Published in final edited form as:
Gastroenterology. 2010 November ; 139(5): 1559–1566. doi:10.1053/j.gastro.2010.07.056.

BOWEL DISTURBANCES ARE THE MOST IMPORTANT RISK FACTORS FOR LATE ONSET FECAL INCONTINENCE: A POPULATION-BASED CASE-CONTROL STUDY IN WOMEN

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Abstract

Background and Aims—Age, diarrhea and certain chronic illnesses are risk factors for fecal incontinence (FI). However, the contribution of obstetric injury to the development of FI later in life is unclear. We sought to better understand the risk factors for FI.

Methods—Through the Rochester Epidemiology Project, a nested case-control study of 176 randomly selected women with FI (cases; mean age, 58y) and 176 age-matched community controls was conducted in a population-based cohort from Olmsted County, MN. Risk factors for FI were evaluated by reviewing inpatient and outpatient medical (including original obstetric) records. Analyses focused on conditions which preceded the index date (incidence date of FI for case in each matched pair).

Results—In 88% of cases, FI began at age ≥ 40y; severity was mild (37%), moderate (58%), or severe (5%). By multivariable analysis, current smoking (odds ratio [OR]=4.7; 95% confidence interval [CI]: 1.4–15), body mass index (OR per unit=1.1; 95% CI: 1.004–1.1), diarrhea (OR=53; 95% CI: 6.1–471), irritable bowel syndrome (OR=4.8; 95% CI, 1.6–14), cholecystectomy (OR=4.2; 95% CI: 1.2–15), rectocoele (OR=4.9; 95% CI: 1.3–19) and stress urinary incontinence (OR=3.1; 95% CI: 1.4–6.5), but not obstetric events, were independent risk factors for FI.

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Contributions

Adil E. Bharucha - study concept and design; acquisition of data; interpretation of data; drafting and critical revising the manuscript; statistical analysis; obtained funding; technical; or material support; study supervision)

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This work was presented at the 111th annual meeting of the American Gastroenterological Association in 2010 and appears in abstract form in Gastroenterology 2010;138(5):S-99.

Conclusions—Bowel disturbances rather than prior obstetric injury are the main risk factors for FI. Measures to ameliorate bowel disturbances and other potentially reversible risk factors should be implemented before anal imaging is performed on women with FI.

Keywords

epidemiology; forceps; episiotomy; constipation

BACKGROUND

The etiology of fecal incontinence (FI) among women in whom the symptom cannot be attributed to an underlying organic disorder (e.g., inflammatory bowel disease) is unclear. 1 While clinical practice guidelines often emphasize anal sphincter injury, which is frequently attributed to obstetric trauma, nearly 70% of community women with FI report that the symptom began after age 40 years. 2 Community-based studies have associated advancing age, diarrhea, rectal urgency, cholecystectomy, anal fistula, non-childbirth anal injury, urinary incontinence, chronic illnesses (e.g., diabetes mellitus or stroke), and psychoactive medications, but not obstetric injury, with FI. 3–9 However, these studies focused on selected risk factors, which were ascertained by questionnaires rather than by reviewing medical records. While several studies have evaluated obstetric risk factors for FI in selected populations (e.g., after childbirth), only 3 truly population-based studies have evaluated the relationship between obstetric events and FI, and both depended on questionnaires; operative vaginal deliveries were 4 or were not 6, 10 risk factors for FI. However, maternal recall of distant pregnancy events is variable, being excellent for certain items (e.g., cesarean section) but weaker for other features (e.g., induced labor or problems during delivery). 11 Perhaps the most important limitation of these studies, however, as enunciated by a State-of-the-Science Conference in Prevention of Fecal and Urinary Incontinence in Adults, is “the fact that most existing studies of fecal and urinary incontinence used a cross sectional design. Such studies let us examine associations with incontinence but not cause. We cannot be sure that the associated factor comes before the recurrence of incontinence or determine whether it is the cause of the incontinence and therefore whether changing the associated factor would reduce to eliminate the incontinence.” 12 To address these issues and, in particular, to examine the temporal relationships among obstetric events, bowel symptoms, and other risk factors and FI, we conducted a nested case-control study of risk factors for FI among a community sample of Olmsted County, Minnesota, women. An accurate understanding of the risk factors for FI is necessary to develop appropriate strategies to prevent and treat this problem.

