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Risk factors for fecal incontinence in older women

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Abstract

Objective—To estimate the prevalence of fecal incontinence (FI) in older women, and examine associations between potential risk factors and prevalent FI.

Methods—We conducted a cross-sectional study of prevalent FI in 64,559 women, aged 62–87 years, in the Nurses' Health Study. Since 1976, participants provided information on health and lifestyle on mailed biennial questionnaires. Data on FI were collected in 2008. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for FI were calculated using logistic regression models.

Results—The reported prevalence of liquid or solid stool incontinence at least monthly increased from 9% in women age 62 to 64 years to 17% in women age 85 to 87. Prevalent FI was 50% less common in black women compared with white women (6% vs. 12%, respectively). Other variables associated with increased odds of FI at least monthly were pregnancy, higher body mass index, lower physical activity, functional limitations, current cigarette smoking, type 2 diabetes, high blood pressure, and neurologic disease. Urinary incontinence (UI) was a strong correlate of FI, with 63% of women with FI reporting UI at least monthly compared with 45% of women in the whole study population.

Conclusions—FI is a common condition among older women, and often co-occurs with UI. Potentially modifiable risk factors include body mass index, physical activity, and cigarette smoking.

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CONFLICT OF INTEREST/STUDY SUPPORT

Guarantor of the article: Francine Grodstein.

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INTRODUCTION

Fecal incontinence (FI) negatively affects adults' quality of life and has been associated with anxiety, shame, and depression.(1, 2) Moreover, adults with FI have higher health care costs and are more likely to be referred for nursing home placement than those without FI.(3, 4) Although data are somewhat limited, among older women, the burden of FI appears to be substantial, with estimates of the prevalence of FI up to 22%.(5–7)

Despite its public health importance, primary risk factors for FI have been conflicting and not clearly elucidated in large populations. For example, parity has been related to FI risk in some studies(8), but not others(7, 9–11), and although white race has consistently been associated with increased risk of UI(12–15), whether a similar association exists with FI is unclear(8, 11, 16). In addition, the relations between FI and potentially modifiable factors, such as obesity and cigarette smoking, have been inconsistent.(8, 11, 16, 17) Better understanding of both the prevalence of FI as well as FI risk factors is important to increase recognition and discussion of the condition among both physicians and their patients, and to suggest potential means of prevention and treatment.

Therefore, we estimated the prevalence of liquid and solid stool incontinence among over 64,000 older women enrolled in the Nurses' Health Study (NHS). In addition, we examined whether higher parity, white race, worse physical status (i.e., older age, higher body mass index, lower physical activity, functional limitations), and behaviors or conditions related to neurologic or microvascular damage (i.e., cigarette smoking, type 2 diabetes, high blood pressure, neurologic disease) were associated with increased odds of prevalent FI.

METHODS

Study population

The NHS is a longitudinal closed cohort study which was initiated in 1976 when 121,700 female nurses, age 30 to 55 years, responded to a mailed questionnaire about their health and lifestyle.(18) Since then, information has been updated using biennial mailed questionnaires. Each participant has a unique identification code, which both conceals participants' identities from researchers and allows linkage of individual participant data across biennial questionnaires. To encourage continued participation, an abbreviated version of the questionnaire is sent to women who do not respond to initial mailings of the full-length questionnaire. Questions about liquid and solid stool incontinence were included for the first time on the full-length questionnaire mailed in 2008, when 96,480 women were still alive. Participants provided informed consent by returning their questionnaires. The Institutional Review Board of Brigham and Women's Hospital approved this study.

For these analyses, we excluded 17,175 women who did not return a questionnaire in 2008 and 5,618 women who returned the abbreviated version of the 2008 questionnaire. In addition, we excluded 9,128 women who returned the full-length 2008 questionnaire, but did not respond to the liquid and solid stool incontinence items. Thus, 64,559 participants were included in the analyses. Compared with women in the analysis population, the 31,921 women who were excluded due to missing data were more likely to be African American (4% versus 2%). However, all other factors (e.g., age, parity, cigarette smoking, type 2 diabetes) were similar in women who were excluded and those in the analysis population.

