Longitudinal Changes in Overactive Bladder and Stress Urinary Incontinence Among Parous Women

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Aims: To describe longitudinal changes in symptoms of overactive bladder (OAB) and stress urinary incontinence (SUI) among parous women. Methods: At annual examinations, beginning at least 5 years from first delivery, OAB and SUI were assessed using the Epidemiology of Prolapse and Incontinence Questionnaire. Published thresholds were used to define “bothersome” symptom scores. The prevalence, the incidence of bothersome symptoms, and treatment rates were calculated. In separate analyses for women who delivered by cesarean versus vaginal delivery, odds of SUI or OAB symptoms (score > 0) were modeled as a function of time since childbirth, age, race, and obesity. Among those with persistent symptoms, severity symptom score was modeled as a function of time since childbirth and these same covariates. Results: One thousand four hundred and eighty-one participants completed up to 5 annual assessments (2,722 woman-years). During follow-up, the incidences of bothersome SUI and OAB were 2.5/100 woman-years and 1.7/100 woman-years, respectively. Although SUI and OAB symptoms were more common in the vaginal birth group (P < 0.001), the odds of symptoms increased since increasing time from delivery in the cesarean group. Symptom severity did not change substantially over time in either group. Obesity was strongly associated with symptoms related to SUI and OAB. Conclusions: Five years from first delivery, symptoms related to SUI and OAB were more common and of greater severity after vaginal than cesarean birth. However, differences between these two groups lessen as time from childbirth increases. Obesity control should be a primary target for reduction of incontinence and incontinence severity among parous women. Neurourol. Urodynam. © 2014 Wiley Periodicals, Inc.

Key words: longitudinal cohort study; overactive bladder; stress urinary incontinence

INTRODUCTION

Urinary incontinence, including stress incontinence and overactive bladder (OAB), is common among adult women. For example, in 2005 and 2006, a survey conducted by the National Centers for Health Statistics estimated that 16% of adult US women (95% confidence interval [CI], 13.2–18.2%) suffer from moderate to severe urinary incontinence, defined as monthly leakage of volumes more than just drops or weekly leakage of any volume. Given this prevalence for moderate to severe incontinence, the public health burden of this problem is substantial.

Researchers who study the epidemiology of urinary conditions have used various definitions for stress urinary incontinence (SUI) and OAB. Some investigations have focused on the presence or absence of relevant symptoms,2 while others have defined a threshold for symptom severity.3,4 While both approaches have merit, an advantage of a definition that includes a continuous measure or scale5 is the opportunity to consider changes in symptom burden across populations and over time.

Epidemiologic evidence2,3,6,7 suggests that obstetrical events play a central role in the development of incontinence in women. Specifically, most studies suggest that parous women who have experienced at least one vaginal birth are at much higher risk of pelvic floor disorders than those who have delivered exclusively by cesarean.3,7 The association between obstetrical history and urinary incontinence appears to be strongest early in life and much weaker among postmenopausal women.2 However, very little is known about how various obstetrical exposures affect the course and progression of urinary disorders across a woman’s lifespan.

In this investigation, we used a life course approach8 to investigate longitudinal changes in SUI and OAB after cesarean versus vaginal birth. Specifically, the first delivery was considered the origin for longitudinal analysis of changes in urinary symptoms over time. We hypothesized that obstetrical events early in adult life would have long-term effects on the incidence and severity of urinary symptoms later in life. We used data from a longitudinal study of urinary symptoms among parous women, enrolled 5–10 years after first delivery and assessed annually thereafter. The specific goals of this analysis were (1) to describe the prevalence and incidence of SUI and OAB among parous women; (2) to investigate the relative odds of urinary symptoms as a function of increasing time since cesarean or vaginal birth; and (3) to describe changes in the severity of SUI, OAB, and related symptoms over time. These goals reflect the objectives of the parent study, which are to examine factors that influence disease progression, to model the prognosis for women with mild disease, and to understand how symptom severity changes over time.