METHODS

The Olmsted County population comprises approximately 124,000 persons, of whom the majority are white; sociodemographically, the community is similar to the United States white population. 13 Residents receive their medical care almost exclusively from 2 large group practices: Mayo Medical Center and Olmsted Medical Center. Annually, more than 80% of the entire population is attended by one or both of these two practices, and nearly everyone is seen at least once during any given 3-year period. A unique medical records linkage system, the Rochester Epidemiology Project, provides an enumeration of this population (including both free-living and institutionalized) from which samples can be drawn. [13] A random sample of 5300 Olmsted County (including 84 nursing home) residents, stratified by age (10-year intervals between 20–29 and 80+ years), was drawn from a sampling frame consisting of the unique Olmsted County residents seen at least once during the 10-year period, 1992–2002. A questionnaire-based study on the prevalence and risk factors for FI was conducted in 2800 of 5300 respondents, of whom 507 had FI, defined as accidental leakage of liquid or solid stool unrelated to a short-term, self-limited, diarrheal illnesses in the past year. 2, 14 The present

investigation is a nested case-control study, which was approved by the Institutional Review Boards at Olmsted Medical Center and Mayo Clinic, from that cohort.

Identification of Cases and Controls

This study was designed to enroll 200 randomly selected cases and 200 age-matched control women without FI. Women who reported FI during the previous questionnaire-based study were approached in random order to participate in this study; to facilitate a proportional distribution of younger and older women, separate lists of women aged < 50 and ≥ 50 years were prepared. Then, a brief structured telephone interview was conducted to confirm that prospective participants were residing in Olmsted County; cases did, while controls did not, have FI unrelated to a temporary diarrheal illness over the past year; and cases did not have organic diseases known to be associated with FI. Since our objective was to better understand the etiology of FI in women without an organic cause for FI, 26 women with other conditions identified during the interview (i.e., dementia, stroke, Parkinson's disease, multiple sclerosis, myotonic dystrophy, motor neuron disease, inflammatory bowel disease, congenital anorectal conditions, short bowel syndrome, metastatic disease) were excluded. Thus, the 176 cases who agreed to participate were matched to a control subject of the same age (± 5 years) without FI whose first contact with the local medical system for inpatient or outpatient medical care occurred in the same year (± 5 years) as the index case. Among potential controls for each index case, the volunteer with the closest medical registration year was enrolled. Because unique registration numbers are assigned at the initial visit for each patient, this matches for the duration of documented clinical history.

Study Protocol

During a single study visit lasting 2 hours, participants completed validated questionnaires pertaining to the characteristics of FI. Severity of FI was calculated by the validated Fecal Incontinence and Constipation Assessment (FICA). 14, 15 The incidence date of FI was ascertained both by reviewing community medical records and interviewing subjects; the earlier date was used in the analysis. If the incidence date could not be assessed from either source, it was obtained from the original mailed questionnaire. For each case and control, the complete (inpatient and outpatient) medical records from all medical care providers who attended the subject were retrieved and reviewed to determine any history of a long list of diagnoses and other conditions conceivably associated with secondary FI. 1 The mean duration of prior medical record documentation was 44 years (median, 46.5 years; range, 16–71 years) for cases and 44 years (median, 46.5 years; range, 15–75 years) for controls; the records spanned more than a decade for all cases and controls and more than 20 years for 95% and 95% of cases and controls, respectively.

Conditions were considered present (ever versus never) if there was mention of them in the documented medical history prior to the incidence date among cases and prior to the corresponding index date among the matched controls, with 3 exceptions: Bowel symptoms were also recorded if they were known to be present within 3 months of the index date; since smoking status in the distant past was not always available from records, this was classified relative to the date of interview rather than the incidence date as never, current, or past; and height and weight were taken from the most recent data available adjacent to the index date. The medical and surgical conditions documented in the medical records were diagnosed largely by specialists at Mayo Clinic. Bowel symptoms (diarrhea, constipation, irritable bowel syndrome) were considered present only if symptoms were present for six months. A gastroenterologist (AEB) categorized the bowel disturbance based on the original clinical diagnosis and a description of symptoms in the records. Thus, irritable bowel syndrome was defined by bowel disturbances with abdominal discomfort, while diarrhea and constipation were defined by bowel disturbances without abdominal discomfort. Diarrhea was defined as

loose watery stools or soft stools without abdominal discomfort. Constipation was defined by two of the following 6 symptoms: excessive straining, anal digitation, or anorectal blockage during defecation, hard stools, infrequent stools, or sense of incomplete evacuation. Stress and urge urinary incontinence were identified as occurring in the context of physical activity and a sudden urge to urinate, respectively. Pelvic organ prolapse and rectoceles were deemed present only when documented at surgery.

