menstrual irregularities in the previous year; early peri-menopause was less than three months of amenorrhea and some menstrual irregularities in previous year; late peri-menopause was three to 11 months of amenorrhea; and postmenopause as 12 consecutive months of amenorrhea. Women who used hormone therapy (oral contraceptives or systemic estrogen and/or progestin) prior to the last menstrual period were considered to have an “unclassifiable” menopausal status at the time of use. Similarly, we could not classify the menopausal stage of women who underwent hysterectomy as data on whether one or both ovaries remained in situ could not be confirmed. To assess whether change in menopausal status was associated with the development of incontinence, we created a variable with four mutually exclusive categories comparing the status in the previous year to the current year, ie: change in menopausal stage (eg: from pre- to early peri-menopause); started hormones (from any stage to hormone use); or stopped hormones (from hormone use to none) compared with no change in stage or hormone use.

We calculated body mass index (BMI) as weight in kilograms/(height in meters)² based on measurements taken annually by certified staff who used calibrated scales and a stadiometer. Socioeconomic status was approximated by level of difficulty paying for basics (food, heat and shelter). Interviewers obtained self-reported medical histories, smoking history and medication use. Each year SWAN used the same questions from the Center for Epidemiological Studies-Depression scale (9) (for characterizing our cohort, we defined depressive symptoms as a score of 16 or above), the Medical Outcomes Study Social Support Survey (10), the Life Stressors and Social Resources Inventory (11), and the Psychiatric Epidemiology Research Interview (12). SWAN measured anxiety symptoms by a summed score of days in the past two weeks in which certain symptoms were experienced (grouchiness or irritability, feeling tense or nervous, pounding or racing heart, feeling fear for no reason); for characterizing our cohort, we defined anxiety symptoms by a score of 4 or more (13). At year one only, SWAN combined responses to questions assessing sensitivity to physical sensations into a Symptom Sensitivity Scale (14)

Our fixed or baseline covariates included baseline age, race/ethnicity, BMI, diabetes, hypertension, self-reported diagnosis of fibroids, parity, marital status, socioeconomic status, education, social support, general health and symptom sensitivity. Time dependent co-variables were menopausal status, hormone use prior to the final menstrual period, new self-reported diabetes and hypertension, smoking status (never, ever, current). We created variables to represent change in certain characteristics by subtracting values in the current year from values in the previous year: weight change (per pound), waist to hip ratio change (per 0.1 units), anxiety and depressive symptoms score change (per one unit), change in the number of stressful life events (per one event), change in social support scores (per one unit), and overall health status change on a five-point scale.

Drop outs were those deceased, who discontinued the study voluntarily, or who could not be contacted after missing two or more visits at the 6th annual visit. When a woman was missing data on frequency and type of incontinence from one or two visits, we imputed

values as follows. If the missing value occurred at year 6, we imputed by using the value at the previous visit. If women reported no incontinence in the years previous and subsequent to a missing response, we assumed no incontinence in those missing years. If a woman was missing incontinence data in the one to two years previous to a first report of incontinence we randomly assigned her missing values to either no incontinence or the frequency and/or type of incontinence in that subsequent year. We imputed incontinence frequency for 324 women (13.5%) and type for 18 women (0.2%). When weight was missing for one or two visits, the we imputed values for 88 visits (1.2%) as the mean between the two known values. In the same way, we imputed waist circumference values for 138 visits (1.8% of all visits). For all other independent variables, we dropped missing data from the analysis. We excluded New Jersey year 6 data from our models because that site had disproportionate and systematic loss of the Hispanic and Caucasian participants during that year.

We compared proportions and means of each variable for women who were continent at baseline and who remained in or dropped out of the study using the t- and chi-squared tests. For our survival analysis, we used discrete proportional hazards models (15). First, in our main models, we evaluated whether menopausal stage at the annual visit concurrent with the first report of incontinence and other time dependent factors were associated with the development of monthly or more any incontinence compared with no development of any incontinence. Here we included a variable to account for whether a woman had advanced to another menopausal stage or had started or stopped hormones. We created similar separate models for stress and urge incontinence. For stress incontinence, our comparison group was those women who had no development of stress incontinence and for urge incontinence it was those women who had no development of urge incontinence. Second, we evaluated menopausal stage in the year previous to the first report of incontinence, controlling for the same covariates. Finally, we examined whether concurrent menopausal stage and change in status was associated with the development of more frequent incontinence by modeling weekly or more incontinence compared to no development of incontinence. The candidate covariates described above were chosen based on the literature, a priori hypotheses and/or were associated with the outcome in univariable analysis at $p < 0.10$. We used SAS 9.1, SAS Institute Inc., Cary, NC, USA.