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For the MOAD study, urinary symptoms are assessed annually using the Epidemiology of Prolapse and Incontinence Questionnaire (EPIQ). This instrument is designed to identify and quantify the severity of pelvic floor disorders in community populations. This questionnaire resulted from NIH-supported research and has been rigorously validated. In particular, test–retest reliability of items related to urinary incontinence and related bother has been good to excellent (correlations greater than 0.70). The EPIQ includes questions designed to capture presence and severity of urinary symptoms. From these questions, summary scores were calculated for SUI and OAB. The SUI summary score was derived from two symptoms (urine leakage related to activity, coughing, or sneezing; and small amounts of urine leakage (drops)) and two impact items (feeling frustrated by urine leakage and impact of incontinence on physical recreation such as walking, swimming, or other exercise). The OAB summary score was derived from five symptoms (frequent urination; the need to rush to the bathroom to prevent leakage of urine; the need to get up at night to empty your bladder; frequency of daytime urination; and urine leakage related to a feeling of urgency).

Each EPIQ item includes a stem question (e.g., “Do you experience urine leakage related to a feeling of urgency?”) and a bother score (on a visual analogue scale from 0, indicating no bother, to 100, indicating maximum bother). Per the design of the EPIQ, only participants who answer “yes” to a given stem question are asked to rate the related bother. Women who deny a specific symptom are assigned a bother score of 0. Thus, EPIQ symptoms are rated from 0 (indicating either the absence of the symptom or no bother related to the symptom) to 100 (indicating the highest possible bother related to the symptom). One exception to this question design is the item for “frequency of daytime urination.” Because it is presumed that all respondents urinate at least once in the daytime, all respondents are asked to provide a bother score for “frequency of daytime urination.”

The SUI and OAB summary scores are the averages of the respective items in each score and are therefore also scored from 0 to 100. Validation studies indicated that an OAB threshold score of >59.6 maximized the positive predictive value for identifying women with clinically significant symptoms of OAB (sensitivity 77, specificity 90). Similarly, an SUI threshold score of 47.3 was optimal for identifying women with clinically significant symptoms of SUI (sensitivity 80, specificity 92). Thus, using the EPIQ SUI summary score, women can be divided into those with any symptom (summary score = 0), those with highly bother-some SUI symptoms (summary score > 47.3), and an intermediate group with low symptom bother (summary score > 0 but < 47.3). A similar classification can be used to describe OAB.

Using this classification, we estimated the annual incidence of highly bothersome SUI and OAB. Women were also asked annually whether they had received treatment for urinary problems, including surgery, medications, or supervised physical therapy. Using these data, we estimated the treatment rate, defined as the number of treatments initiated during the follow-up period per woman-years of observation.

A second goal of this study was to investigate the relative odds of urinary symptoms as a function of increasing time since first delivery and attained age. For these analyses, we considered individually the outcome of answering “yes” to each of the six SUI and OAB stem questions contributing to the respective summary scores (urine leakage related to activity/coughing/sneezing; small amounts of urine leakage (drops); frequency; nocturia; urgency; and urgency incontinence). To account for the repeated outcome measures from a given participant, we used generalized estimating equations to model the log odds of reporting “yes” to each symptom as a function of time since 5 years after first delivery (e.g., because women are not recruited to the MOAD study until at least 5 years from first delivery). In subscribing to this biological time scale, we hereafter refer to the time of 5 years from first delivery as “baseline.” To reflect the longitudinal analysis employed herein, the axis of time is described in years since delivery. Methods to describe the effects of exposures of interest, as well as the multiple axes of time, were employed to create a graphic description of symptom prevalence over time. Covariates in the model included age at first delivery, current obesity (defined as BMI ≥ 30 kg/m²), and race (Black vs. non-Black). Previously, our group demonstrated that urinary symptoms, especially those related to stress incontinence, are significantly more common among women who have experienced at least one vaginal birth (versus delivery by cesarean exclusively). Therefore, analysis was stratified by delivery history (those who have experienced at least one vaginal birth versus those who have delivered only by cesarean) to assess the heterogeneity of temporal patterns and association of covariates with delivery history on the respective outcomes.