Obstetric records from providers in and outside Olmsted County were reviewed in detail. For a total of 727 live births in 137 of 176 cases and 135 of 176 controls, information for all live births was obtained directly from obstetric records. In an additional 30 cases and 41 controls, details of obstetric events (118 live births) were obtained by recall. In one control, no obstetric history was available for 1 delivery.

Statistical Analysis

The analysis evaluated matched case-control pairs and, except as described above, focused on risk factors (i.e., medical, surgical, and gynecological events) which preceded the onset of FI. Univariate analyses (McNemar's test) and conditional logistic regression models were used to identify factors associated with FI. The backward elimination method was used to identify variables retained in the final model. Additional conditional logistic models compared risks associated with mild versus moderate or severe FI, as well as interactions between obstetric events and bowel disturbances.

Certain medical conditions were combined to facilitate analysis. Psychiatric diagnoses were categorized into 2 groups, i.e., depressive disorders and other conditions (attempted suicide without evidence of depression, dysthymic disorder, anxiety, panic disorder, eating disorders, psychological factors affecting physical condition, substance abuse, and schizoid disorders). Bronchial asthma, emphysema, and chronic bronchitis were combined into chronic respiratory conditions. For the multiple variable analysis, known obstetric risk factors for anal sphincter injury (i.e., birth weight over 4000 grams, forceps delivery, prolonged second stage of labor, and a persistent occipital posterior position) 16, 17 were summarized into 4 risk categories (i.e., none, low risk, moderate risk, and high risk). Subjects in the none, low, and moderate risk groups had none, one, or two of these risk factors, respectively. The high risk group was defined by tears involving the anal sphincter complex either without (i.e., grade 3) or with (i.e., grade 4) extension to the rectal mucosa or anal epithelium. Odds ratios (OR) are reported with 95 percent confidence intervals computed from the estimated logistic regression model coefficients and their standard errors.

RESULTS

Demographic Features and Characteristics of FI

By design, the age distribution at index date (i.e., onset of FI) was similar in 176 cases (58 ± 1 years, mean ± SEM) and controls (57 ± 1 years). At time of interview for this study, the duration of FI was 1 to < 5 years in 34% of cases, 5 to < 10 years in 24%, 10 to < 15 years in 19%, 15 to < 20 years in 9%, and 20 years or longer in 14%. The problem began before age 40 years in 20 women (11%), between 40 and 59 years in 80 (45%), and at age 60 years and older in 76 women (43%). At the interview date, the FICA symptom severity scale revealed that women had mild (66 women [37%]), moderate (102 women [58%]), or severe (8 women [5%]) FI.

Univariate Analysis of Medical and Surgical Risk Factors for Fecal Incontinence

Tables 1 and 3 compare the prevalence of non-obstetric and obstetric risk factors, respectively, prior to the first episode of FI. Table 2 documents the duration for which risk factors preceded

the onset of FI in cases and the corresponding date in the matched control. Since a matched case-control analysis was utilized, these tables also provide proportions for discordant pairs (i.e., pairs in which the case did not have the same value of the risk factor as the control). The body mass index (BMI) at index date was higher ($p < 0.001$) in cases (29.6 ± 0.6 kg/m^2) than controls (26.6 ± 0.4 kg/m^2). For smoking status, there were 72 similar case-control pairs (55 pairs were both non-smokers; 13 were ex-smokers, and 4 were current smokers). Among discordant pairs, the proportion of current smokers was higher ($p = 0.02$) in cases than controls.