Measurement of FI

Frequency of liquid stool and solid stool incontinence was assessed on the 2008 questionnaire using an item based on the Fecal Incontinence Severity Index developed by Rockwood et al.(19) The item included the question, “On average, how often in the past

year have you experienced any amount of accidental bowel leakage?", followed by sub-parts "a" and "b" allowing participants to respond separately for leakage of liquid stool and solid stool, respectively. Response options in parts "a" and "b" were: never, less than 1/month, 1–3/month, about once/week, several times/week, and nearly daily.

Measurement of potential risk factors

Data on potential FI risk factors, including demographic variables, lifestyle factors, and medical history, were obtained from participants' reports on all biennial questionnaires up to and including the 2008 questionnaire. Specifically, women reported their race in 1992. In 1986, when the youngest women were age 40 years, participants reported the birth weight of their heaviest child and in 1996, participants reported their total number of pregnancies lasting at least 6 months. On almost all biennial questionnaires from 1986 to 2008, participants reported the average amount of time they spent per week on leisure time physical activities, such as walking or hiking, swimming laps, and tennis, as well as usual outdoor walking pace and number of flights of stairs climbed daily. Standard metabolic equivalent (MET) scores, where 1 MET represents the amount of energy expended while sitting quietly, were assigned to each activity.(20) Activity-specific MET-hours per week were calculated by multiplying the time spent performing an activity by its MET score. We summed MET-hours per week for all reported activities to derive a total activity score for each participant and then averaged total activity scores from 1986 to 2008 to create a measure of long-term activity. Responses on the Medical Outcomes SF-36 physical functioning sub-scale(21), included on the 2008 questionnaire, were used to identify women with functional limitations; functional limitations were defined as being limited "a lot" due to health reasons in walking 1 block, climbing 1 flight of stairs, bathing, or dressing. Frequency of urinary incontinence (UI) during the past year, weight, and current living arrangement were also assessed on the 2008 questionnaire. Cigarette smoking and clinician-diagnosed illnesses, including type 2 diabetes, high blood pressure, and various neurologic conditions (i.e., stroke, Parkinson's disease, multiple sclerosis, amyotrophic lateral sclerosis, Alzheimer's disease), have been assessed on all biennial questionnaires since 1976; all reports were used to classify participant's smoking status and history of clinician-diagnosed illnesses.

Statistical analysis

The age-specific prevalence of at least monthly leakage of liquid stool, solid stool, and liquid or solid stool were calculated by dividing the number of women in a particular age stratum who reported monthly leakage by the total number of women in that age stratum.

Logistic regression models were used to calculate age-adjusted and multivariable-adjusted odds ratios (ORs) and their 95% confidence intervals (CIs) for at least monthly fecal incontinence (defined as at least monthly leakage of liquid or solid stool) according to various potential risk factors. For these analyses, non-cases were women who reported never leaking liquid or solid stool. For variables included on multiple questionnaires, we utilized data as of the 2008 questionnaire. Since vascular factors may plausibly act as mediators of the association between BMI and odds of FI, we did not adjust for type 2 diabetes or high blood pressure when calculating multivariable-adjusted ORs according to BMI. Analyses of birth weight were restricted to parous women.

In secondary analyses, we examined the associations between the various potential risk factors and two additional outcomes: 1) at least monthly liquid stool incontinence (with or without leakage of solid stool) and 2) at least monthly solid stool incontinence (with or without leakage of liquid stool). Two-tailed p-values <0.05 were considered statistically significant. Data were analyzed using SAS 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

In 2008, participants were age 62 to 87 years. The large majority was white (97.5%) and had had at least one pregnancy (94.5%) (table 1). Over half of the women reported having a BMI of 25 kg/m^2 or higher, being a current or past cigarette smoker, or having high blood pressure. In addition, UI was common among women in the population, with 45% reporting at least monthly UI (table 1).