We evaluated proportional hazards assumptions by plotting $\log(-\log(\text{survival}))$ functions for various groupings of the data based on the time independent covariates and estimated survival functions for each group using the Kaplan-Meier estimates. Since the proportional hazards held regardless of the covariate groupings, the assumption appeared to be adequate for all the fixed and time-dependent covariates. We tested model stability by running models with and without imputed data and respectively forcing in menopausal status, change in status and age without significant changes in the point estimates of the other variables. Correlation matrices showed no significant co-linearity among our independent variables, including between menopausal status and age. We chose our final models based on the lowest Akaike Information Criterion (AIC) which indicate the best fit for discrete proportional hazards models.

RESULTS

In the subset of SWAN participants who did not report incontinence at baseline, we compared relevant baseline characteristics of the 1529 who remained in the study (the follow-up cohort) with the 279 who we classified as lost to follow up (drop-out cohort) as of the sixth follow up (Table 1). Women who dropped out were more likely to be Hispanic, were less likely to have gone to college, had a lower socioeconomic status, had a higher BMI, reported poorer health and were more likely to smoke.

During the 6-year study period, 41.3% of the women transitioned from pre- or early peri-menopause to postmenopause; 6.4% had undergone hysterectomy with or without oophorectomy, and 6.7% had used hormones. By year 6, 28.7% of the women had gained greater than 5% of their baseline body weight, and only 7.8% had lost the equivalent weight. Of the women who were continent at baseline, 739 reported new onset monthly or more incontinence over the 6 years of follow up (8.7 per 100 per year) while 108 reported new onset weekly or more incontinence (2.3 per 100 per year). Overall, the incidence of incontinence in woman years decreased with each stage of the menopausal transition (Figure 2).

Being in late peri-menopause was associated with an increased hazard of developing any incontinence and urge incontinence during the 6 years of follow-up compared to pre-menopause (Table 2). For any incontinence, being in early peri-menopause also increased the hazard. While not statistically significant, the estimated hazard ratios (HRs) for developing stress and urge incontinence in early peri-menopause were similar in magnitude and direction to the estimated HR for any incontinence in this menopausal stage. Whether menopausal status changed or women started or stopped using hormones was not associated with the development of incontinence in that year and did not stay in our models.

Because we could not determine precisely when incontinence developed between two annual visits, we also examined menopausal stage in the year prior to the first report of incontinence. We found the estimated HRs to be similar or larger for any incontinence and stress incontinence compared to our models for menopausal stage in the concurrent year (Table 3). We also found that being postmenopausal significantly decreased the hazard for the development of any incontinence and stress incontinence in the subsequent year. The HRs for urge incontinence were in a similar direction for each menopausal status, but were not statistically significant. Again, whether menopausal status changed or women started or stopped using hormones was not associated with the development of incontinence and did not stay in our models.

The development of any incontinence was associated with a higher baseline BMI, weight gain, and an increase in anxiety symptoms (Table 2). A higher baseline BMI and weight gain were associated with new onset stress incontinence while an increase in anxiety symptoms were associated with urge incontinence. The estimated HR for the association between weight gain and urge incontinence was similar to that for any incontinence and stress incontinence but did not meet our definition of statistical significance. Neither the number of live births nor the route of delivery (vaginal versus cesarean section) were associated with incontinence development (data not shown).

We also evaluated factors associated with the development of more frequent (weekly or more) incontinence (Table 4). We observed no association between menopausal status and the development of weekly or more incontinence. While our numbers in this analysis were small ($N = 108$), the estimated HRs were closer to 1.00. Some factors were the same as in our main models for any monthly or more incontinence (baseline BMI, weight gain and an increase in anxiety symptoms), but the HRs were larger. Development of diabetes was a unique factor associated with about a 50% increased hazard for developing weekly or more incontinence.

