Parity, Mode of Delivery, and Pelvic Floor Disorders

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OBJECTIVE: This study aimed to assess the associations between parity, mode of delivery, and pelvic floor disorders.

METHODS: The prevalence of pelvic organ prolapse, stress urinary incontinence, overactive bladder, and anal incontinence was assessed in a random sample of women aged 25–84 years by using the validated Epidemiology of Prolapse and Incontinence Questionnaire. Women were categorized as nulliparous, vaginally parous, or only delivered by cesarean. Adjusted odds ratios and 95% confidence intervals (CIs) for each disorder were calculated with logistic regression, controlling for age, body mass index, and parity.

RESULTS: In the 4,458 respondents the prevalence of each disorder was as follows: 7% prolapse, 15% stress urinary incontinence, 13% overactive bladder, 25% anal incontinence, and 37% for any one or more pelvic floor disorders. There were no significant differences in the prevalence of disorders between the cesarean delivery and nulliparous groups. The adjusted odds of each disorder increased with vaginal parity compared with cesarean delivery: prolapse = 1.82 (95% CI 1.04–3.19), stress urinary incontinence = 1.81 (95% CI 1.25–2.61), overactive bladder = 1.53 (95% CI 1.02–2.29), anal incontinence = 1.72 (95% CI 1.27–2.35), and any one or more pelvic floor disorders = 1.85 (95% CI 1.42–2.41). Number-needed-to-treat analysis revealed that 7 women would have to deliver only by cesarean delivery to prevent one woman from having a pelvic floor disorder.

CONCLUSION: The risk of pelvic floor disorders is independently associated with vaginal delivery but not with parity alone. Cesarean delivery has a protective effect, similar to nulliparity, on the development of pelvic floor disorders when compared with vaginal delivery.

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LEVEL OF EVIDENCE: II-2

Common pelvic floor disorders include pelvic organ prolapse, stress urinary incontinence, overactive bladder, and anal incontinence. At least 11% of women will require surgery for pelvic floor disorders in their lifetimes.[1] Many studies suggest that vaginal delivery is associated with pelvic floor disorders.[2–5] Thus, the route of delivery is a potentially modifiable risk factor. As a result, the role of elective cesarean delivery in reducing the risk of pelvic floor disorders is being debated in both the medical and lay communities (Cole DS, Dayal AK, Chazotte C. Elective primary cesarean delivery [letter]. *N Engl J Med* 2003;348:2364–5; author reply 2364–5; Jukelevics N. Once a cesarean, always a cesarean: the sorry state of birth choices in America. *Mothering* 2004 March/April; DeMott RK. Should primary elective cesarean section be performed on demand in the absence of medical indications? Pro & Con. *OB/GYN News* 1999 October).[6–10] These debates are limited by an incomplete understanding of the association between vaginal delivery and pelvic floor disorders. However, an increasing number of women are requesting elective cesarean delivery, despite obstetric practice guidelines developed over the past decade aimed at reducing the cesarean delivery rate.[11,12] Existing epidemiologic evidence is mixed on associations between pregnancy, labor, and mode of delivery and pelvic floor disorders.[13–16] Thus, in counseling and managing

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women appropriately, these associations must be better understood.

The Kaiser Permanente Continence Associated Risks Epidemiologic Study (KP CARES) was designed to assess the associations between parity, mode of delivery, and the presence of the most common pelvic floor disorders and to test the hypothesis that vaginal delivery is associated with an increased risk of pelvic floor disorders compared with cesarean delivery.

MATERIALS AND METHODS

The Kaiser Permanente Continence Associated Risks Epidemiology Study was a cross-sectional sample of 12,200 women from the 950,000 women, aged 25 through 84 years, enrolled in a large health maintenance organization (Kaiser Permanente Southern California medical program) consisting mostly of employed, middle class subscribers. A total of 3,050 women were randomly selected from each of 4 age groups (25–39, 40–54, 55–69, and 70–84 years) using an administrative membership data file that included age, sex, enrollment history, and most current address and phone number for all active members of the program. The study protocol was reviewed and approved by the institutional review board.