Overall, the prevalence of at least monthly liquid stool leakage was 7.9% and the prevalence of at least monthly solid stool leakage was 6.5% (table 1). Twelve percent of women had liquid or solid stool incontinence at least monthly; as expected, the prevalence was higher among the small number of women who lived in a nursing home (data not shown in table: N=122, prevalence=43%). Among women with at least monthly liquid stool incontinence, 48% reported that leakage occurred once per week or more frequently. However, among women with at least monthly solid stool incontinence, 72% reported that leakage occurred weekly or more often. Of those women with monthly liquid or solid stool incontinence, 43% leaked only liquid stool, 33% leaked only solid stool, and 24% leaked both liquid and solid stool (data not shown in table). In addition, the prevalence of UI was 63% among women with monthly liquid or solid stool incontinence (data not shown in table).

The prevalence of liquid and solid stool incontinence increased with increasing age (table 2). For example, from age 62–64 years to age 85–87 years, the prevalence increased from 5.9% to 10.7% for liquid stool incontinence, and from 4.8% to 11.4% for solid stool incontinence. Together, the prevalence of monthly liquid or solid stool incontinence was 9% among women age 62–64 and increased almost 2-fold to 17.0% in the oldest women.

We examined associations of several risk factors with odds of prevalent FI, defined as at least monthly leakage of liquid or solid stool (table 3). In multivariable models, odds of FI were reduced by 59% in black compared with white women (OR 0.41, 95% CI 0.31–0.54). Regarding obstetric history, odds of FI were higher in parous versus nulliparous women. We observed little association between birth weight of the heaviest child and prevalent FI.

Several physical status variables were related to increased odds of FI. For example, in multivariable-adjusted models, increasing age was associated with increasing odds of FI. Specifically, odds were 1.3 times higher in women aged 75–79 years and 1.7 times higher in women aged 85–87 years compared with those aged 62–64. In addition, women with higher BMI had modestly increased odds of FI. For example, the odds of at least monthly FI were 1.4 times higher in women with BMI ≥35 versus 21–22.9 kg/m^2. Odds of FI appeared to increase with decreasing physical activity. Also, women with functional limitations were more likely to have FI than those without limitations (OR 1.58, 95% CI 1.47–1.69).

Finally, several behaviors and conditions related to neurologic or microvascular damage (cigarette smoking, type 2 diabetes, high blood pressure, and neurologic disease) were related to modestly increased odds of FI in multivariable-adjusted models. Regarding cigarette smoking, women who currently smoked 25 or more cigarettes per day had 1.5-fold higher odds of FI compared with never smokers. Odds of FI were not different in past smokers or women who currently smoked <25 cigarettes/day compared with never smokers. Type 2 diabetes, high blood pressure, and neurologic disease were associated with 1.2 to 1.7-fold increased odds of FI.

In secondary analyses, we estimated associations of each potential risk factor separately with liquid stool incontinence and with solid stool incontinence (data not shown in tables). Associations were generally similar to those in the primary analyses, although several variables—parity and BMI—appeared to have stronger relations with leakage of liquid stool

compared with solid stool. For parity, odds ratios for liquid stool incontinence were statistically significant beginning with the first pregnancy. In particular, odds ratios were 1.29 for 1 pregnancy and 1.66, 1.75, 1.74, and 1.84 for 2, 3, 4, and 5 or more pregnancies, respectively. However, for solid stool incontinence, there were statistically significant differences in odds beginning with the second pregnancy; odds ratios ranged from 1.25 for 2 pregnancies to 1.50 for 5 or more pregnancies. Finally, higher BMI was significantly associated with leakage of liquid stool, with odds ratios ranging from 1.21 (95% CI 1.08–1.36) in women with BMI 27.5–29.9 versus 21–22.9 kg/m^2 to 1.55 (95% CI 1.35–1.76) in women with BMI ≥35 kg/m^2. However, the odds of solid stool incontinence did not vary across categories of BMI. For example, odds ratios were 1.04 for BMI 27.5–29.9 kg/m^2, 1.03 for BMI 30–34.9 kg/m^2, and 1.08 for BMI ≥35 kg/m^2.