DISCUSSION

We found that early and late peri-menopause stages were associated with an increase, and that postmenopause was associated with a decrease in the hazard for developing monthly or more frequent incontinence. However, the development of weekly or more frequent

incontinence (leaking several times per week or more) was not associated with any stage of the menopausal transition. Additionally, advancing from one menopausal stage to the next was not associated with the development of incontinence. This suggests that the risk of developing only mild incontinence (leaking less than several times per week) was affected by the menopausal transition. While not statistically significant, both stress and urge incontinence showed similar patterns of positive and negative association.

A biological basis may explain the association between menopausal stage and the reporting of new onset incontinence. Some women report that their incontinence is affected by menstrual cycle phase, with most women reporting increases in incontinence in the luteal phase when both estradiol and progesterone levels are elevated (16). Exogenous hormone use in postmenopausal women has a weak negative effect on both stress and urge urinary incontinence (17). Sharp declines in estradiol levels have been associated with a lower risk of urinary incontinence (18). It is possible that for women in the peri-menopause, the increased frequency of anovulatory cycles and the associated relatively prolonged elevated levels or peaks of estrogen in a subset of women (19) increases the likelihood of developing infrequent incontinence, while the lower or declining estrogen levels of postmenopause decreases that risk.

In addition to hormonal or biological effects of progression through the menopausal transition on incontinence, women may change reporting behavior over the menopause transition. Women transitioning through menopause have other symptoms such as hot flashes, night-time awakening, and changes in vaginal bleeding, especially in the peri-menopause, and increased annoyance with these symptoms may heighten reporting of incontinence that in and of itself was less bothersome in other menopausal stages. Increases in vaginal discharge could be mistaken for new onset incontinence during the early peri-menopause. Additionally, women in the peri- and postmenopause may change unmeasured behaviors that could initially increase and then decrease the chance of developing incontinence. For example, women may change diet and exercise habits that unmask incontinence symptoms as they transition from pre- to peri-menopause.

A few other associations with the development of incontinence in midlife women are worth noting. While cross-sectional studies have described a relationship between depression (20) or anxiety (21) and incontinence, our longitudinal analysis demonstrates that the development of anxiety symptoms was strongly associated with incident any monthly or more incontinence and urge monthly or more incontinence. The strength of this association doubled with the development of more frequent (weekly or more) incontinence. Higher anxiety could increase the likelihood of reporting of incontinence, or a physiological relationship may exist. For example, the sympathetic nervous system stimulation associated with anxiety could affect the sensitivity and activity of the nerves to the lower urinary tract or affect the resting tension, fatigability, and/or function of the levator ani muscles of the pelvic floor which help maintain continence (22). Weight gain among mid-life women was common—almost 30% of the women in SWAN gained 5% or more of their body weight over the first six years—and was associated with an increased risk for developing any and stress incontinence, likely related to increased intra-abdominal pressures (23).

The diagnosis of diabetes in the previous year increased the likelihood of reporting new onset weekly or more frequent incontinence. Diabetes is consistently one of the strongest risk factors for prevalent urinary incontinence (24). How diabetes increases risk is not known, but potential mechanisms include diabetic associated neuropathy, ischemia, and polyuria due to glucosuria.

Some factors associated with incident incontinence in this survival analysis with time-dependent co-variables are similar to those we have identified with incontinence in two previous SWAN analyses. For example, we found that baseline BMI was associated with both prevalent and incident incontinence in our logistic regression models of baseline factors only (25) and baseline BMI and weight gain were both associated with worsening incontinence in our generalized estimating equation longitudinal models (7). The greater intra-abdominal pressure of high BMIs and weight gain can theoretically overload the continence mechanism over time leading to the development of incontinence in continent women and worsening incontinence in incontinent women. Other factors, such as baseline self-reported health status associated with incident incontinence in our logistic regression models (25) were not associated with incident incontinence in this survival analysis. The advantage of longitudinal analysis is that specific factors affecting health status such as new onset medical problems and/or changes in mental health symptoms proximal to the first report of incontinence can be modeled and may explain this discrepancy.

