Published in final edited form as:

Am J Obstet Gynecol. 2006 February ; 194(2): 339–345.

Risk Factors for Urinary Incontinence among Middle-aged Women

Kim N. DANFORTH, MPH, Mary K. TOWNSEND, BA, Karen LIFFORD, MD, Gary C. CURHAN, MD, ScD, Neil M. RESNICK, MD, and Francine GRODSTEIN, ScD

Channing Laboratory (KND, KL, GCC, FG), Department of Medicine, Brigham and Women's Hospital, Harvard Medical School; Department of Epidemiology (KND, MKT, KL, GCC, FG), Harvard School of Public Health, Boston, MA; and Division of Geriatric Medicine, School of Medicine, University of Pittsburgh, Pittsburgh, PA (NMR)

Abstract

Objective: Identify risk factors for urinary incontinence in middle-aged women.

Study Design: Cross-sectional analysis of 83,355 Nurses' Health Study II participants. Since 1989, women have provided health information on mailed questionnaires; in 2001, at age 37–54 years, information on urinary incontinence was requested. We examined adjusted odds ratios of incontinence using logistic regression.

Results: 43% of women reported incontinence. After adjustment, African-American (OR=0.49, 95% CI 0.40–0.60) and Asian-American women (OR=0.57, 95% CI 0.46–0.72) were at reduced odds of severe incontinence compared to Caucasians. Increased age, body mass index, and parity were all positively associated with incontinence, as were current smoking, type 2 diabetes, and hysterectomy. Women aged 50–54 years had 1.81 times the odds of severe incontinence compared to women <40 years (95% CI 1.66–1.97); women with BMI ≥ 30 kg/m² had 3.10 times the odds of severe incontinence compared to BMI 22–24 kg/m² (95% CI 2.91–3.30).

Conclusions: Urinary incontinence is highly prevalent among these middle-aged women. Potential risk factors include age, race/ethnicity, body mass index, parity, smoking, diabetes, and hysterectomy.

Keywords

urinary incontinence; epidemiology

INTRODUCTION

Urinary incontinence affects women of all ages. In middle-aged women, prevalence estimates range from 30% to 40%, and rise to about 50% in older women.¹ Incontinence is associated with embarrassment and anxiety,^{2,3} which may negatively affect social participation, intimate relationships, and self-esteem.^{2,3} Moreover, the economic impact of incontinence is substantial; in 2000, the estimated total cost of urinary incontinence in the United States was \$19.5 billion.⁴

Although several large-scale studies have focused on risk factors for urinary incontinence in older women,^{5,7} limited data are available in middle-aged women. Primary risk factors for incontinence may differ over a woman's lifetime (e.g., parity appears to be a more important

CORRESPONDENCE / REPRINT REQUESTS: Kim Danforth, Channing Laboratory, 3rd Floor, 181 Longwood Ave, Boston, MA 02115, telephone 617-525-2279, fax 617-525-2008, email kdanfort@hsph.harvard.edu.

Supported by grants DK62438, CA50385 from the National Institutes of Health.

risk factor in women less than age 60 compared to older women),^{7, 8} thus it is important to explore risk factors for incontinence in younger women. Moreover, several potentially important predictors of incontinence have not been sufficiently investigated in any age group. For example, although limited findings are suggestive of a positive association,^{9,11} the relation between incontinence and cigarette smoking – a common risk factor – has not been well-examined. Likewise, observed racial differences in incontinence prevalence¹ in limited studies suggest that additional analysis of race as a potential modifier of incontinence risk is warranted. Studies of the association between hysterectomy and incontinence have reported conflicting results,^{12,14} indicating a need for further study. Finally, although the role of elevated body mass index (BMI) in the development of incontinence has been explored in numerous studies,¹ information about the role of type 2 diabetes, one of its potential sequelae, is scarce. Thus, we examined these potential risk factors for urinary incontinence in a large cohort of women aged 37 to 54 years from the Nurses' Health Study II.