DISCUSSION

Overall, we observed that the prevalence of FI increased with increasing age from 9% among women age 62–64 years to 17% among women age 85–87. Variables that were associated with higher FI prevalence were older age, white race, pregnancy, higher BMI, functional limitations, current smoking (25 or more cigarettes/day), type 2 diabetes, high blood pressure, and neurologic disease. Results from additional analyses indicated that pregnancy was more strongly related to liquid than solid stool leakage, and higher BMI was related to risk of leakage of liquid stool, but not solid stool. These findings help to identify groups at particular risk of FI, with whom healthcare providers may want to discuss incontinence. Moreover, relations between FI and many of these potentially modifiable factors are suggestive of areas for future investigation that may lead to preventive strategies for FI.

Previous studies have utilized a variety of definitions of FI, making comparisons across studies difficult. Nonetheless, our prevalence estimates are similar to those observed by Melville et al.(5) in over 3500 women; the prevalence of FI, defined as at least monthly liquid or solid stool leakage, was about 12% in women aged 60–69 years, 11% in women aged 70–79 years, and 15% in women aged 80–90 years. Corresponding estimates in our study were 11% (age 62–69), 11%, and 15% (age 80–87), respectively. Among 2229 women in NHANES, the prevalence of at least monthly FI was 14% in women age 60–79 and 22% in women aged 80 years and older, which was higher than the rates we observed (11% and 15%, respectively).(6) However, the FI definition in NHANES included leakage of mucus, whereas ours did not.

Our finding of a higher prevalence of FI in women age 75 years and older compared with those age 62 to 64 years is consistent with several(7, 8, 22), but not all(16), studies that reported increasing FI with increasing age, even after adjusting for health-related variables. For example, among women age 40 years and older in RRISK, the multivariable-adjusted odds ratio for at least monthly FI was 1.2 (95% CI 1.1–1.4) for each 5 years of age.(8)

Data on the relation of race with FI have been inconsistent, with studies reporting a lower risk in black compared with white adults(16) as well as no difference in risk(8). In our study, odds of FI were 59% lower in black versus white women. Women who were missing from our study were more likely to be black than those in the analysis population, which could have led to underestimation of FI in black women (e.g., if sick women, who are most likely to have missing data, are more likely to have FI than healthy women), and thus overestimation of the risk reduction in black women. However, given the small absolute percentage of black women with missing data, it is unlikely that this could completely explain the nearly 60% lower odds of FI we observed. For example, even if the prevalence of FI was twice as high in black women with missing data compared with those in the

analysis population, prevalence estimates would be 9% in black women and 12% in white women, or approximately a 25% lower prevalence of FI in black than white women. While there are data suggesting that racial differences in pelvic floor anatomy and function contribute to lower rates of UI in black women(23–26), whether a similar explanation is relevant in FI is unknown and should be further explored to help understand how FI develops in different racial and ethnic groups.

Parity and obstetrical injury could affect risk of FI by causing trauma to the pelvic floor muscles, nerves, and support structures. Several studies found a higher prevalence of FI in women who had vaginal deliveries compared with nulliparous women in unadjusted analyses, but these associations did not persist after adjusting for other FI risk factors.(7, 9) In contrast, in RRISK, at least one vaginal delivery versus none was strongly associated with odds of monthly FI (OR 3.2, 95% CI 1.4–7.3).(8) The odds of prevalent monthly FI were higher in parous versus nulliparous women in our study, although the magnitude of the association was much smaller than in RRISK. Similar to previous results(10), we did not observe an association between higher birth weight of the heaviest child and higher odds of FI. However, as data on potentially relevant obstetric variables (e.g., mode of delivery, length of second stage labor, forceps-assisted delivery, episiotomy) were not collected in our cohort, we cannot exclude the possibility that many women with higher birth weight infants had a cesarean delivery and we cannot discern whether pregnancy versus other variables related to obstetric injury were causative risk factors. Additional research is needed to better understand the role of parity and obstetrical injury in FI.