Chronic constipation ($p = 0.03$), diarrhea ($p < 0.0001$), and irritable bowel syndrome ($p < 0.0003$) were all associated with FI and often preceded FI by many years. Among surgical procedures, a history of cholecystectomy ($p < 0.0001$) or a vaginal hysterectomy associated with repair of prolapse in the posterior or combined anterior-posterior compartment ($p = 0.004$) were associated with FI. However, total abdominal hysterectomy (13 cases and 11 controls) and the broad category of vaginal hysterectomy (i.e., with and without repair procedures) were not associated with FI. A rectocele ($p = 0.02$), uterine prolapse ($p = 0.03$), urinary stress ($p < 0.0001$) and urge ($p = 0.04$) incontinence, were also associated with FI.

Univariate Analysis of Obstetric Risk Factors for Fecal Incontinence

A majority of subjects (i.e., 140 cases, 136 controls) had at least one vaginal delivery. (Table 3) Both cases and controls averaged 2 ± 2 vaginal deliveries. A substantial proportion of cases and controls also had at least one delivery with forceps-assistance or an episiotomy. In addition, 13 women (5 cases and 8 controls) had one or more cesarean sections; in 12 women (3 cases and 9 controls), all children were born by cesarean section. Age at first pregnancy (23.1 ± 0.3 years for cases; 23.6 ± 0.4 years for controls) and vacuum-assisted deliveries were not significantly associated with FI (data not shown). Univariate analysis suggested that the prevalence of several putative obstetric risk factors for pelvic floor trauma did not differ significantly between cases and controls. While a 3rd or 4th degree episiotomy was more prevalent in cases than controls, the association with case-control status was not significant ($p = 0.15$). Compared to women who had no obstetric risk factors, the risk of FI was not increased in women with a low grade (OR, 0.7; 95% CI, 0.4 – 1.3), intermediate grade (OR, 1.3; 95% CI, 0.6 – 2.8), or high grade (OR, 1.7; 95% CI, 0.8 – 3.6) of obstetric risk factors as defined in Methods.

Multivariable Analysis of Risk Factors for Fecal Incontinence

In the multiple logistic regression analysis, (Table 4) bowel disturbances (i.e., diarrhea [OR, 53; 95% CI, 6.1 – 471]; IBS [OR, 4.8; 95% CI, 1.6 – 14]), a cholecystectomy (OR, 4.2; 95% CI, 1.2 – 15), pelvic floor disorders (a rectocoele [OR, 4.9; 95% CI, 1.3 – 19]; stress urinary incontinence [OR, 3.1; 95% CI, 1.4 – 6.5]), elevated BMI (OR per unit, 1.1; 95% CI, 1.004 – 1.1), and current smoking (OR, 4.7; 95% CI, 1.4 – 15) were independent risk factors for FI. Since chronic constipation was not a significant risk factor for FI in forwards and backwards stepwise regression models, it was not included in the final model. In contrast, obstetric events did not predict FI.

For most risk factors listed in Table 4, univariate odds ratios for cases versus controls were higher for moderate or severe FI than for mild FI. For example, current smoking was associated with a higher risk of moderate or severe FI (OR, 3.3; 95% CI, 1.2 – 9.2) than mild FI (OR, 2.5; 95% CI, 0.7 – 8.6). In contrast, stress urinary incontinence was associated with a lower risk of moderate or severe (OR, 2.4; 95% CI, 1.3 – 4.4) than mild FI (OR, 4.0; 95% CI, 1.6 –9.8). However, none of these differences were statistically significant, and data for other comparisons are not shown.

Do Obstetric Risk Factors Modify the Risk Associated with Non-Obstetric Risk Factors?

Three models examined potential interactions between obstetric events and, separately, demographic and lifestyle variables (i.e., smoking status, BMI), bowel disturbances, and other pelvic floor disorders (i.e., stress urinary incontinence, rectocoele). Among women who had IBS or diarrhea, the risk of FI was higher (OR, 9.2; 95% CI, 2.8 – 30.4, relative to women with neither) among women who had obstetric risk factors compared to women who did not have obstetric risk factors (OR, 4.3; 95% CI, 1.1 – 17, relative to women with neither). (Table 5) However, these odds ratios did not differ significantly (p = 0.27). Among women who had a cholecystectomy, the risk of FI was not significantly higher among women with obstetric risk factors compared to those without obstetric risk factors. Similarly, interactions between obstetric risk factors and demographic and lifestyle variables and, separately, with other pelvic floor disorders were not significant (data not shown).