MATERIAL AND METHODS

Study Population

The Nurses' Health Study II (NHS II) began in 1989 when 116,671 female, registered nurses completed a mailed questionnaire. At enrollment, study participants were 25 to 42 years of age and lived in 14 US states. Follow-up questionnaires are mailed biennially to update information on lifestyle and health; information on urinary incontinence was first requested in 2001. Follow-up remains high, at 90% to date (including a small proportion of known deaths). The study was approved by the Institutional Review Board of Brigham and Women's Hospital.

Information on Urinary Incontinence

In 2001, study participants were asked “during the last 12 months, how often have you leaked or lost control of your urine?”, with response categories of: never, less than once a month, once a month, 2 to 3 times a month, about once a week, and almost every day. Women who reported that they lost urine were then asked “when you lose your urine, how much usually leaks?”, with response categories of: a few drops, enough to wet underwear, enough to wet outer clothing, and enough to wet the floor. Self-reported frequency and quantity of urinary incontinence has been shown to be highly reproducible in a similar population of nurses.⁷

We created two case groups: (1) occasional urine loss, defined as leaking 1-3 times per month, and (2) frequent urine loss, defined as leaking at least once a week. We further defined severe incontinence as frequent urine loss of at least enough to wet the underwear. This definition was based on a validated severity index, which correlates well with pad weights¹⁵. Controls were defined as women who reported never leaking urine in the past 12 months, or leaking less than once a month and only a few drops. In a given analysis, women who did not meet the relevant case/control definition were not included in that analysis; for example, in analyses of occasional urine loss, women with frequent urine loss were not included as cases or controls but were included in separate analyses of frequent urine loss.

Information on Risk Factors

In general, the risk factor information was based on data collected through the 1999 questionnaire. Although this is a cross-sectional study, we attempted to reduce the likelihood of reverse causation by imposing a short lag period between the report of risk factors and of incontinence; we chose a two-year lag period since we also did not want to assess risk factors too far remote from outcome status. Parity, history of oral contraceptive use, and history of smoking were derived using data from all questionnaires between 1989 and 1999. BMI was calculated using self-reported height from 1989 and self-reported weight in 1999. Information on race/ethnicity was obtained in 1989, when participants were asked to “mark their major

ancestry", with response options of Southern European/Scandinavian/Other Caucasian, African-American, Hispanic-American, Asian-American, and other ancestry.

In addition, on each questionnaire, participants were asked whether they had received a physician-diagnosis of diabetes, or if they had a hysterectomy. Validation studies have established that these nurses' self-reports of health and medical conditions, including type 2 diabetes, are highly valid.¹⁶

Data Analysis

Of the 101,294 women who returned the 2001 questionnaire, we restricted analyses to women who answered the incontinence questions (n=86,006), which were only included on initial questionnaire mailings (after initial mailings the questionnaire is abbreviated to encourage participation), and who provided information on parity (n=83,355), a key risk factor and potential confounder. Thus, the sample for analysis included 83,355 women. Characteristics of participants analyzed were quite similar to those of the entire cohort (e.g., mean age was 44.8 in both the study sample and cohort; 8.7% of the population analyzed were current smokers compared with 8.6% in the entire cohort). Separate multivariate logistic regression models were used to calculate odds ratios and 95% confidence intervals for each of the incontinence case definitions. In all models, the primary risk factors examined were included: age (<40 years, 40 to 44, 45 to 49, 50 to 54), race/ethnicity (Caucasian, African-American, Hispanic-American, Asian-American, and other race/ethnicity), BMI (<22 kg/m², 22-24, 25-29, ≥30), type 2 diabetes (yes, no), hysterectomy (yes, no), parity (nulliparous, 1, 2, ≥ 3 births), oral contraceptive use (never, former, current), and smoking (never, former, current). In addition, we adjusted for the following potential confounding factors in all models: stroke (yes, no), significant functional limitations (yes, no; defined as significant limitations in climbing one flight of stairs, walking one block, or bathing/dressing), and menopausal status (premenopausal, postmenopausal/never used hormone therapy, formerly used hormone therapy, currently use hormone therapy).