Similar to other studies(5, 8, 16), we found modest increased odds of FI in women with higher BMI. For example, in a cross-sectional study of 3536 women age 30 to 90 years, the adjusted odds ratio for monthly FI comparing women with BMI >29 versus <25 kg/m^2 was 1.38 (95% CI 0.99–1.93).(5) In addition, a randomized trial of overweight and obese women with UI observed improvements in FI severity and frequency among women assigned to an 18-month weight loss intervention compared with controls.(27) Higher BMI may affect continence by causing a chronic state of increased pressure that stresses the pelvic floor.(28) In a secondary analysis, we found that BMI appeared to be associated with leakage of liquid, but not solid, stool; however, existing data on risk factors for specific types of FI are very limited and thus, additional research is needed to confirm this result.

Few studies have investigated the association between physical activity and FI, although there are data suggesting that the prevalence of FI is lower in physically active women.(7, 10) However, these are all cross-sectional data, and if women with worse FI feel functionally less able to participate in physical activity, then some reverse causation bias may underlie these results. Therefore, it is difficult to make definitive conclusions regarding a relation between physical activity and FI. Future prospective studies are needed to investigate whether physical activity is associated with lower risk of developing FI.

Functional limitations, which may indicate impairment in ability to reach a toilet quickly, have been consistently related to FI prevalence in several studies.(3, 7, 11, 12, 29) For example, among women in NHANES, those who were unable to do any activity were more likely to report FI than women who were able, but did not do vigorous activity (adjusted OR 2.23, 95% CI 1.09–4.57). Also, among 1707 older adults, average physical function scores were 8 points lower in those with versus those without FI after multivariable adjustment.(3)

In general, cross-sectional studies have not found a significant association between smoking and prevalent FI.(8, 11) However, these studies did not distinguish among lighter versus heavier current smokers. In our study, there were modest increased odds of FI only in women who currently smoked 25 or more cigarettes per day. In addition, in another study

among 134 women, a history of smoking ≥20 pack-years was more common in those with versus those without external sphincter atrophy (50% versus 23%, p=0.05).(30) Together, these results suggest that it may be important to separately consider risk in heavier smokers.

Finally, similar to our results, conditions related to neurologic damage have been associated with FI in previous studies. For example, in RRISK, the odds of monthly FI were 2.3 (95% CI 1.3–4.0) times higher in women with diabetes.(8) In addition, among 8949 older adults, stroke was associated with modest increased odds of FI (adjusted OR 1.54, 95% CI 0.78–3.07), comparable to our result for neurologic disease.(31) Diabetes and stroke may promote FI by damaging pelvic floor innervations, and may represent groups in whom FI should be discussed.

A significant strength of our study is the large sample size, which enabled precise estimation of FI odds ratios for most risk factors, as indicated by the narrow confidence intervals. In addition, we were able to examine associations between FI and a wide range of potential risk factors. Nonetheless, several limitations of our study should be considered. First, all FI data were self-reported and were not based on a stool diary. However, our questionnaire items assessing frequency of liquid and solid stool incontinence were based on a validated instrument that has been used in previous studies.(7, 19) In addition, since we assessed cross-sectional associations between potential risk factors and FI, it is possible that the associations we observed for some variables partially reflect reverse causation (as mentioned previously for FI and physical activity). However, the cross-sectional study design would not lead to bias for many of the variables we examined (e.g., race, parity). Also, we did not collect data on several known risk factors for FI (e.g., bowel disturbances, usual stool frequency), and thus could not account for their associations with FI in our multivariable analyses. Finally, since the majority of women in our study were white, and all women were age 62 years and older, our estimates of FI prevalence and risk factor associations with FI may not be generalizable to broader populations of non-white or younger women.