DISCUSSION

Contrary to a current focus on obstetric anal sphincter injury, this large and first-ever case-control study from a geographically-defined population that simultaneously assessed obstetric and non-obstetric risk factors demonstrates that diarrhea, IBS, and prior cholecystectomy were the strongest independent risk factors for FI among community women. Higher BMI, current smoking, rectocoele, and stress urinary incontinence were also, to a lesser extent, risk factors for FI. However, obstetric events did not independently predict FI. These observations confirm previous observations from questionnaire-based population surveys demonstrating that FI is associated with chronic diarrhea and irritable bowel syndrome. [3, 6, 8, 9] Unique to this study, contemporary medical records were scrutinized to ascertain the temporal relationship between risk factors and the onset of FI. Except for smoking, only risk factors which preceded the onset of FI were considered, which strongly suggests that these events or symptoms were more likely causative for FI than consequences of the condition.

In addition to overt pelvic floor injury and postpartum FI, vaginal delivery can also cause clinically occult anal sphincter injury. [18, 19] However, among women in the community, who generally develop FI at an older age (e.g., 55 years in our previous study), obstetric risk factors, as evaluated by questionnaire rather than by reviewing medical records, were not associated with FI by multivariate analysis as suggested previously. [6, 10] In this study, nearly 90% of women developed FI at age 40 years or older; and obstetric events, based on a comprehensive medical record review, were not independent risk factors for FI. Grade 3/4 episiotomy or perineal tear was associated with a higher risk of FI by univariate but not multivariable analysis. Post hoc power calculations indicate that we had sufficient power to detect increased risk associated with obstetric risk factors. For example, assuming a modest exposure correlation of 0.22 and an exposure proportion of 15%, which approximates the observed proportion of 17% for grade 3/4 episiotomies in controls, we had 82% power to detect a relative risk of 2.25 in cases versus controls. While obstetric events were associated with a higher risk for FI among women who had bowel disturbances, these differences were not significant, perhaps because the sample size was limited. Overall, these findings argue against the concept that obstetric events are a primary determinant of late-onset FI and suggest that, similar to urinary incontinence, 20 obstetric trauma (e.g., forceps use) is a stronger risk factor for post-partum FI 21 than for delayed onset FI. 22 Since obstetric risk factors (e.g., forceps use) are not always accompanied by pelvic floor injury, they are imperfect surrogate markers for actual pelvic floor injury. Moreover, anal injury may be missed immediately after delivery. [18, 19] Hence, pelvic floor imaging studies are necessary to refine our understanding of the relationship between obstetric events and FI. We cannot comment, specifically, on the relative risk of FI after cesarean section compared to vaginal delivery since only a minority of women delivered by cesarean section alone. 23 From a public health perspective, these population-based data

suggest that current consensus guidelines which emphasize the continued contribution of obstetric anal sphincter injury to FI even in older women, recommend imaging to identify anal sphincter defects, and promote surgical repair of sphincter defects in women with "idiopathic" FI [24, 25] need to be revisited based on the time interval between vaginal delivery and the onset of FI.

Reinforcing clinical observations, as well as a larger questionnaire-based population-based study from Olmsted County, [6] a cholecystectomy increased the risk for FI. Cholecystectomy may predispose to FI by altering colonic transit and stool consistency secondary to bile acid-mediated stimulation of colonic motility and colonic transit. 26 Herein, a cholecystectomy increased the risk of FI even after adjusting for diarrhea and IBS, perhaps because a cholecystectomy may also be associated with increased rectal sensitivity, which can cause rectal urgency, and also with intermittent bowel disturbances not severe enough to be characterized as chronic diarrhea or IBS. 26 We previously observed that the symptom of rectal urgency, as assessed by a questionnaire and bowel diaries, was an independent risk factor for FI. [6, 27] However, rectal urgency cannot be quantified from medical records. Bile acid sequestrants (i.e., cholestyramine and colesevelam), which improve bowel function and fecal continence, should be considered in FI patients who have had a cholecystectomy. [28, 29]

In this study, the association between FI and urinary incontinence [4, 8, 30] was stronger for stress than for urge urinary incontinence. This association may perhaps be explained by similarities in the innervation and risk factors for injury of the external urethral and anal sphincters. While differences were not statistically significant, stress urinary incontinence posed a higher risk for mild than for moderate or severe FI, perhaps suggesting that cases with stress urinary incontinence are prone to leak a small amount of stool retained in the rectum during events accompanied with increased abdominal pressure. We also observed, for the first time, that a rectocele documented during surgery and a vaginal hysterectomy with posterior or anterioposterior repair also increased the risk for FI. In contrast, cystocoeles and uterine prolapse did not increase the risk for FI, suggesting that the association is genuine and attributable to pelvic organ prolapse or surgery affecting the posterior compartment rather than generalized pelvic weakness. While the mechanisms by which a rectocele may predispose to FI have not been studied, it is conceivable that stool retained in a rectocele, which is associated with disordered defecation, [31] is prone to leak in patients with anal weakness.