The Epidemiology of Prolapse and Incontinence Questionnaire (EPIQ) is a validated survey instrument developed to ascertain the prevalence of pelvic floor disorders in a community-based population.[17] The full questionnaire, condition definitions, and results of psychometric and criterion validation have been reported previously.[17,18] Positive and negative predictive values for the detection of specific conditions are 76% and 97% for prolapse, 88% and 87% for stress urinary incontinence, 77% and 90% for overactive bladder, and 61% and 91% for anal incontinence, respectively. The definition of anal incontinence included flatal, solid, and/or liquid incontinence. The survey also included questions on menopause, hormone use, hysterectomy, height and weight, smoking, chronic lifting, caffeine intake, and relevant medical history.

A professional survey company conducted mailings between April 2004 and January 2005. English and Spanish language versions were mailed, along with a 1-hour telephone card incentive. Reminder postcards were mailed 3 weeks later, and a second survey was sent to nonresponders. Additional attempts to improve the response rate included telephone calls to remind women to complete the survey, a third survey mailing if requested by the respondent at the time of the reminder call, and a third survey mailing to the lowest responding group (women ages 25–39), regardless of whether they were reached for the reminder call.

Women who completed the surveys were categorized into one of three birth groups based on self-reported pregnancy and delivery experience. For the purpose of examining the effects of pelvic floor damage during delivery, we defined the *nulliparous group* as those women who had never been pregnant or who had delivered an infant weighing only 2 kg or less. The cut point for vaginal delivery was based on opinion from an expert panel who felt that 2 kg was approximately half the weight of an average infant, resulting in faster delivery, less pushing in the second stage, and less pelvic and perineal trauma. The *cesarean delivery group* was defined as having been delivered by one or more cesarean deliveries and no vaginal births exceeding 2 kg. *Vaginally parous women* were defined as having one or more vaginal deliveries exceeding 2 kg in birth weight, regardless of history of cesarean delivery. Women who were pregnant at the time of the survey or who provided insufficient information to categorize their pregnancy or delivery group were excluded. The nulliparous group was further subcategorized as never pregnant (nulligravid) or previously pregnant but not delivering an infant larger than 2 kg (gravid-nulliparous). The cesarean group was further subcategorized as with or without labor. Women who returned surveys with incomplete information about a specific pelvic floor disorder, but who had information to assess at least one pelvic floor disorder, were included in the analyses for the specific pelvic floor disorder that was accompanied by complete information.

Age was calculated in completed years on the date of survey completion. Body mass index was calculated as weight in kilograms divided by the square of the height in meters and dichotomized into nonobese (< 30 kg/m^2) or obese (≥ 30 kg/m^2). Parity was calculated based on reported number of pregnancies minus the number of abortions. Smoking was categorized as never smoked, past smoker, or current smoker. Chronic lifting was defined as repetitive lifting of more than 9 kg regularly for more than one year. Caffeine intake was defined as more than one cup of caffeinated beverage per day. Medical comorbidities, hysterectomy, menopause status, and hormone use were determined by using survey data. Hormone use was categorized into never, past, or current use. Conditions of diabetes, neurologic disease, and lung disease were also obtained by self-report.

Differences between nulliparous, cesarean, and vaginally parous groups were identified with Student

t and χ^2 tests. Associations between birth groups and pelvic floor disorders were initially assessed with χ^2 tests of proportions. Fisher exact tests were used when expected frequencies were less than 5. Confounders were identified from the univariable analyses using the Mantel-Haenszel tests of significance. Multivariable analyses were performed with multiple logistic regression using the significant variables identified in the comparisons of each birth group and are reported in crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Age was modeled as a continuous variable, while other independent variables were categorical. Outcomes were expressed dichotomously as pelvic floor disorder "present" or "absent." Prevalence of each condition was expressed as the number of women with the condition divided by the total number of women with complete information for that condition. The attributable risk of vaginal delivery in the exposed group was calculated by the formula ([Pe – Po]/Pe) × 100, where Pe and Po are the prevalence in the exposed and prevalence in the unexposed, respectively. Significance was evaluated using a 2-sided $P < .05$. Statistical analyses were performed with SAS 8.02 (SAS Institute, Cary, NC).