In conclusion, we observed a near-doubling in the prevalence of monthly liquid or solid stool incontinence, from 9% to 17%, between age 62 to 87 years in women. Independent risk factors for prevalent FI included white compared with black race, parity, higher BMI, lower physical activity, functional limitations, heavy cigarette smoking, type 2 diabetes, high blood pressure, and neurologic disease. However, for many of these potential risk factors, supporting data are limited and inconsistent. Given how common FI is among older women, more attention is needed to understand high-risk groups and modifiable risk factors for prevention.

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STUDY HIGHLIGHTS

1. WHAT IS CURRENT KNOWLEDGE
   - Fecal incontinence is common in older women and negatively affects quality of life.
   - Data on potential risk factors for fecal incontinence have been conflicting.
2. WHAT IS NEW HERE
   - Fecal incontinence, and particularly leakage of liquid stool, was more common in women with higher body mass index.
   - Women who were heavy smokers were more likely to have fecal incontinence than non-smokers.

Table 1

Characteristics of Nurses' Health Study participants in 2008 (n=64,559)

Characteristic	Percentage or Mean
Age, years (mean)	72.7
Race (%)	
White	97.5
Black	1.5
Asian American	0.8
Other or missing	0.3
Parity (%)[a]	
0 births	5.5
1–2 births	36.5
≥ 3 births	58.1
Body mass index, kg/m^2 (%)[a]	
<21	12.5
21–24	31.7
25–29	33.4
≥30	22.4
Physical activity, MET-hours/week (mean)[a]	17.9
Functional limitations (%)[c]	12.7
Cigarette smoking (%)[a]	
Never	45.3
Past	49.1
Current	5.6
Type 2 diabetes (%)	13.8
High blood pressure (%)	65.9
Neurologic disease (%)[b]	5.3
Urinary incontinence frequency (%)[a]	
Never or <1/month	55.0
1–3/month	18.4
≥ 1/week	26.7
Leakage of liquid stool in the past year (%)	
Never	75.7
<1/month	16.5
1–3/month	4.1
1–3/week	3.1
Nearly daily	0.6
Leakage of solid stool in the past year (%)	
Never	87.1
<1/month	6.3

Characteristic	Percentage or Mean
1–3/month	1.8
1–3/week	2.8
Nearly daily	2.0

MET, metabolic equivalent.

[a]Percentages and means were calculated among non-missing values.

[b]Neurologic disease includes stroke, Parkinson's disease, multiple sclerosis, amyotrophic lateral sclerosis, and Alzheimer's disease.

[c]Functional limitations were defined as substantial limitation in climbing one flight of stairs, walking one block, bathing, or dressing.

Table 2

Prevalence of fecal incontinence at least monthly by age

Age (years)	N	Liquid stool, n (%)	Solid stool, n (%)	Liquid or solid stool, n (%)
62–64	7,985	473 (5.9)	382 (4.8)	717 (9.0)
65–69	16,118	1086 (6.7)	931 (5.8)	1669 (10.4)
70–74	15,301	1103(7.2)	823 (5.4)	1563 (10.2)
75–79	12,380	1080 (8.7)	896 (7.2)	1588(12.8)
80–84	9,716	928 (9.6)	869 (8.9)	1421 (14.6)
85–87	3,059	328 (10.7)	348(11.4)	521 (17.0)

Table 3

Odds ratios (95% confidence intervals) for prevalent liquid or solid stool incontinence at least monthly according to potential risk factors

Variable	Cases	Age-adjusted OR (95% CI)[a]	Multivariable OR (95% CI)[b]
Race			
White	7338	1.00	1.00
Black	56	0.43 (0.33–0.57)	0.41 (0.31–0.54)
Asian	65	1.16 (0.89–1.51)	1.21 (0.92–1.59)
Other	20	0.93 (0.58–1.49)	0.91 (0.57 1.47)
Parity			
Nulliparous	310	1.00	1.00
1 birth	445	1.21 (1.03–1.41)	1.20 (1.03–1.40)
2 births	2069	1.43 (1.26–1.62)	1.42 (1.25–1.62)
3 births	2117	1.50 (1.32–1.70)	1.50 (1.32–1.70)
4 births	1277	1.53 (1.34–1.75)	1.53 (1.33–1.74)
≥ 5 births	1141	1.69 (1.48–1.93)	1.65 (1.44–1.89)
Birth weight of heaviest child (pounds)[c]			
<8.5	3533	1.00	1.00
8.5–9.5	1557	1.14 (1.07–1.22)	1.10 (1.03–1.17)
9.6–10.5	439	1.30 (1.16–1.45)	1.18 (1.06–1.32)
>10.5	79	1.47 (1.15–1.87)	1.25 (0.97–1.61)
Age (years)			
62–64	717	1.00	1.00
65–69	1669	1.19 (1.08–1.30)	1.15 (1.04–1.26)
70–74	1563	1.17 (1.06–1.28)	1.06 (0.96–1.17)
75–79	1588	1.53 (1.39–1.68)	1.30 (1.18–1.44)
80–84	1421	1.81 (1.64–1.99)	1.46 (1.32–1.62)
85–87	521	2.21 (1.95–2.50)	1.73 (1.52–1.97)
Body mass index (kg/m^2)[d]			
<21	978	1.10(0.99–1.21)	1.09(0.99–1.20)
21–22.9	982	1.00	1.00
23–24.9	1162	0.99 (0.90–1.08)	0.98 (0.90–1.08)
25–27.4	1435	1.10 (1.00–1.20)	1.06 (0.97–1.16)
27.5–29.9	992	1.19 (1.08–1.31)	1.12 (1.02–1.24)
30–34.9	1153	1.30 (1.18–1.42)	1.17 (1.07–1.29)
≥35	640	1.65 (1.48–1.84)	1.36 (1.21–1.52)
Physical activity (MET-hrs/week)			
Quartile 4	1623	1.00	1.00
Quartile 3	1790	1.14(1.06–1.23)	1.08(1.00–1.16)
Quartile 2	1895	1.24 (1.16–1.34)	1.11 (1.04–1.20)
Quartile 1	2149	1.46 (1.36–1.57)	1.24 (1.16–1.34)
Functional limitations	1504	1.87 (1.75–2.00)	1.58(1.47–1.69)

Variable	Cases	Age-adjusted OR (95% CI)[a]	Multivariable OR (95% CI)[b]
Cigarette smoking			
Never	3291	1.00	1.00
Past	3758	1.08 (1.02–1.13)	1.06 (1.00–1.11)
Current (cigarettes/day)			
1–14	222	0.92 (0.80–1.07)	0.91 (0.79–1.06)
15–24	148	1.24 (1.03–1.48)	1.18 (0.99–1.42)
≥25	47	1.63 (1.18–2.25)	1.50 (1.09–2.08)
Type 2 diabetes	1434	1.68 (1.57–1.79)	1.45 (1.35–1.55)
High blood pressure	5365	1.33 (1.26–1.41)	1.19 (1.12–1.26)
Neurologic disease	688	1.96 (1.78–2.14)	1.73 (1.58–1.90)

CI, confidence interval; MET, metabolic equivalent; OR, odds ratios.

[a] Odds ratios for age are unadjusted.

[b] Multivariable-adjusted odds ratios were adjusted for all other variables in the table.

[c] Estimates for birth weight of the heaviest child are only among parous women.

[d] Multivariable-adjusted odds ratios for BMI were not adjusted for potential mediating factors (diabetes and high blood pressure).