Our study had a number of limitations. With prospective cohort studies, dealing with loss to follow-up and missing data are challenging. While SWAN's retention rate of 86.1% over 6 years is very good, the differences between those who remained in the study at 6 years and those who dropped out potentially introduces bias and limits the generalizability of our results. A higher proportion of women who reported no incontinence at baseline dropped out of the study, possibly inflating our incidence rates and reducing the size of our comparison group. Our definition of incident incontinence may also have overestimated our incidence rates in the first few annual follow-up visits. Some women who reported no incontinence at baseline may have had incontinence in previous years that was not troubling them at the time of study. Because the population of continent women at risk declined over the 6 years of this study, women most at risk for incontinence may have been culled from the study in the earlier years. Finally the incontinence questions used in this study were not from validated questionnaires.

The study also had important strengths. Seven years of longitudinal data on incontinence in over 2800 racially/ethnically diverse, community-based, mid-life women is remarkable. It permits generation of incidence during the menopausal transition, information that has been noted to be limited by the National Institutes of Health state-of-the-science conference on urinary incontinence (26). The same incontinence questions were asked on an annual basis; these questions, which allowed classification of incontinence symptoms by clinical type (stress and urge), were similar to validated questions that have been developed since the inception of SWAN and those that have been used widely in other incontinence epidemiological studies assessing (27). The sensitivity and specificity of self-reported incontinence by type is estimated at 71–85% and 60–79% in validated questionnaires (28). Finally, these findings are consistent with the results of our previous study evaluating factors associated with worsening symptoms in incontinent women (7).

In the popular health media, urinary incontinence is often listed as a symptom of menopause but the findings from SWAN indicate that this is inaccurate. While we found an association between the development of incontinence and the peri-menopausal stages, the incontinence was limited to mild symptoms reported to occur less than weekly. Taken with the findings of our previous study showing that incontinence symptoms improve in the peri-menopause (7) suggests that incontinence during this stage is likely to be transient and self-limited. Mid-life women should be counseled that their risk of developing incontinence in the early postmenopause is less than in the years before and during the menopausal transition. From a public health stand point, clinicians and women should focus on the other factors consistently shown to be risk factors for both the development and worsening of incontinence: being overweight, weight gain and the development of diabetes. Because a

number of these factors are modifiable, determining whether healthy life changes and treating associated medical problems can prevent the development of incontinence is a priority.

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Figure 1. Flow Diagram Showing Identification of Women Included in Analytic Cohort

* Two women were missing incontinence data at baseline.

† Reported monthly or more incontinence. Subject of another investigation (10)

§ Those deceased, who voluntarily withdrew or could not be contacted for 2 or more visits by year 6.

Figure 2. Incidence of Any, Stress and Urge Urinary Incontinence per 100 Woman Years by Menopause Status Over 6 Years in SWAN

Any UI: Premenopause (N = 151 per 911 woman years), Early peri-menopause (N = 486 per 2718 woman years), Late peri-menopause (N = 62 per 429 woman years), Postmenopause (N = 67 per 813 woman years).

Stress UI: Premenopause (N = 109 per 972 woman years), Early peri-menopause (N = 376 per 3069 woman years), Late peri-menopause (N = 36 per 490 woman years), Postmenopause (N = 54 per 1017 woman years).

Urge UI: Premenopause (N = 79 per 1024 woman years), Early peri-menopause (N = 281 per 3317 woman years), Late peri-menopause (N = 48 per 564 woman years), Postmenopause (N = 43 per 1104 woman years).

Characteristics of Continent Women at Baseline and Differences between Women Who Followed-up and Dropped-out of SWAN over Six Years