RESULTS

The mean age of the study population was 44.8 years (table 1). Self-reported incontinence was highly prevalent: 43% of women reported leaking urine at least once a month. African-Americans and Asian-Americans reported urinary incontinence less frequently than Caucasian women. Overall, of women who leaked urine at least once a month, 6% reported leaking enough to wet their outer clothing or the floor.

After adjusting for potential confounding factors, there was a highly significant trend of increasing prevalence of incontinence with increasing age (table 2). For example, women aged 50 to 54 years had almost twice the odds of severe incontinence compared to women less than 40 years. In addition, African-American (OR=0.49, 95% CI 0.40-0.60) and Asian-American (OR=0.57, 95% CI 0.46-0.72) women were at significantly reduced odds of severe incontinence compared to Caucasian women. Hispanic-American women did not significantly differ from Caucasian women in their prevalence of incontinence.

Body mass index was strongly associated with incontinence (table 2). Comparing obese (BMI ≥ 30 kg/m²) women to those with BMI 22-24 kg/m², the odds of occasional incontinence was almost two-fold higher (OR=1.80, 95% CI 1.70-1.91), which rose to a threefold higher odds of severe incontinence (OR=3.10, 95% CI 2.91-3.30). Women with BMI's less than 22 kg/m² had significantly reduced odds of incontinence compared to those with BMI's of 22-24 kg/m² (OR from 0.70-0.80 across case definitions). After adjusting for BMI, as well as many other potential confounding factors, type 2 diabetes was associated with a modest but statistically

significant increase in the odds of frequent incontinence (OR=1.18, 95% CI 1.10-1.26) and severe incontinence (OR=1.30, 95% CI 1.20-1.41).

Parity, as expected, was positively associated with incontinence (table 2). Women with two livebirths had as much as a 67% increased odds compared to nulliparous women. In addition, hysterectomy was associated with a significant increase in incontinence (OR=1.59 for severe incontinence). We found a modest but significantly higher odds of incontinence for women who used oral contraceptives in the past, although no consistent association was observed for current users of oral contraceptives.

Finally, both former and current cigarette smoking were positively associated with frequent and with severe incontinence (table 2), with a somewhat stronger relation among women currently smoking (OR = 1.34, 95% CI 1.25-1.45).

COMMENT

Among over 80,000 participants of the Nurses' Health Study II, aged 37 to 54 years, 43% reported leaking urine at least once per month during the previous year. After multivariate adjustment, the prevalence of incontinence was higher in Caucasian women than in Asian-American or African-American women. In addition, the prevalence of incontinence increased with increasing age and BMI, and was higher in parous women as compared with nulliparous women. We found that current smoking, diabetes, and hysterectomy appeared to modestly elevate the odds of frequent or severe incontinence in these middle-aged women.

Overall, in studies of young and middle-aged women using similar definitions of incontinence to ours, prevalence reports are generally consistent with those we observed. Chiarelli et al.¹⁷ found a 36% prevalence of any self-reported leakage during the past year among 14,070 Australian women aged 45 to 50 years. In a review of 13 general population studies, Hunnskaar et al. reported a 30% to 40% prevalence of incontinence among middle-aged women.¹ Indeed, although our nurse-participants likely have better access to healthcare and health knowledge than those in many other studies (as reflected in a lower prevalence of smoking in our subjects compared with the general population¹⁸), the prevalence of many health characteristics, such as obesity, hysterectomy¹⁸ and type 2 diabetes¹⁹ are quite similar to national estimates.