Our final objective was to investigate how (among women indicating a given symptom) symptom severity changed over time. For these analyses, we considered the bother score for each of the six specific symptoms as well as the SUI and OAB summary scores. Exploratory analysis of the data showed that the majority of women who reported a given symptom did so consistently over follow-up. Therefore, analysis was restricted to women who consistently reported the symptom at all attended study visits as well as women who did not report the symptom at enrollment but subsequently developed the symptom and reported it consistently thereafter. For the latter group of women, only data from study visits at which symptoms were reported were included in analysis. The mean symptom score was modeled as a function of time (years since 5 years after first delivery), age at first delivery and current obesity. Because these analyses were restricted to women who reported the symptom in question, the sample size was not sufficient to assess the impact of race. Again for this analysis, women who had delivered vaginally were considered separately from those who had delivered exclusively by cesarean.
At the time of this analysis, 1,497 women were enrolled in this study. Sixteen women were excluded due to missing data for race, BMI, age, delivery status, or total parity. Table I presents the descriptive statistics for 1,481 women included in this analysis. Only 13 women reported an additional delivery during the follow-up period. Compared to the 728 women with at least one vaginal delivery during the study period, the 753 women who had delivered by cesarean had higher frequencies of obesity and primiparity.

### RESULTS

All analyses were performed using SAS statistical software version 9.3 (Cary, NC). Statistical significance was assessed at the \( P < 0.05 \) level.

#### TABLE I. Descriptive Statistics (Median [Interquartile Range] or % [n]) of 1,483 Women, by Delivery Type

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cesarean delivery only (N = 753)</th>
<th>At least one vaginal birth (N = 728)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black race</td>
<td>18% (137)</td>
<td>13% (92)</td>
</tr>
<tr>
<td>Normal (C20-C27)</td>
<td>55% (419)</td>
<td>55% (418)</td>
</tr>
<tr>
<td>Overweight (C25-C30)</td>
<td>31% (238)</td>
<td>25% (198)</td>
</tr>
<tr>
<td>Normal (C30-C35)</td>
<td>24% (179)</td>
<td>30% (215)</td>
</tr>
<tr>
<td>Maternal age, years at first delivery</td>
<td>31 [28, 35]</td>
<td>31 [28, 35]</td>
</tr>
<tr>
<td>Parity</td>
<td>Primiparity (23%)</td>
<td>At least 1 [54]</td>
</tr>
<tr>
<td>Years from first delivery</td>
<td>6.5 [5.6, 8.2]</td>
<td>6.4 [5.6, 8.1]</td>
</tr>
<tr>
<td>Body mass index at enrollment</td>
<td>46% (499)</td>
<td>45% (498)</td>
</tr>
<tr>
<td>Maternal age at first delivery</td>
<td>31 [28, 35]</td>
<td>31 [28, 35]</td>
</tr>
</tbody>
</table>

#### TABLE II. Baseline Prevalence of Each Urinary Symptoms and Relative Odds (With 95% CI) for Each Urinary Symptom, by Delivery Type

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Cesarean delivery only (2,143 observations among 753 women)</th>
<th>At least one vaginal birth (1,853 observations among 728 women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaking related to activity, coughing, or sneezing</td>
<td><strong>Baseline prevalence</strong></td>
<td>Relative odds per year increase in maternal age at first birth</td>
</tr>
<tr>
<td>Leakage related to activity, coughing, or sneezing</td>
<td>20 1.06 (1.01, 1.11)</td>
<td>1.02 (0.99, 1.05)</td>
</tr>
<tr>
<td>Leakage of “drops”</td>
<td>17 1.04 (0.99, 1.09)</td>
<td>1.02 (1.00, 1.05)</td>
</tr>
<tr>
<td>Frequent urination</td>
<td>17 1.04 (0.99, 1.10)</td>
<td>1.01 (0.98, 1.04)</td>
</tr>
<tr>
<td>Nocturia</td>
<td>43 1.02 (0.97, 1.06)</td>
<td>1.02 (1.00, 1.05)</td>
</tr>
<tr>
<td>Need to rush to the bathroom for urination</td>
<td>7 1.07 (1.00, 1.14)</td>
<td>1.05 (1.01, 1.09)</td>
</tr>
<tr>
<td>Leaking related to a feeling of urgency</td>
<td>7 1.04 (0.98, 1.11)</td>
<td>1.05 (1.01, 1.08)</td>
</tr>
</tbody>
</table>