Power calculations and sample size were determined from published estimates of the prevalence of pelvic floor disorders.[15,19–23] Power analysis assumed the prevalence of stress urinary incontinence and overactive bladder to be 20% and that of anal incontinence and prolapse to be 6%. Assumptions were based on the prevalence of pelvic floor disorders in the nulliparous and the cesarean groups being equal and the prevalence in the vaginally parous group being 1.5 times that of the other two. We also estimated that 15% of the women in the study population were nulliparous, 15% delivered by cesarean, and 70% vaginally parous. Based on these assumptions, 5,400 respondents (1,350 per 15-year age bracket) were needed to achieve 80% power to detect a 50% difference with a significance of .05. Assuming a 45% response rate, a total of 3,050 women in each 15-year age bracket were selected to receive a questionnaire.

RESULTS

Of the 4,458 (37%) surveys returned, 140 were in Spanish and 4,318 in English. Racial and ethnic distributions of the returned samples were representative of the Kaiser Permanente membership: 60% non-Hispanic white, 20% Hispanic, 10% African American, 8% Asian-Pacific Islander, 1% Native American, and 1% other or unknown. There were insufficient data to categorize 289 women into one of the birth groups, and 66 surveys had insufficient information to assess any of the pelvic floor disorders. Thus, 4,103 subjects were available for analysis (Table 1). Nonresponders were significantly younger than responders (53 ± 17 versus 57 ± 16 years, $P < .001$).

Table 1. Demographics of the Study Sample by Birth Group

	Nulliparous (N = 787)			Cesarean Delivery (N = 389)			Vaginally Parous (N = 2927)		
Age [mean years ± SD (range)]	51.0 ± 17.4 (25–84)			50.7± 14.1 (25–84)			58.8 ± 15.1 (25–84)*†		
Parity [median (mean)]	0 (0)			2 (2.1)*			2 (2.7)*		
Obese (≥ 30 kg/m^2)	25	[22–28]	(188/756)	32*	[27–37]	(119/370)	28	[26–29]	(784/2,840)
Postmenopausal	52	[48–55]	(404/779)	49*	[44–55]	(190/388)	72*†	[70–73]	(096/2,921)
Hormone use									
None	37	[32–42]	(148/404)	45	[38–52]	(85/190)	32†	[30–35]	(681/2,096)
Past	42	[37–47]	(168/404)	36	[29–43]	(68/190)	46†	[44–49]	(974/2,096)
Current	19	[16–24]	(78/404)	18	[13–24]	(34/190)	20	[18–22]	(415/2,096)
Unknown	2	[1–5]	(10/404)	1	[0–5]	(3/190)	1	[0–2]	(26/2,096)
Hysterectomy	19	[16–22]	(146/776)	17	[13–21]	(64/386)	32*†	[30–34]	927/2,911
Diabetes	7	[5–9]	(49/747)	14*	[11–8]	(54/374)	12*	[11–13]	339/2,787
Neurologic disease	3	[2–4]	(20/742)	2	[0–4]	(6/365)	3	[2–3]	73/2,679
Lung disease	10	[8–13]	(78/748)	12	[9–16]	(45/374)	15*	[13–16]	399/2,751
Caffeine use	52	[48–55]	(399/773)	65*	[60–69]	(247/382)	57*	[55–58]	1,637/2,895
Current cigarettes	10	[8–12]	(77/767)	8	[5–11]	(30/379)	9	[8–10]	263/2,879
Past cigarettes	24	[21–27]	(183/767)	23	[19–28]	(89/379)	31*†	[30–33]	906/2,879
Lifting	30	[27–33]	(221/742)	33	[28–38]	(121/364)	36*	[34–38]	1,014/2,822

n, number of women with the specific pelvic floor disorder; N, total is the number of women with enough data to categorize status of specific pelvic floor disorder, SD, standard deviation.
Data are expressed as % [95% confidence interval] (n/N), unless otherwise indicated.
* $P < .05$ for differences between cesarean delivery versus nulliparous and vaginally parous versus nulliparous groups.
† $P < .05$ for differences between vaginally parous and cesarean delivery groups.

Other medical, historical, and demographic data for nonresponders are not available for comparison.

The distribution of women by birth group was as follows: nulliparous = 787 (19%), cesarean = 389 (10%), and vaginally parous = 2,927 (71%). The overall prevalence of each pelvic floor disorder was as follows: prolapse = 7% (268/4,043), stress urinary incontinence = 15% (511/4,043), overactive bladder = 13% (533/4,006), anal incontinence = 25% (989/3,954), and any one or more pelvic floor disorder = 37% (1,452/3,886). Of the women classified as having anal incontinence, 38% had incontinence of flatus only, resulting in an overall rate of 10% flatal and 17% fecal incontinence. The vaginally parous group had a significantly higher prevalence of every pelvic floor disorder when compared with the nulliparous and cesarean groups (Table 2). There were no significant differences in the prevalence of pelvic floor disorders between the nulliparous and cesarean groups.

Table 3 displays the crude and adjusted ORs with 95% CIs for each pelvic floor disorder studied across birth groups for the models including age, obesity, and parity. Additional modeling adjusting for obesity, menopause, caffeine, and diabetes in the cesarean versus nulliparous groups did not change the associations. Similar adjustments for age, menopause, hysterectomy, caffeine, past cigarettes, lifting, diabetes, and lung disease in the vaginally parous versus nulliparous group and adjustments for age, menopause, hormone use, hysterectomy, and past cigarettes in the vaginally parous versus cesarean groups did not change the associations either (data not shown). Overall, an increased odds of every pelvic floor disorder was found in women who delivered vaginally compared with those who never delivered or delivered only by cesarean.

Subanalysis of the nulliparous and cesarean groups is presented in Table 4. The prevalence of prolapse was significantly higher in the gravid-nulliparous than in the nulligravid group. The majority (96%) of the gravid-nulliparous group experienced first-trimester pregnancy losses. Only 11 of 270 subjects in this group had second-trimester delivery of infants weighing less than 2 kg, and none of these subjects had prolapse, 2 had stress urinary incontinence, 1 had overactive bladder, and 4 had anal incontinence. Within the cesarean group an increased prevalence of prolapse and stress urinary incontinence was observed in the labored cesarean group compared with the unlabored cesarean group. The difference was statistically significant for prolapse but not for stress urinary incontinence. An increased odds ratio for every disorder was observed when comparing vaginally parous with unlabored cesarean (Table 5). These odds ratios were significant for stress urinary incontinence and any pelvic floor disorder. Given that only 99 women were in the unlabored cesarean group, the power to detect significance was limited in prolapse, overactive bladder, and anal incontinence. When comparing vaginally parous to labored cesarean, there was likewise a significantly increased odds of stress urinary incontinence, anal incontinence, and any pelvic floor disorder, although this association appears to be less than for vaginally parous compared with unlabored cesarean.

The attributable risk of vaginal delivery, or the amount of pelvic floor disorders in a population that could be avoided by implementing a policy of universal cesarean delivery, was 46% for prolapse, 37% for stress urinary incontinence, 37% for overactive bladder, 41% for anal incontinence, and 36% for any pelvic floor disorder. The number needed to treat was calculated as the number of women who would have to deliver only by cesarean delivery to prevent any one pelvic floor disorder in this population. Seven women, who otherwise would have had a vaginal delivery, would have to deliver only by cesarean delivery to prevent one woman from having a pelvic floor disorder. When comparing the vaginally parous

Table 2. Prevalence of Selected Pelvic Floor Disorders by Birth Group

	Nulliparous (N = 787)			Cesarean Delivery (N = 389)			Vaginally Parous (N = 2,927)		
	%	[95% CI]	(n /N)	%	[95% CI]	(n /N)	%	[95% CI]	(n /N)
Pelvic organ prolapse	4	[3–5]	(29/774)	4	[2–7]	(16/386)	8*†	[7–9]	(223/2,883)
Stress urinary incontinence	8	[6–10]	(64/771)	11	[8–15]	(43/387)	18*†	[16–19]	(505/2,885)
Overactive bladder	9	[7–11]	(70/773)	9	[7–13]	(36/381)	15*†	[14–16]	(427/2,852)
Anal incontinence	19	[16–22]	(143/766)	16	[13–21]	(60/365)	28*†	[26–30]	(786/2,823)
Any pelvic floor disorder	27	[24–30]	(201/750)	27	[22–31]	(98/369)	42*†	[40–44]	(1,153/2,767)

n, number of women with the specific pelvic floor disorder; N, total is the number of women with enough data to categorize status of specific pelvic floor disorder.

* $P < .05$ for differences between cesarean delivery versus nulliparous and vaginally parous versus nulliparous groups.

† $P < .05$ for differences between vaginally parous and cesarean delivery groups.

Table 3. Crude and Adjusted Odds Ratios With 95% Confidence Intervals for Selected Pelvic Floor Disorders by Birth Group

Birth Group	Pelvic Organ Prolapse	Stress Urinary Incontinence	Overactive Bladder	Anal Incontinence	Any Pelvic Floor Disorder
Cesarean delivery versus nulliparous*					
Crude OR (CI)	1.72 (0.87–3.38)	1.38 (0.92–2.07)	1.05 (0.69–1.60)	0.86 (0.62–1.19)	0.99 (0.75–1.31)
Adjusted OR (CI)†	1.61 (0.80–3.24)	1.26 (0.82–1.93)	1.00 (0.64–1.55)	0.84 (0.60–1.18)	0.92 (0.69–1.24)
Vaginally parous versus nulliparous*					
Crude OR (CI)	3.33* (2.07–5.36)	2.34* (1.78–3.08)	1.77* (1.35–2.31)	1.68* (1.38–2.05)	1.95* (1.63–2.33)
Adjusted OR (CI)†	3.21* (1.96–5.26)	2.26* (1.70–3.00)	1.46* (1.11–1.93)	1.53* (1.24–1.89)	1.76* (1.46–2.12)
Vaginally parous versus cesarean delivery*					
Crude OR (CI)	1.94* (1.15–3.26)	1.70* (1.22–2.36)	1.69* (1.18–2.41)	1.96* (1.45–2.62)	1.98* (1.55–2.52)
Adjusted OR (CI)‡	1.82* (1.04–3.19)	1.81* (1.25–2.61)	1.53* (1.02–2.29)	1.72* (1.27–2.35)	1.85* (1.42–2.41)

OR, odds ratio; CI, 95% confidence interval.
* Indicates reference group.
† Adjusted for age and obesity.
‡ Adjusted for age, obesity, and parity.

Table 4. Prevalence of Each Pelvic Floor Disorder by Pregnancy Exposure and Cesarean Delivery With and That Without Labor*

	Nulligravid (N = 517)	Gravid-Nulliparous (N = 270)		Unlabored Cesarean Delivery (N = 93)	Labored Cesarean Delivery (N = 199)	
	% [95% CI] (n/N)	% [95% CI] (n/N)	*P*	% [95% CI] (n /N)	% [95% CI] (n/N)	*P*
Pelvic organ prolapse	2 [0–3] (8/510)	4 [2–7] (11/264)	.027†	1 [0–6] (1/92)	7 [4–11] (13/198)	.043†
Stress urinary incontinence	7 [5–10] (37/509)	10 [7–15] (27/262)	.148	5 [2–12] (5/93)	13 [9–19] (26/198)	.065
Overactive bladder	8 [6–11] (41/509)	11 [7–15] (29/264)	.178	9 [4–16] (8/92)	11 [7–16] (21/193)	.678
Anal incontinence	18 [15–22] (93/505)	18 [15–24] (50/261)	.803	17 [10–26] (15/90)	16 [11–22] (30/185)	.925
Any pelvic floor disorder	25 [21–29] (125/499)	30 [25–36] (76/251)	.127	22 [14–32] (19/88)	31 [24–38] (58/189)	.116

CI, confidence interval; n, number of women with the specific pelvic floor disorder; N, total is the number of women with enough data to categorize status of specific pelvic floor disorder; nulligravid, never pregnant; gravid-nulliparous, pregnant but never delivered an infant weighing more than 2 kg.
* Cesarean delivery unknown = 102; 11 women delivered infants weighing less than 2 kg.
† $P < .05$ using 2-sided Fisher exact test.

Table 5. Crude Odds Ratios for Each Pelvic Floor Disorder by Vaginal Delivery Versus Labored and Unlabored Cesarean Delivery

Birth Group	Pelvic Organ Prolapse	Stress Urinary Incontinence	Overactive Bladder	Anal Incontinence	Any Pelvic Floor Disorder
Vaginally parous versus unlabored cesarean delivery					
Crude OR (CI)	7.63* (1.06–55.00)	3.73* (1.51–9.24)	1.85 (0.89–3.85)	1.93* (1.10–3.38)	2.59* (1.55–4.33)
Adjusted OR (CI)†	5.81 (0.80–42.04)	3.91* (1.41–10.82)	1.72 (0.73–4.03)	1.53 (0.85–2.76)	2.26* (1.30–3.91)
Vaginally parous versus labored cesarean delivery					
Crude OR (CI)	1.19 (0.67–2.13)	1.40 (0.92–2.14)	1.44 (0.91–2.30)	1.99* (1.34–2.97)	1.61* (1.17–2.22)
Adjusted OR (CI)*	1.18 (0.62–2.23)	1.63* (1.01–2.63)	1.24 (0.74–2.08)	1.88* (1.21–2.93)	1.56* (1.10–2.22)

OR, odds ratio; CI, 95% confidence interval.
Unlabored cesarean delivery, n = 93; labored cesarean delivery, n = 199; unknown labor status, n = 102.
* $P < .05$.
† Adjusted odds ratios included age, obesity, and parity.

group with the unlabored cesarean group, that number decreases to 5.

DISCUSSION

This study examined the contribution of parity and delivery to the development of patient-reported pelvic floor disorders across a broad age range by using a well-validated instrument with defined predictive values. These data indicate that a woman who delivers an infant vaginally has a risk of a pelvic floor disorder that is higher than a woman who delivers all infants by cesarean delivery. Based on these data, parity itself does not increase the odds of developing a pelvic floor disorder; rather, the labor process and vaginal birth does. Overall, vaginal delivery increased the odds of any pelvic floor disorder compared with cesarean delivery by 85% when controlling for age, parity, and body mass index. Although development of pelvic floor disorders may be dependent on multiple risk factors, the attributable risk calculation suggests that vaginal birth confers one third of the burden in this population.

There are conflicting reports about the influence of parity, labor, and mode of delivery on the development of pelvic floor disorders. Our results are consistent with other epidemiological and prospective studies, which demonstrate vaginal delivery is a risk for urinary incontinence.[5,16,24,25] Rortveit et al[16] found an increased odds (2.4) of moderate or severe stress incontinence with vaginal delivery compared with cesarean delivery, with no significant difference in urge incontinence. We conducted our multivariable analyses in a similar manner, and our findings differed only in that overactive bladder was 1.5 times more common in the vaginally parous group than in the cesarean group. This difference may be reflected in our definition of overactive bladder, which included urinary urgency and frequency without leakage. In subanalyses of the cesarean group, we found that labor was associated with a trend toward increased stress urinary incontinence, but labor may not be entirely responsible for this increased risk because there remains an increased odds of stress urinary incontinence when comparing vaginal delivery with labored cesarean delivery. This is in keeping with the findings of others that cesarean delivery at any stage of labor reduced postpartum urinary incontinence.[24]

Epidemiological studies have not determined the effect of vaginal delivery on anal incontinence. Our study found a high prevalence of anal incontinence, which could be explained by a previous lack of standard definitions and patient underreporting.[26] Alternately, the questionnaire has a positive predictive value of 61%, which could lead to an overestimation of the prevalence of anal incontinence. However, a prevalence of solid or liquid stool incontinence of 17% is consistent with the findings of others.[27–29] These studies are in keeping with our data. There was no increased prevalence of anal incontinence in the cesarean group, whether labored or not. This may reflect that anal incontinence results from a mechanical disruption of the sphincter and terminal stretch of the pudendal nerve occurring at delivery and not during labor.[30] Other reports refute the relationship between vaginal delivery and anal incontinence by citing equal rates of anal incontinence in women delivered vaginally or by cesarean.[5,31] By using the Epidemiology of Prolapse and Incontinence Questionnaire, we aimed to identify women who were bothered enough by the loss of solid, liquid, or gas material to seek medical care.

Prolapse was the least prevalent pelvic floor disorder (7%) in our population. A recent study using a validated instrument supports our findings with a prevalence of prolapse of 8%.[32] Before our work, the relationships between parity and mode of delivery on prolapse were not well studied. Some have reported an increased degree of prolapse with increasing parity and vaginal deliveries,[33–35] whereas others have shown no significant increase.[14] As with the other pelvic floor disorders, these studies are limited by the lack of standard definitions and validated instruments. In our primary analysis, the risk of developing prolapse was significantly higher in women who had a vaginal delivery than in women who were nulliparous or had undergone cesarean. Although the odds of prolapse did not meet statistical significance, in the vaginally parous versus unlabored cesarean analysis, the odds ratio was high (5.8). There was no difference in prolapse rates when comparing labored cesarean and vaginal delivery, indicating that cesarean following labor does not protect against prolapse. Interestingly, the prevalence of prolapse was significantly higher in those women who had been pregnant but never delivered an infant compared with the nulligravid women, which suggests a multifactorial component, including exposure to the hormones of pregnancy as a risk of prolapse. Future study is necessary to confirm these relationships.

The strength of this study includes the use of a carefully validated instrument to assess a broad spectrum of pelvic floor disorders in a large, ethnically diverse population distributed across a wide age range. Although this study was not designed or sufficiently powered to completely assess the association between pregnancy and labor and the development

of pelvic floor disorders, the subanalysis comparing the gravid-nulliparous with the nulliparous and the labored cesarean with the unlabored cesarean groups would suggest that prolapse may be due to a combination of factors, including the hormonal exposure of pregnancy and the act of labor, whereas stress urinary incontinence, overactive bladder, and anal incontinence are more dependent on the actual delivery event. Most studies to date have been limited by the use of nonvalidated instruments and relatively small numbers of women delivered by cesarean delivery. The use of the validated questionnaire, the broad age range, and the large sample size of this study were chosen to overcome these limitations.

There are limitations to large-scale epidemiologic studies. Our response rate was lower than anticipated, despite considerable effort. Although response rates fell short of the required 5,400 women set by the power analysis, statistically significant differences were identified for the primary outcome of cesarean versus vaginal delivery, with a power ranging between 83% and 99.9% for each pelvic floor disorder. Responder bias may have altered the results if those with or those without the disorders respond differently to the questionnaire. Additionally, birth groups and demographic information were defined by self-report, thus imposing a risk of recall bias. Recent studies have demonstrated that up to 60% of women cannot remember major delivery events, even at 6 weeks postpartum.[36] For this reason, we did not attempt to further delineate delivery events, such as episiotomy, assisted delivery, and birth weight, for the primary analysis. Finally, indications for cesarean were determined by self-report. Prospective studies are needed to validate the associations found in our study.

Current therapies for pelvic floor disorders are frequently invasive and yield incomplete restoration of function. This makes prevention of these disorders a priority. Our study demonstrates that vaginal delivery increases the odds of pelvic floor disorders. However, the majority of women delivered vaginally did not have any pelvic floor disorders, and the risks of prophylactic cesarean delivery operation must be considered. It appears reasonable to counsel nulliparous women that prophylactic cesarean delivery would reduce the risk of a pelvic floor disorder by up to 85%. However, because these conditions affect only approximately 40% of women delivered vaginally, 5–7 women would need to deliver only by cesarean delivery to prevent one individual from developing a pelvic floor disorder.

Previous research has indicated that there is an association between birth weight, duration of the second stage of labor, instrumentation, and now, route of delivery. Translating these findings into meaningful guidelines to assist both patients and health care providers in decision making will require careful consideration and additional information.

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