Table 1

Baseline Characteristics	Baseline Continent Cohort N = 1808	Follow-Up Cohort N = 1529	Drop out Cohort* N = 279	p-value [†]
Age in years (mean (SD))	45.6	45.6	45.3	0.67
Race/ethnicity (N, %)				
Caucasian	713	613	100	35.8
Black				<0.001
Chinese	574	483	91	32.6
Japanese	161	144	17	6.1
Hispanic				
	168	154	14	5.0
	192	135	57	20.4
Menopausal status (N, %)				
Pre-menopausal	755	630	125	44.8
Early peri-menopausal	1003	855	148	53.1
Education (N, %)				
High school or less	487	385	102	36.6
College or higher				<0.01
	1302	1129	173	62.0
Marital status (N, %)				
Single	257	213	44	15.8
Married, living as				<0.01
Separated/Divorced/Widowed	1156	1001	155	55.6
	359	285	74	26.5
Social Support, (N, %)				
>25 th percentile	1234	1054	180	64.5
≤ 25 th percentile	574	475	99	35.5
General Health Status (N, %)				
Excellent	413	358	55	19.7
Very good				<0.01
Good	632	549	83	29.7
Fair	505	422	83	29.7
Poor	192	150	42	15.1
	31	21	10	3.6
Difficulty paying for basics (N, %)				
Not at all hard	1066	933	133	47.7
Somewhat hard				<0.01
Very hard	559	455	104	37.3

Baseline Characteristics	Baseline Cohort N = 1808	Follow-Up Cohort N = 1529	Drop out Cohort* N = 279	p-value†
	170	131	39	14.0
Body Mass Index in kg/m ² (mean (SD))	26.3	26.1	27.0	6.4
Waist-hip ratio (mean (SD))	0.80	0.80	0.81	0.07
Parity (mean (SD))	2.0	2.0	2.2	1.6
Smoking History, (N, %)				
Never smoked	1060	919	141	50.5
Current smoker	300	232	68	24.4
Past smoker	395	333	62	22.2
Baseline medical conditions (N, %)				
Diabetes	72	50	16	5.7
Hypertension	319	239	57	20.4
Fibroids	335	265	52	18.6
Depressive symptoms	392	302	67	24.0
Anxiety symptoms	319	261	58	20.8
Symptom sensitivity (mean (SD))	9.8	5.1	9.8	5.2
				4.0
				0.87

N = number, SD = standard deviation

Due to missing data, numbers may not add to column total and percentages may not add to 100%

* Drop out cohort: those deceased, who voluntarily withdrew or could not be contacted for 2 or more visits by year 6.

† Comparison between follow-up and drop-out cohorts using t-test and chi-squared test

Adjusted Hazard Ratios for Menopausal Status in the Concurrent Year and Other Factors Associated with the Development of Any, Stress and Urge Monthly or More Urinary Incontinence

Table 2

Time Dependent Factors	Any Incontinence [*]		Stress Incontinence [†]		Urge Incontinence [‡]	
	HR	95% CI	HR	95% CI	HR	95% CI
Menopausal status in year concurrent with first report of incontinence						
Pre-menopause	Ref		Ref		Ref	
Early Peri-menopause	1.34	1.07, 1.68	1.40	0.96, 2.03	1.41	0.93, 2.14
Late Peri-menopause	1.52	1.12, 2.05	1.24	0.75, 2.05	2.12	1.26, 3.56
Postmenopause	0.88	0.63, 1.23	0.98	0.60, 1.61	0.88	0.48, 1.60
Unclassifiable during or after hormone use	1.06	0.78, 1.46	1.25	0.79, 1.98	0.59	0.29, 1.21
Unclassifiable after hysterectomy with or without oophorectomy	0.45	0.18, 1.18	0.38	0.07, 1.96	0.46	0.09, 2.39
Weight Gain (per 1 lb increase)	1.04	1.02, 1.07	1.05	1.02, 1.08	1.04	1.00, 1.08
Change in anxiety symptoms (per unit increase in score)	1.05	1.01, 1.09			1.08	1.01, 1.15
Change in depressive symptoms (per unit increase in score)	0.99	0.98, 1.00				
Change in life stressors (per event increase)					0.91	0.85, 0.98
Baseline Factors						
Age at baseline (per year)	1.00	0.97, 1.03	1.00	0.96, 1.04	1.00	0.94, 1.06
Parity						
Nulliparous	Ref					
Parous	1.11	0.98, 1.26				
Hypertension at baseline					1.19	1.00, 1.41
BMI in kg/m ² at baseline (per unit)	1.02	1.01, 1.03	1.02	1.00, 1.04		
Difficulty paying for basics						
Not hard at all	Ref				Ref	
Somewhat to very hard	1.09	1.00, 1.18			1.16	1.00, 1.35
Education at baseline						
High school or less	Ref				Ref	
College or more	1.08	0.98, 1.19			1.25	1.02, 1.53
Race/ethnicity						