Current smoking posed a higher risk for FI than a higher BMI; indeed, the risk of FI among current smokers was comparable to that for IBS and cholecystectomy. Smoking has also been associated with more severe postpartum FI. 32 However, this is the first study to associate current smoking with FI in older adults. Urinary incontinence is also associated with smoking. [33, 34] Our findings suggest that this increased risk cannot be explained by chronic respiratory conditions (e.g., chronic cough). Other potential mechanisms include anti-estrogenic effects of nicotine [35] or nicotine-induced colonic high-amplitude propagated contractions, which may accelerate colonic transit. 36 Similar to some [7, 30, 37] but not all [8, 38] studies, a higher BMI increased the risk for FI. Of note, the risk was increased even though, on average, cases were overweight (BMI, 29.6 kg/m^2) but not obese. While obesity is associated with diarrhea [39] and rapid colonic transit, [40, 41] this association was significant even after incorporating diarrhea in the multivariate analysis. A higher BMI is associated with a greater intra-abdominal pressure, which may predispose to acute leakage by virtue of higher rectal pressure, or by damaging the pelvic floor over time. [42, 43] An alternative explanation (i.e., that FI is associated with a sedentary lifestyle which predisposes to obesity) seems less likely since higher BMI preceded the onset of FI. The association between obesity and FI is underappreciated and significant, particularly given the alarming increase in the prevalence of obesity and because bariatric surgery (e.g., intestinal bypass procedures) can aggravate diarrhea and FI. [44, 45]

This population-based study reduces the potential for selection and measurement biases often associated with case-control studies. There are, however, important limitations. These relate to our reliance on retrospective review of medical records written by diverse physicians over a long period of time, the impossibility of evaluating anorectal structure and functions at the onset of FI, and our inability to evaluate FI risk factors in minority women due to the racial composition of the community. [13] There is potential for experimenter bias since records were reviewed by individuals who could not be blinded to case-control status. However, risk factors were defined by established and consistent criteria. Since rectoceles and pelvic organ prolapse were only considered if documented by physical examination before surgery, our findings may underestimate the prevalence of these conditions. Nonetheless, our findings demonstrate that increased BMI, current smoking, bowel disturbances (i.e., diarrhea, IBS), cholecystectomy, and pelvic floor issues (rectocele, stress urinary incontinence) but not obstetric events were important risk factors for FI among women in the community. From a public health perspective, these observations have important implications for prevention and management of a common symptom which can significantly impair quality of life.

Acknowledgments

This work was supported in part by Grants R01 DK78924, RO1 AR30582 and UL1 RR024150 from the National Institutes of Health, U.S. Public Health Service.

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Table 1

Distribution of Non-Obstetric Risk Factors by Fecal Incontinence Status among Women in Olmsted County, Minnesota

Risk Factor	All cases (n = 176)	All controls (n = 176)	Discordant pairs		P value
			Only case has risk factor	Only control has risk factor	
Post-menopause	101	87	24	10	0.02
Ex-smoker	53	54	35*	34*	0.02
Current smoker	30	13	19*	4*	
Chronic constipation	46	29	36	19	0.03
Chronic diarrhea	42	2	41	1	< 0.0001
Irritable Bowel Syndrome	38	14	33	9	0.0003
Chronic respiratory disease	12	9	10	7	0.63
Varicose veins	23	14	19	10	0.14
Stress urinary incontinence	89	52	57	20	< 0.0001
Urge urinary incontinence	42	27	32	17	0.04
Depressive disorder	33	23	29†	18†	0.12
Other psychiatric conditions	12	5	11†	5†	
Cholecystectomy	36	7	35	6	< 0.0001
Anal procedures	20	12	16	8	0.15
Colonic operations	3	1	3	1	0.63
Spine surgery	21	10	19	8	0.05
Endometriosis	14	11	14	11	0.69
Any vaginal hysterectomy	18	15	18	15	0.73
Vaginal hysterectomy with posterior or anterioposterior repair	21	6	20	5	0.004
Cystocoele	22	11	19	8	0.05
Rectocoele	25	12	20	7	0.02
Uterine prolapse	20	8	19	7	0.03

For these discordant pairs, the reference group includes

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*lifetime nonsmokers only and

†individuals without any psychiatric diagnoses.

However, all groups were considered for univariate analyses.

Table 2

Duration of Non-Obstetric Risk Factors by Fecal Incontinence Status among Women in Olmsted County, Minnesota

Risk Factor	Cases N (%)	Controls N (%)
Diarrhea	**42 (25%)**	**2 (1%)**
0–12 months	13	0
>1 – 5 years	9	1
More than 5 years	19	1
IBS	**38 (22%)**	**14 (8%)**
0 – 12 months	1	1
>1 – 5 years	7	1
>5 years	30	12
Cholecystectomy	**36 (20%)**	**7 (4%)**
0 – 12 months	7	0
>1 – 5 years	3	0
>5 years	25	6
Rectocoele	**25 (14%)**	**11 (6%)**
0 – 12 months	1	0
>1 – 5 years	4	0
> 5 years	20	8
Stress urinary incontinence	**89 (51%)**	**52 (30%)**
0 – 12 months	82	48
>1 – 5 years	1	1
> 5 years	5	3

Numbers in individual rows may not equal total number because the duration between onset of symptoms or risk factor and onset of FI was not available in all subjects.

Table 3

Distribution of Obstetric Risk Factors by Fecal Incontinence Status among Women in Olmsted County, Minnesota

Risk Factor	All cases (n = 176)	All controls (n = 176)	Discordant pairs		P value
			Only case has risk factor	Only control has risk factor	
Pregnancy	143	145	26	28	0.89
Vaginal delivery	140	136	31	27	0.60
Delivery with prolonged 2nd stage of labor	11	24	7	20	0.19
Forceps-assisted delivery	89	76	47	34	0.18
Low forceps-assisted delivery	67	59	41	33	0.42
Delivery with shoulder dystocia	5	8	5	8	0.58
Perineal laceration	15	28	11	24	0.04
Third or fourth degree perineal laceration	4	1	4	1	0.38
Episiotomy	134	122	40	28	0.18
Midline episiotomy	53	53	37	37	1.0
Third or fourth degree episiotomy	27	17	25	15	0.15

Table 4

Analysis of Risk Factors[†] for Fecal Incontinence among Women in Olmsted County, Minnesota.

Variable	Odds Ratios (95% CI)
BMI (per unit)	1.1 (1.004, 1.1)
Past Smoker	0.98 (0.5, 1.9)
Current Smoker	4.7 (1.4, 15)
Diarrhea	53 (6.1, 471)
IBS	4.8 (1.6, 14)
Cholecystectomy	4.2 (1.2, 15)
Rectocele	4.9 (1.3, 19)
Stress Urinary Incontinence	3.1 (1.4, 6.5)
Obstetric Risk Factors (grade 1)	0.8 (0.4, 1.9)
Obstetric Risk Factors (grade 2)	1.1 (0.4, 3.6)
Obstetric Risk Factors (grade 3)	1.9 (0.7, 5.2)

[†]Only those variables that were significant in the multivariable analysis are shown.

Table 5

Interaction Between Obstetric Risk Factors and Bowel Disorders for Fecal Incontinence among Women in Olmsted County, Minnesota.

Obstetric Risk Factors	IBS or diarrhea	Cholecystectomy	Odds Ratios (95% CI)
None	No	No	Reference group
Mild	No	No	0.8 (0.4–1.7)
Moderate	No	No	1.3 (0.5–3.6)
Severe	No	No	1.4 (0.6–3.7)
None	Yes	No	4.2 (1.1–17)
Mild	Yes	No	
Moderate	Yes	No	
Severe	Yes	No	9.2 (2.8–30)
None	No or Yes	Yes	7.2 (0.95–54)
Mild	No or Yes	Yes	
Moderate	No or Yes	Yes	
Severe	No or Yes	Yes	11 (3.0–38)