It is interesting to note that the overall prevalence of incontinence in these middle-aged women is somewhat higher than the prevalence of 34.1% that we previously reported in a study of older nurses (aged 50-75 years).⁷ Our findings are consistent with the existing literature, which reports that the prevalence of incontinence peaks in mid-life, and then declines somewhat before rising again at older ages.¹⁵ The explanation for such a pattern is unclear. It may be physiologic, or may be due to a cohort effect. For example, perhaps younger generations are more willing to discuss certain health issues and thus report their incontinence more often than older women.

After adjustment for various risk factors, we found a lower prevalence of frequent urine leaking among African-American and Asian-American women relative to Caucasian women. Data on incontinence prevalence across racial groups are scarce and the heterogeneity that may exist within racial categories could limit the validity of comparisons across studies. Nevertheless, two studies have reported a higher prevalence of incontinence in middle-aged Caucasian compared with African-American women. In the Study of Women's Health Across the Nation (SWAN),⁹ African-American women were 70% less likely than Caucasians to report any incontinence (multivariate-adjusted RR=0.31, 95% CI 0.23-0.40) and, among 486 women aged 45 to 53 years, Burgio et al.²⁰ observed a higher prevalence of incontinence in Caucasian compared with African-American women (32.0% vs. 17.9%, $p<0.01$, without adjustment for risk factor differences). In addition, in our previous study among older nurses (50-75 years),

we also found significantly lower prevalence of urinary incontinence among African-Americans.⁷ Because incontinence was self-reported in all these studies, it is possible that observed differences in prevalence are mediated by differences in reporting urinary symptoms among various racial groups. However, we believe that the likelihood of differential reporting by race is lessened in our cohort of health professionals with comparable education and socioeconomic status. Moreover, structural and functional differences in the urethra and its support systems have been demonstrated between African-American and Caucasian women.^{21,23}

In addition, our finding of a 43% (95% CI 28% - 54%) decreased prevalence of severe leaking in Asian-American women compared with Caucasian women is comparable to the 42% (95% CI 14% - 61%) decreased prevalence of incontinence in Japanese women in the SWAN study,⁹ and also generally consistent with the lower prevalence found in our previous study of older nurses.⁷ We did not observe significant differences in incontinence between Caucasian and Hispanic-American women, as found by Sampsel et al.⁹ and as we found in our cohort of older nurses.⁷ Given the paucity of epidemiologic or biologic data on incontinence in different racial or ethnic groups, it is difficult to conclude why findings on race/ethnicity may vary across studies, and further research is needed.

Higher BMI is generally considered an incontinence risk factor,¹ and a positive association between BMI and incontinence has been observed in other cross-sectional studies of middle-aged women. Among 14,070 women aged 45 to 50 years in the Women's Health Australia project, obese women (BMI 30-40 kg/m²) had an increased risk (RR=2.05, 95% CI 1.70-2.46) of any incontinence compared with BMI < 20 kg/m²;¹⁷ these results are consistent with our finding of a 2.43-fold (95% CI 2.31-2.55) increase in the prevalence of frequent incontinence in obese women. In another study, a 5-unit increase in BMI was associated with a 30% (95% CI 10% - 60%) increased risk of severe incontinence among 48-year-old women²⁴ and, in the SWAN study, Sampsel et al.⁹ observed a 5% (95% CI 4% - 7%) increased risk of any incontinence with each one unit increase in BMI. It is possible that episodes of urine leaking led to increases in BMI by dissuading some women from being physically active. However, there is evidence that BMI has both chronic and acute effects on urinary function. Noblett et al.²⁵ found strong correlations between BMI and intra-abdominal pressure ($r=0.76$, $P < .0001$) and intravesical pressure ($r=0.71$, $P < .0001$), suggesting that obesity may cause a chronic state of increased pressure that stresses the pelvic floor. Furthermore, massive weight loss in morbidly obese women has been associated with a decrease in stress incontinence (61.2% prevalence before bariatric surgery vs 11.6% prevalence after weight loss stabilization, $p < .001$).²⁶