Time Dependent Factors	Any Incontinence [*]		Stress Incontinence [†]		Urge Incontinence [‡]	
	HR	95% CI	HR	95% CI	HR	95% CI
Caucasian	Ref		Ref		Ref	
African-American	1.09	0.94, 1.28	0.75	0.59, 0.95	1.96	1.45, 2.65
Chinese	0.93	0.75, 1.15	1.09	0.84, 1.43	0.77	0.47, 1.28
Japanese	0.91	0.73, 1.13	1.01	0.77, 1.33	0.71	0.42, 1.18
Hispanic	0.88	0.68, 1.13	0.95	0.70, 1.30	0.57	0.29, 1.12

HR = Hazard Ratio, 95% CI = 95% Confidence Interval, Ref = Reference

Bold = p < 0.05

All variables in each model represented in table

Women using hormones after being classified as postmenopause or after hysterectomy were not included in our analysis due to small numbers.

^{*} Any Incontinence N = 855

[†] Stress Incontinence N = 433

[‡] Urge Incontinence N = 244

Adjusted Hazard Ratios for Menopausal Status In the Previous Year Associated with the Development of Any, Stress and Urge Monthly or More Urinary Incontinence

Table 3

	Any Incontinence [*]		Stress Incontinence [†]		Urge Incontinence [‡]	
	HR	95% CI	HR	95% CI	HR	95% CI
Menopausal status in year previous to first report of Incontinence						
Pre-menopause	Ref		Ref		Ref	
Early Peri-menopause	1.32	0.99, 1.76	1.39	1.05, 1.84	1.04	0.67, 1.63
Late Peri-menopause	1.69	1.15, 2.51	1.97	1.26, 3.08	1.64	0.86, 3.12
Postmenopause	0.57	0.34, 0.95	0.31	0.13, 0.71	0.61	0.28, 1.33
Unclassifiable during or after hormone use	1.14	0.75, 1.70	1.03	0.64, 1.66	1.07	0.55, 2.08
Unclassifiable after hysterectomy with or without oophorectomy	0.56	0.17, 1.79			0.72	0.14, 3.76

HR = Hazard Ratio, 95% CI = 95% Confidence Interval, Ref = Reference

Bold = $p < 0.05$

Women using hormones after being classified as postmenopause or after hysterectomy were not included in our analysis due to small numbers.

^{*} Any Incontinence N = 855 Model adjusted for: change in anxiety, BMI, education, difficulty paying for basics, race/ethnicity, parity, weight change

[†] Stress Incontinence N = 433 Model adjusted for: BMI, race/ethnicity, weight changes

[‡] Urge Incontinence N = 244 Model adjusted for: change in anxiety education, difficulty paying for basics, race/ethnicity, baseline hypertension, change in life stressors.

Table 4

Adjusted Hazard Ratios for Concurrent Menopausal Status and Factors Associated with the Development of Weekly or More Any Urinary Incontinence (N = 108)

Time Dependent Factors	HR	95% CI
Menopausal Status		
Pre-menopause	Ref	
Early Peri-menopause	0.99	0.60, 1.63
Late Peri-menopause	1.14	0.51, 2.54
Postmenopause	1.10	0.46, 2.64
Unclassifiable during or after hormone use	1.01	0.46, 2.22
Unclassifiable after hysterectomy with or without oophorectomy	0.84	0.15, 4.72
Weight Gain (per 1 lb increase)	1.07	1.02, 1.13
<u>Change in anxiety symptoms (per unit increase in score)</u>	1.14	1.03, 1.27
Developed diabetes in previous year	1.48	1.06, 2.07
Baseline Factors		
Age at baseline (per year)	0.94	0.86, 1.03
BMI in kg/m ² at baseline (per unit)	1.07	1.04, 1.10
Education at baseline		
High school or less	Ref	
College or more	0.80	0.64, 1.00
Smoking status		
Never	Ref	
Past	0.68	0.45, 1.03
Current	1.46	0.99, 2.17

HR = Hazard Ratio, 95% CI = 95% Confidence Interval, Ref = Reference, **Bold** = $p < 0.05$

All variables in model represented in table

Women using hormones after being classified as postmenopause or after hysterectomy were not included in our analysis due to small numbers.