*Estimated prevalence for reference group, defined as 5 years from first delivery, 30 years old at first delivery, non-obese body mass index, and non-Black race.

Relative odds and 95% CIs derived from multivariate generalized estimating equation logit models with empirical covariance matrix and exchangeable working correlation to account for repeated measures. Models control for age at first delivery, body mass index (obese vs. non-obese) and race (Black vs. non-Black).

P values differ but are < 0.05 for all bolded values.
the cesarean group and 6.0% in the vaginal birth group (P for difference < 0.001).

Table II presents a comprehensive analysis of the prevalences of individual symptoms between the vaginal and cesarean delivery groups. Women in the vaginal birth reference group (e.g., 5 years from first delivery, maternal age 30 years at first delivery, non-Black and non-obese) were significantly more likely than those in the cesarean birth reference group to report urine leakage related to activity/coughing/sneezing (P < 0.01); small amounts of urine leakage (P < 0.01); frequency (P < 0.01); urgency (P < 0.01); and urgency incontinence (P < 0.01). There was no significant difference between the birth groups in the prevalence of nocturia (P = 0.43).

Table II also describes the relative odds for each symptom with increasing time since first delivery. The models described in Table II are also graphically shown in Figure 1, with the prevalence of each symptom illustrated as a function of both years since delivery and attained age. For the first three symptoms in Table II, shown in the upper three panels of Figure 1, it can be seen that the difference between vaginal and cesarean groups lessen with age and time since first delivery. Specifically, among women who had delivered exclusively by cesarean, the odds of leakage with activity/coughing/sneezing increased 6% per year after first delivery (odds ratio 1.06, 95% CI 1.01, 1.11). In contrast, the odds of this symptom did not increase over time for women with a history of at least one vaginal birth (difference in relative odds, P = 0.014). In both birth groups, the relative odds of urinary urgency (the need to rush to the bathroom for urination) increased significantly with increasing interval from first birth (1.07 per year in the cesarean group and 1.06 in the vaginal birth group). The relative odds for the other symptoms did not increase significantly over time from first delivery, although there was a trend toward increasing symptoms among women who had delivered by cesarean (e.g., relative odds > 1 for all six symptoms). Obesity was also noted to be a powerful risk factor for all symptoms considered, especially in the cesarean birth group. Due to small sample sizes, not shown in Table II is the impact of Black race, which was associated with a reduced odds of leakage related to activity/coughing/sneezing in both groups (odds ratio 0.52 [95% CI: 0.34, 0.82] for the cesarean group and 0.34 [95% CI: 0.21, 0.53] for the vaginal birth group) but with increased odds of urgency (odds ratio 1.80 [95% CI: 1.17, 2.79]) and urgency incontinence (odds ratio 1.99 [95% CI: 1.31, 3.02]) in the.

Fig. 1. Estimated changes over time in prevalence of six symptoms: (a) urine leakage related to activity, coughing, or sneezing; (b) small amounts of urine leakage (drops); (c) frequent urination; (d) the need to get up at night to urinate; (e) the need to rush to the bathroom to prevent leakage of urine; (f) urine leakage related to a feeling of urgency. For each symptom, separate estimates are presented for each of four groups, according to birth history (cesarean/vaginal) and presence/absence of obesity. Estimates are derived from multivariate generalized estimating equation logit models. Each curve reflects prevalence for a reference group of non-Black women whose first delivery occurred at age 30. Two axes of time are shown: attained age (top axis) and years since first delivery (bottom axis).

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However, we were surprised to find very little change in the cesarean group compared with the vaginal birth group. For example, controlling for time since first delivery, age at first delivery and obesity, the mean bother score for urinary leakage related to activity was 25% lower in the vaginal birth group. In addition, we also controlled for parity and found similar patterns of urinary incontinence after age 65 among women with a history of cesarean versus vaginal birth.2

Table III shows, by delivery type, the mean change in bother score (with 95% CI) for each urinary symptom among women who consistently reported the presence of each symptom, by delivery type.

![Table III](image)

**DISCUSSION**

Vaginal childbirth is an important risk factor for urinary symptoms, especially symptoms related to SUI. Parous women are more likely to report urinary symptoms, especially SUI, after vaginal versus cesarean birth.3,7 However, the present study suggests that the elevated risk associated with a vaginal delivery may diminish over time. Among women who delivered vaginally, the mean bother score for leakage related to a feeling of urgency decreased almost two points over every 1-year increase in the interval from delivery. A similar pattern was noted for the SUI and OAB summary scores.

Attained age is not explicitly represented in Table II. However, attained age is the arithmetic sum of age at first birth and current delivery. For example, the mean estimated bother score for leakage related to a feeling of urgency (P = 0.008) was significantly higher after vaginal birth than cesarean birth. In addition, we also controlled for parity and found similar patterns of urinary incontinence after age 65 among women with a history of cesarean versus vaginal birth.2
mean bother scores over time (e.g., with increasing interval from first birth). In fact, the bother score for some urinary symptoms (leakage of “drops,” urgency, and urgency incontinence) declined one to two points per year among women with a history of vaginal birth. We speculate that the observed decrease in bother score might be because women become more tolerant of chronic symptoms as they age. However, it is unclear whether this trend is clinically significant. A critical question is whether the observed pattern is sustained over longer periods. Moreover, the present study considered <5 years of observation and this duration of observation may not be sufficient. Indeed, Donaldson et al. followed a sample of women for 4 years. Although they failed to see a significant change in severity score over 4 years for individual women (especially for SUI), they observed significant cross-sectional differences in severity across age groups (ranging from 40 to 49 years to >80 years). This suggests that changes in incontinence severity may evolve slowly (e.g., over decades). Additional follow-up of our enrolled participants will provide insights and will help us to identify characteristics associated with changes in bother score over more extended periods of time.

Another important finding from this study is that obesity is a powerful risk factor for urinary symptoms and for symptom severity. For example, obese women were significantly more likely to report leak with activity/cough/sneeze than women of normal weight, particularly in the cesarean group. Also, obesity increased the severity of bother among symptomatic women. In general, these findings suggest the importance of obesity control as a strategy for reduction of incontinence and incontinence severity among parous women.

Strengths of this study include the relatively large sample size, the use of a validated symptom measure, and the opportunity to follow a population longitudinally (annually). In addition, while other researchers have focused either on the presence versus absence of relevant symptoms or a binary measure of severity among those with symptoms, the longitudinal analyses presented here are congruent with the nature of the outcome as a mixture of both. A limitation is that our study did not include an objective measure of incontinence. However, patient-centered outcomes are increasingly used as an outcome in incontinence studies. Another possible limitation of this study is that the trends observed may be relevant only to a certain period in women’s lives, such that these trends might not be sustained later in life. Additional follow-up of this cohort will clarify whether changes are observed as the population ages.

CONCLUSIONS

This study suggests a substantial impact of vaginal delivery on the presence and on the severity of urinary symptoms, especially 5 years from delivery. However, over the subsequent 5 years, the odds for urinary symptoms increase annually among those who delivered by cesarean, especially for symptoms related to SUI. Thus, rates of stress incontinence among women delivering exclusively by cesarean may converge with those who delivered vaginally as time from childbirth increases. Our results also demonstrate that obesity is an important risk factor for bladder symptoms and therefore obesity control should be a primary target for reduction of incontinence and incontinence severity among parous women.

REFERENCES