Type 2 diabetes has not been well-studied as a possible incontinence risk factor. However, in the SWAN study,⁹ those with diabetes had a 53% (95% CI 12% - 110%) increased risk of any incontinence and, among women older than 60 years, diabetes has been associated with a 30% to 70% increased risk of incontinence.⁸ Moreover, several possible mechanisms suggest that diabetes may adversely affect continence. Hyperglycemia has been associated with increased urine volume and detrusor overactivity, and the microvascular complications of diabetes may damage innervation of the bladder, alter detrusor muscle function, or predispose to impaired bladder sensation as well as overflow incontinence.⁸ Given the increasing prevalence of type 2 diabetes in the United States, further research on this issue is warranted.

Our finding of a modest increased odds of frequent leaking in women with a previous hysterectomy is similar to that of Miller et al.,²⁷ who reported higher incontinence severity scores in women with a history of hysterectomy than without hysterectomy (adjusted OR=1.49, 95% CI 1.01-2.22) among incontinent women aged 45 to 50 years. However, this is a controversial issue, and hysterectomy could be a marker of pelvic floor dysfunction. Indeed,

study results are conflicting. Two prospective studies^{12, 13} reported no association between hysterectomy and incontinence in women under age 60, but time since hysterectomy was less than 2 years and neither study controlled for potential confounders. In a meta-analysis of 11 observational studies, Brown et al.¹⁴ found a significant increase in odds of incontinence after hysterectomy in women aged 60 years and older (summary OR=1.6, 95% CI 1.4-1.8), but not in women younger than age 60 (summary OR=1.1, 95% CI 1.0-1.4), suggesting that hysterectomy may have long-term, but not short-term, effects on continence.

Childbearing is an established incontinence risk factor.¹ In our study, the first two births seemed to account for most of the effect; the odds ratios for three or more births compared to none were nearly identical to the odds ratios for two births. Our findings are comparable to the SWAN study, which found a 62% (95% CI 31% - 101%) increased risk of any leakage in parous women compared with nulliparous women aged 42-52 years.⁹ In the Women's Health Australia project, Chiarelli et al.¹⁷ observed similar odds of leaking urine among women with one childbirth (adjusted OR=1.58, 95% CI 1.29-1.93) and women with two childbirths (adjusted OR=1.81, 95% CI 1.54-2.12). Additionally, as expected,⁸ the odds ratios in these younger women were somewhat higher than those we had found in our cohort of older nurses. We did not collect information on mode of delivery. Cesarean-section may avoid trauma to the muscles and connective tissue of the pelvic floor and damage to the pudendal and pelvic nerves associated with vaginal delivery¹; consequently, the risks we observed for parity may underestimate true relations.

Current smoking appeared to increase frequent or severe leaking urine in our cohort by 20% and 34%, respectively. Similarly, Sampsel et al.⁹ reported a 38% (95% CI 4% - 82%) increased risk of moderate/severe incontinence among current smokers relative to never smokers in the SWAN study. After adjustment for multiple variables, Hannestad et al.¹⁰ observed a 40% (95% CI 20% - 60%) increased risk of severe incontinence in current smokers relative to never smokers among 27,936 women aged 20 to 64 years in the Norwegian Epidemiology of Incontinence (EPINCONT) study. There are numerous potential pathways through which cigarette smoking may affect continence¹¹: smoker's cough may result in damage to the urethral sphincter mechanism; decreases in collagen synthesis associated with smoking may weaken pelvic support structures; and smoking-related diseases, such as vascular disease, asthma, and obstructive pulmonary disease, may have indirect or direct effects on bladder and urethra function.

Some limitations should be considered. All information on urine leaking was self-reported. However, we found that the responses of a similar group of nurses to these questions on leaking urine were highly reliable.⁷ In addition, several studies in educated populations have established the high validity of self-reported incontinence compared to clinical assessment.^{28, 29} Moreover, self-reported severity of incontinence, based on the frequency and amount of urine leakage, has been found to correlate highly with pad weights.¹⁵ We did not have information on type of incontinence, thus we could not explore whether risk factors vary for stress, urge, or mixed incontinence. However, the odds ratios reported here represent the average effects of suspected risk factors on stress and urge incontinence, and thus have broad public health importance. Most importantly, in this cross-sectional study, we did not have information on incident incontinence, preventing the establishment of temporal relations between potential risk factors and incontinence. For example, it is possible that incontinence leads to high BMI (e.g., if women with incontinence stop exercising and gain weight) rather than that high BMI leads to incontinence. To partially address this issue, we identified potential risk factors from information reported two years prior to the reports of incontinence; nonetheless, this would likely only modestly address this problem as many of the women may have longstanding incontinence (i.e., substantially more than 2 years prior to their reports).

However, in the analysis of some risk factors (eg, age, race/ethnicity, parity), such limitations would not be relevant.

Overall, although urinary incontinence is relatively common in middle-aged women, there have been little available data on incontinence risk factors in this age group. In this cross-sectional analysis of women aged 37 to 54 years, we found that age, race/ethnicity, BMI, diabetes, smoking, parity, and hysterectomy appear to be associated with incontinence. Future studies are needed to further explore risk factors for incontinence.

References

1. Hunskaar S, Arnold EP, Burgio K, Diokno AC, Herzog AR, Mallett VT. Epidemiology and natural history of urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct* 2000;11:301–19. [PubMed: 11052566]
2. Herzog AR, Diokno AC, Fultz NH. Urinary incontinence: medical and psychosocial aspects. *Annu Rev Gerontol Geriatr* 1989;9:74–119. [PubMed: 2514773]
3. Wyman JF, Harkins SW, Fantl JA. Psychosocial impact of urinary incontinence in the community-dwelling population. *J Am Geriatr Soc* 1990;38:282–8. [PubMed: 2179369]
4. Hu TW, Wagner TH, Bentkover JD, Leblanc K, Zhou SZ, Hunt T. Costs of urinary incontinence and overactive bladder in the United States: a comparative study. *Urology* 2004;63:461–5. [PubMed: 15028438]
5. Brown JS, Grady D, Ouslander JG, Herzog AR, Varner RE, Posner SF. Prevalence of urinary incontinence and associated risk factors in postmenopausal women. Heart & Estrogen/Progestin Replacement Study (HERS) Research Group. *Obstet Gynecol* 1999;94:66–70. [PubMed: 10389720]
6. Brown JS, Vittinghoff E, Wyman JF, et al. Urinary incontinence: does it increase risk for falls and fractures? Study of Osteoporotic Fractures Research Group. *J Am Geriatr Soc* 2000;48:721–5. [PubMed: 10894308]
7. Grodstein F, Fretts R, Lifford K, Resnick N, Curhan G. Association of age, race, and obstetric history with urinary symptoms among women in the Nurses' Health Study. *Am J Obstet Gynecol* 2003;189:428–34. [PubMed: 14520212]
8. Brown JS, Nyberg LM, Kusek JW, et al. Proceedings of the National Institute of Diabetes and Digestive and Kidney Diseases International Symposium on Epidemiologic Issues in Urinary Incontinence in Women. *Am J Obstet Gynecol* 2003;188:S77–88. [PubMed: 12825024]
9. Sampsel CM, Harlow SD, Skurnick J, Brubaker L, Bondarenko I. Urinary incontinence predictors and life impact in ethnically diverse perimenopausal women. *Obstet Gynecol* 2002;100:1230–8. [PubMed: 12468167]
10. Hannestad YS, Rortveit G, Daltveit AK, Hunskaar S. Are smoking and other lifestyle factors associated with female urinary incontinence? The Norwegian EPINCONT Study. *Bjog* 2003;110:247–54. [PubMed: 12628262]
11. Bump RC, McClish DK. Cigarette smoking and urinary incontinence in women. *Am J Obstet Gynecol* 1992;167:1213–8. [PubMed: 1442969]
12. Griffith-Jones MD, Jarvis GJ, McNamara HM. Adverse urinary symptoms after total abdominal hysterectomy—fact or fiction? *Br J Urol* 1991;67:295–7. [PubMed: 2021819]
13. Carlson KJ, Miller BA, Fowler FJ Jr. The Maine Women's Health Study: I. Outcomes of hysterectomy. *Obstet Gynecol* 1994;83:556–65. [PubMed: 8134066]
14. Brown JS, Sawaya G, Thom DH, Grady D. Hysterectomy and urinary incontinence: a systematic review. *Lancet* 2000;356:535–9. [PubMed: 10950229]
15. Sandvik H, Hunskaar S, Seim A, Hermstad R, Vanvik A, Bratt H. Validation of a severity index in female urinary incontinence and its implementation in an epidemiological survey. *J Epidemiol Community Health* 1993;47:497–9. [PubMed: 8120507]
16. Carey VJ, Walters EE, Colditz GA, et al. Body fat distribution and risk of non-insulin-dependent diabetes mellitus in women. The Nurses' Health Study. *Am J Epidemiol* 1997;145:614–9. [PubMed: 9098178]

17. Chiarelli P, Brown W, McElduff P. Leaking urine: prevalence and associated factors in Australian women. *Neurourol Urodyn* 1999;18:567–77. [PubMed: 10529705]
18. Behavioral Risk Factor Surveillance System (BRFSS)[database on the Internet]. Atlanta (GA): National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention [updated 2004 Dec 20; cited 2005 Jan] Available from: <http://www.cdc.gov/brfss/>
19. Narayan KM, Boyle JP, Thompson TJ, Sorensen SW, Williamson DF. Lifetime risk for diabetes mellitus in the United States. *Jama* 2003;290:1884–90. [PubMed: 14532317]
20. Burgio KL, Matthews KA, Engel BT. Prevalence, incidence and correlates of urinary incontinence in healthy, middle-aged women. *J Urol* 1991;146:1255–9. [PubMed: 1942274]
21. Graham CA, Mallett VT. Race as a predictor of urinary incontinence and pelvic organ prolapse. *Am J Obstet Gynecol* 2001;185:116–20. [PubMed: 11483914]
22. Howard D, Delancey JO, Tunn R, Ashton-Miller JA. Racial differences in the structure and function of the stress urinary continence mechanism. *Obstet Gynecol* 2000;95:713–7. [PubMed: 10775735]
23. Baragi RV, Delancey JO, Caspari R, Howard DH, Ashton-Miller JA. Differences in pelvic floor area between African American and European American women. *Am J Obstet Gynecol* 2002;187:111–5. [PubMed: 12114898]
24. Kuh D, Cardozo L, Hardy R. Urinary incontinence in middle aged women: childhood enuresis and other lifetime risk factors in a British prospective cohort. *J Epidemiol Community Health* 1999;53:453–8. [PubMed: 10562862]
25. Noblett KL, Jensen JK, Ostergard DR. The relationship of body mass index to intra-abdominal pressure as measured by multichannel cystometry. *Int Urogynecol J Pelvic Floor Dysfunct* 1997;8:323–6. [PubMed: 9609328]
26. Deitel M, Stone E, Kassam HA, Wilk EJ, Sutherland DJ. Gynecologic-obstetric changes after loss of massive excess weight following bariatric surgery. *J Am Coll Nutr* 1988;7:147–53. [PubMed: 3361039]
27. Miller YD, Brown WJ, Russell A, Chiarelli P. Urinary incontinence across the lifespan. *Neurourol Urodyn* 2003;22:550–7. [PubMed: 12951662]
28. