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Parturition Events and Risk of Urinary Incontinence in Later Life

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Abstract

Aims—To examine the association between specific events during vaginal deliveries and urinary incontinence later in life.

Methods—A retrospective cohort study of 1521 middle-aged and older women with at least 1 vaginal delivery who were long-term members of an integrated health delivery system. Age, race/ethnicity, current incontinence status, medical, surgical history, pregnancy and parturition history, menopausal status, hormone replacement, health habits, and general health were obtained by questionnaire. Labor and delivery records, archived since 1948, were abstracted by professional medical record abstractors to obtain parturition events including induction, length of labor stages, type of anesthesia, episiotomy, instrumental delivery, and birth weight. The primary dependent variable was current weekly urinary incontinence (once per week or more often) vs urinary incontinence less than monthly (including no incontinence) in past 12 months. Associations of parturition events and later incontinence were assessed in multivariate analysis with logistic regression.

Results—The mean age of participants was 56 years. After adjustment for multiple risk factors, weekly urinary incontinence significantly associated with age at first birth ($p=.036$), greatest birth weight ($p=.005$), and ever having been induced for labor ($OR=1.51$; 95% $CI=1.06–2.16$, $p=.02$). Risk of incontinence increased from $OR=1.35$ (95% $CI=0.92–1.97$, $p=0.12$) for women with one induction to $OR=2.67$ (95% $CI=1.25–5.71$, $p=.01$) for women with 2 or more inductions ($p=0.01$ for trend). No other parturition factors were associated with incontinence.

Conclusions—Younger age at first birth, greatest birth weight, and induction of labor were associated with an increased risk of incontinence in later life.

Keywords

Induction of labor; urinary incontinence; risk factors; vaginal delivery; cohort study

Introduction

It is widely recognized that pregnancy and delivery increase the risk of urinary incontinence in women. Studies have found the risk of post-partum incontinence to be greater following a vaginal birth compared to birth by Cesarean section (1–3), presumably due to trauma to pelvic nerve and muscle during delivery from stretching and compression (4,5). Identifying specific, potentially modifiable, parturition events (e.g., induction of labor, augmentation of labor, instrumental vaginal delivery, episiotomy and type of anesthesia), that increase the risk of incontinence in later life is important for developing strategies to prevent incontinence.

Because randomizing women to receive a specific parturition exposure is difficult or impossible, investigation of the association between specific parturition events during vaginal delivery and later incontinence must rely on observational studies. A prospective cohort study has the advantage of allowing collection of detailed information at the outset, but the need to follow women over several decades to identify the development of urinary incontinence in later life is probably prohibitive. Thus a population-based retrospective cohort study offers the most feasible study design for investigating the association between pregnancy and parturition events and incontinence in later life. A major challenge for such a study is the quality of measurement of specific parturition events assessed decades after delivery. Given the limitations of recall of parturition events (6), access to original detailed labor and delivery records is critically important. To maximize the generalizability of results, such a study should be representative of the general population. Because prevalence and type of incontinence have been found to differ between ethnic and racial groups (7), it is also desirable to study an ethnically/racially diverse population.

To address these challenges, we investigated the association between parturition events and later incontinence in the Reproductive Risks for Incontinence Study at Kaiser (RRISK), a NIH-funded, retrospective cohort study of over 2100 middle-aged and older women representative of the underlying population, for which detailed original documentation of labor and delivery events are available. A specific aim of RRISK was “to determine the association between specific aspects of parturition and incontinence in later life.”

Material and Methods

RRISK cohort participants were enrolled from October 1999 through February 2003 from Kaiser Permanente Medical Care Program of Northern California (KPNC), an integrated health delivery system with a pre-paid group practice. KPNC provides comprehensive inpatient and outpatient care to over 3.3 million members, about 25–30% of general population in the geographic area served. Previous studies have found members of the organization to under represent the very poor and the very wealthy and to be slightly more educated compared to the general population in the same geographic area, but to be very similar with respect to other demographic characteristics (8). KPNC has archived all medical records since 1948.

The target study size of 2100 subjects was chosen to provide a power of at least 80% for detecting a relative risk for incontinence of 1.5 or greater for exposures of interest including all parturition variables, all of which occurred in at least 10% of women. The study cohort was constructed by first identifying women between 40 and 69 years of age as of January 1, 1999. Because we required that women have had at least half of their births within KNPC (and would therefore have original clinical labor and delivery records available), we identified women who had been members of Kaiser since age 18, using computerized membership files. From this group of approximately 66,000 female members, we randomly sampled 10,230 women within age and race strata with a goal of obtaining approximately equal number of women in each 5 year age group with a race/ethnicity composition of 20% African-American, 20% Hispanic, 20% Asian-American and 40% white (non-Hispanic). For 1395 women (13.6%) eligibility could not be determined. Of the remaining 8835 women, 2817 determined to be eligible of which 2109 (74.9%) were enrolled. The primary reasons for ineligibility were race/age strata being already filled (n=2632) or having few than 50% of births within Kaiser (n=2451). For the current study we analyzed data from 1521 women who had at least one vaginal delivery.

The study was approved by the institutional review (human subjects) boards of both the University of California, San Francisco and Kaiser Foundation Research Institute. All participants provided signed informed consent at the time of their enrollment.

Data were collected by pre-interview self-administered questionnaire and in-person interview and from abstraction of labor and delivery records. Incontinence questions were similar or identical to those used in previous large observational studies and shown to be reliable (9) Interviewers were all women, and a bilingual interviewer was available for women who preferred to be interviewed in Spanish. Additional data collected included demographic characteristics, past medical and surgical history (including hysterectomy), current medications, history of hormone use, smoking, and menopausal status. Current body mass index was calculated (kg/m^2) based on the participant's weight and height measured (by the interviewer) at the time of the interview. Medical records for deliveries within Kaiser Permanente were reviewed by trained medical record abstractors to obtain detailed information on labor and delivery events including age at first birth, induction and augmentation of labor, length of first and second stages of labor, type of anesthesia, type of delivery, episiotomy, and birth weight.

Statistical analyses

The parturition events examined were defined *a priori* based on categories used in previous studies of post-partum urinary incontinence as: ever induced, ever prolonged first stage of labor (>12 hours), ever prolonged second stage of labor (> 1 hour), ever augmentation of labor with oxytocin, ever instrumental delivery, ever spinal, saddle or epidural anesthesia, ever pudendal anesthesia, and ever episiotomy, ever 3rd or 4th degree tear, and ever birth weight ≥ 4000 grams. Age at first birth was dichotomized at < 23 years vs. ≥ 23 years old while age at last birth was dichotomized at ≤ 34 and >34 years old. These age cut points were chosen to facilitate comparison with prior reports of the association between urinary incontinence and age at first and last births.(10–13) Continuous variables were also modeled using linear and restricted cubic spline functions to improve the fit of the data, with knots chosen empirically using stepwise selection.(14) Variables were modeled using the function providing the best fit in the final analyses. The primary dependent variable was incontinence “at least weekly during the past 12 months” vs. “incontinence less than monthly (including no incontinence) in the past 12 months.”

Bivariate and multivariate associations of parturition events and incontinence were assessed using logistic models. All variables were evaluated for inclusion in the multivariate model

using backwards selection with the criteria of $p < .2$ for inclusion in the model. Variance inflation factors for parturition risk factors were examined; while some indicated moderate inflation (inflation factors for anesthesia, spinal/epidural, age at first and age and last delivery were 3.2, 2.8, 2.7, 2.6 respectively), none were so high as to raise concerns about multicollinearity.

Missing values were imputed with twenty multiply-imputed data sets created using the Markov chain Monte Carlo method. Summary effect estimates and standard errors were computed using standard methods for imputed data. (15)

Secondary analyses were conducted using different thresholds for urinary incontinence (any in past 12 months, at least monthly, and daily). Weekly incontinence was also further examined by type (stress predominate, urgency predominate or mixed). Because prior studies have reported that the association between parturition and urinary incontinence becomes weaker, or disappears, in women around age 50 or 60 (11,16), we also separately analyzed women age 55 and under (about half of all participants).

All reported p-values are two-sided. All analyses were carried out in SAS Version 9.2 (SAS Institute, Cary, NC).

Results

There were 1521 women with one or more vaginal births. A total of 3362 vaginal births occurred within Kaiser. An additional 322 births were reported to have occurred outside of Kaiser and did not have labor and delivery records available. Parturition variables from these 322 births were therefore missing, though year of birth was included in the data. Values were missing for < 1% of patient characteristic variables except household income for which was missing for 7.4%. Information was missing for less than 10% of parturition variables except ever induced labor (18.4%), length of first or second stage of labor (15.5%), and type of anesthesia (12.6%). Of the 1577 women with one or more vaginal births, 257 (16.3%) reported urinary incontinence at least weekly but less than daily and 202 women (12.8%) reported daily incontinence. Among women with at least weekly incontinence, stress predominate incontinence was the most commonly reported type (38.3%), followed by urgency predominant (28.8%), mixed (25.9%) and other (7.0%). The comparison group was composed of 818 women with incontinence $\leq$ monthly ($n=410$) or no incontinence ($n=408$) in the past 12 months. Two-hundred and forty-four with monthly incontinence were thus excluded. Twenty women reporting 'other' race were not included due to their small number. Thus there were a total of 1257 women included in the analysis.

As seen in Table 1, approximately half the subjects self-identified as white/Caucasian, with the remaining half approximately equally divided among Black/African-American, Latino/Hispanic and Asian. The mean age was 56.1 ± 8.5 years at time of survey with a range from 41 to 73. Approximately one-third of women held a bachelor's degree and approximately two-thirds were employed outside the home.

In univariate analysis (Table 2), urinary incontinence was significantly less common in Asian and Black women. Incontinence was significantly more common in women who had had a hysterectomy, who had ever smoked, and who were in poor health. There was also a significant linear association between parity and incontinence. While age demonstrated a significant general linear association with urinary incontinence ($OR=1.04$ per year, $p < .001$), the spline function provided a better fit to the data and revealed that the association was linear only below age 55 and above age 65, with essentially no association between ages 55 to 65. There was no significant interaction by patient race for any of the associations.

Age at first and last birth, length of labor stages and greatest birth weight are presented both dichotomized by *a priori* cut points to allow for comparison with previous studies, and as continuous variables which provided a better fit to the data. Younger age at first birth, dichotomized at 23 years old, showed a significant association with risk of later incontinence (OR=1.7, $p<.001$). When examined as a continuous variable, age at first birth showed a 'U-shaped' association with the lowest risk of later incontinence seen for women who first gave birth in their late 20s (Figure 1). Ever having a baby weighing 4000 grams or more was also significantly associated with risk of incontinence (OR=1.5, $p=.001$). When analyzed as a continuous variable, greatest birth weight showed evidence of a threshold effect with an increase in the risk of later urinary incontinence associated with increasing birth weight above about 3200 grams (Figure 2). Of the remaining parturition variables, only induction of labor was significantly associated with later urinary incontinence.

In the multivariate model, age, race, current BMI, general health, hysterectomy, age at first birth, ever having been induced and greatest birth weight all remained significantly associated with urinary incontinence (Table 3). For induction, there appeared to be a dose-response effect ($p=0.011$ by test for trend), with a stronger association for women with 2 or more inductions (OR=2.67) than for women with only one induction (OR=1.35).

Additional analyses examining the unadjusted associations of parturition variables restricted to women age 55 years or younger, by other thresholds for incontinence (ever in past 12 months, > monthly and > daily) and by type of incontinence (stress, urge, mixed) provided very similar results (data not shown).

Discussion

The current retrospective cohort study evaluated parturition events documented directly from original labor and delivery records up to 50 years prior as potential risk factors for current urinary incontinence in middle-aged and older women. Among parity related variables, age at first birth, greatest birth weight, and ever having been induced were significantly associated with later incontinence in the adjusted model.

Most studies that have examined the association between age at first birth and later urinary incontinence have found and increased risk of incontinence among women with a younger age at first birth variously dichotomized at <20 years, (10) <21 years, (11) and <22 years. (12) In contrast, one large, well controlled study found a protective effect of age at visit birth ≤ 25 years for urinary incontinence in women below age 50. (13) No studies could be located that reported on the association with age at first birth kept as continuous variable. In the current study, we found that the association between age at first birth and later urinary incontinence was approximately 'U- shaped' with the lowest risk seen in women having their first birth between 25 to 30.

We found that birth weight above 3200 grams was positively associated with later weekly incontinence and this association remained significant in multivariate analysis. Most prior studies have failed to find a significant association between birth weight and later urinary incontinence in (11,17,18) with the exception of one large study which found a weak (OR=1.1) but significant association between birth weight >4000 grams and later incontinence after adjustment for age, parity, BMI and years since last delivery.(19) Previous studies have all treated birth as a categorical variable, usually dichotomized at or near 4000 grams, which would have reduced their power to find an association.

We also found that women who had ever been induced were significantly more likely to have urinary incontinence and this association was stronger for 2 or more inductions. To our knowledge, no study has reported on the association between induction and later urinary

incontinence. Two previous studies have reported a significant association between induction of labor with prostoglandins and risk of urinary incontinence 3 months post-partum (20,21). One study of women age 60 and older has reported that use of oxytocin to be associated with current incontinence but did not distinguish between oxytocin used to augment labor or induce labor (22). We did not have the power to examine the association by indication for induction or type of induction. Based on chart review the majority of inductions (82%) occurred prior to 41 weeks gestational age and most often using oxytocin either alone (66%) or in combination with prostaglandins or rupture of membranes (17%). It is possible that induction could increase the risk of later incontinence, for example by stressing the pelvic floor that is not completely 'prepared' for labor or by direct hormonal effects on the pelvic floor. It is also possible that the association could be the result of confounding by factors related to the decision to induce which were not captured by the labor and delivery records.

Other than induction, no other parturition events were associated with a significant increases risk of later urinary incontinence. While instrumental vaginal delivery was found to be a risk factor for later urinary incontinence in 2 studies, (23,24) other studies did not find a significant association.(11,12,17,18,22) In general, studies have failed to show a significant relationship between other parturition events and later incontinence.(11,12,17,18,22–24)

Other variables associated with incontinence in multivariate analyses were age, BMI, race, hysterectomy, and general health. All have been associated with urinary incontinence in previous studies.(25)

The results of this study should be interpreted in light of several points. Recent data showing that the association between parity and incontinence is weaker in women above age 50 – which were the majority of women in our study. Thus there still may be associations between parturition events and later incontinence in women younger than those enrolled in our cohort. While our data allowed for evaluation of and adjustment for confounding for a large number of potentially important co-variables the possibility of confounding by unmeasured variables, including reason for induction, remains.

Conclusions

In general, we found only weak and non-significant associations between exposure to specific parturition variables and later urinary incontinence, with the exception of age at first birth, greatest birth weight, and induction of labor. The association between greater birth weight (starting above about 3200 grams) and later urinary incontinence could be considered in managing maternal weight gain or other factors associated with larger babies. Similarly, it induction is a confirmed as a risk factor for later urinary incontinence, this association should be considered, especially in cases of elective induction.

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Figure 1. Relationship between age at first birth and later urinary incontinence. Bubbles indicate percent of women in the analysis group (which excluded women with monthly urinary incontinence) with weekly incontinence for each year of age at first birth. Size of bubble corresponds to number of women supplying data for that age.

Figure 2. Relationship between greatest birth weight later urinary incontinence. Bubbles indicate percent of women in the analysis group (which excluded women with monthly urinary incontinence) with weekly incontinence birth weight category. Size of bubble corresponds to number of women supplying data for that weight category.

Table 1

Characteristics of participants (n=1257)*

Characteristic	Number	Percent**
Continence status		
Incontinent at least weekly	452	36
Incontinent < monthly or continent	805	64
Age (years)		
40 to 49	340	27
50 to 59	471	38
60+	446	36
Race/Ethnicity		
White/Caucasian non-Hispanic	581	46
Black/African-American	245	20
Hispanic/Latino	224	18
Asian	207	17
Education		
<=high school grad	282	23
college/tech school	576	46
college grad	398	32
Employed full or part time	769	62
Parity		
1	152	12
2	450	36
3+	655	52
BMI (kg/m2)		
≤ 25	403	32
> 25 to 30	403	32
> 30	443	36
Hysterectomy	309	25
Ever Smoked	548	44
General Health		
Poor/Fair	156	12
Good	362	29
Very good	529	42
Excellent	210	17
Gestational Diabetes	39	3
Diabetes (insulin/oral/SR)	110	9
Age first birth <23 years	621	50
Age at last birth >34 years	162	13

Characteristic	Number	Percent**
Parturition Events		
Gestational age > 41 weeks	129	13
Ever induced labor	196	19
Ever prolonged first stage (>12 hrs)	273	32
Ever prolonged second stage (>1 hr)	325	37
Ever oxytocin during labor	366	35
Ever instrumental delivery	628	58
Ever spinal, saddle or epidural anesthesia	565	53
Ever pudendal anesthesia	478	44
Ever episiotomy	1,142	94
Ever 3 rd or 4 th degree tear	225	22
Ever birth weight $\geq$ 4000 grams	190	18

* Does not include women identified as 'other' race/ethnicity or women with monthly urinary incontinence.

** Percent for each variable is based on number of cases with data available for that variable, which may be less than 1257 due to missing data.

Table 2

Unadjusted association of participant characteristics, parturition variables, and urinary incontinence (UI).

	% with UI $\geq$ weekly	OR	(95% CI)	P-Value
Participant Characteristics				
Age (per year)	-	1.04	1.02–1.05	<.001
Age (spline function)		-	-	<.001 [^]
Race				
White	40.1	Ref		
Hispanic	42.4	1.10	0.81–1.50	ns
Black	31.4	0.69	0.50–0.94	.019
Asian	22.7	0.44	0.31–0.63	<.001
Current BMI (per unit)*	-	1.07	1.05–1.09	<.001
BMI at age 25 (per unit)*	-	1.07	1.03–1.11	<.001
General Health				
Poor/Fair	53.2	Ref		
Good/Very good	34.9	0.47	0.34–0.67	
Excellent	27.6	0.34	0.22–0.52	<.001 ⁺
Hysterectomy				
No	33.0	Ref		
Yes	45.0	1.66	1.28–2.16	<.001
Ever Smoked				
No	33.4	Ref		
Yes	39.2	1.29	1.02–1.62	.034
Current diabetes				
No	35.5	Ref		
Yes	40.9	1.26	0.85–1.88	ns
Gestational diabetes				
No	36.0	Ref		
Yes	33.3	0.89	0.45–1.74	ns
Parity (per birth)		1.13	1.03–1.24	.008
1	33.5	Ref		
2	32.7	0.96	0.65–1.42	
3 ⁺	38.8	1.25	0.87–1.82	ns
Age first birth <23 years				
No	29.9	Ref		
Yes	42.0	1.70	1.35–2.15	<.001
Age first birth (spline function)	-	-	-	.008 [^]
Age at last birth >34 years				
No	36.1	Ref		

	% with UI $\geq$ weekly	OR	(95% CI)	P-Value
Yes	35.2	0.95	0.67–1.34	ns
Age last birth (spline function)	-	-	-	ns [^]
Parturition Events				
Gestational age > 41 weeks				
Never	36.6	Ref		
Ever	32.2	0.82	0.55–1.23	ns
Induced labor				
Never	34.2	Ref		
Ever	44.4	1.53	1.11–2.10	.006
Prolonged first stage (>12 hours)				
Never	35.8	Ref		
Ever	36.5	1.03	0.75–1.41	ns
Duration of first stage (per hour)	-	1.03	0.99–1.04	ns
Prolonged Second stage (>1 hour)				
Never	36.3	Ref		
Ever	35.3	0.96	0.73–1.27	ns
Duration of second stage (per hour)	-	0.97	0.90–1.03	ns
Oxytocin during labor				
Never	35.5	Ref		
Ever	36.8	1.06	0.82–1.37	ns
Instrumental delivery				
Never	33.7	Ref		
Ever	37.5	1.18	0.92–1.51	ns
Spinal, saddle or epidural anesthesia				
Never	36.0	Ref		
Ever	36.0	1.00	0.78–1.29	ns
Pudendal anesthesia				
Never	34.0	Ref		
Ever	38.4	1.20	0.95–1.56	ns
Episiotomy				
Never	33.9	Ref		
Ever	36.0	1.10	0.67–1.81	ns
3 rd or 4 th degree tear				
Never	37.2	Ref		
Ever	32.2	0.80	0.60–1.09	ns
Birth weight $\geq$ 4000 grams				
Never	31.4	Ref		
Ever	40.2	1.47	1.16–1.86	.001
Greatest birth weight (spline function)	-	-	-	<.001 [^]

⁺ test for trend;

[^] global test

Table 3

Adjusted associations of participant characteristics and parturition events and weekly urinary incontinence (UI).

	Adjusted* OR	(95% CI)	P-Value
Participant Characteristics			
Age (spline function)	-	-	<.001 [^]
Race			
White	Ref		
Black	0.58	0.41–0.83	.003
Asian	0.62	0.41–0.93	.020
Hispanic	1.22	0.85–1.74	.NS
Current BMI (linear per unit)	1.06	1.04–1.09	<.001
General Health			
Poor/Fair	Ref		
Good/Very good	0.60	0.40–0.88	
Excellent	0.48	0.29–0.80	.005 ⁺
Hysterectomy	1.36	1.02–1.83	.037
Age first birth <23 years	1.47	1.11–1.54	.007
Age first birth (spline function)	-	-	.036 [^]
Parturition Events			
Induced labor	1.51	1.06–2.16	.023
Ever birth weight ≥ 4000 grams	1.36	(1.05–1.97)	.02
Greatest birth weight (spline function)	-	-	.005 [^]

* Adjusted for variables in the table plus parity, current diabetes, income, employment, smoking, age at last birth and gestational age > 41 weeks

⁺ test for trend

[^] global test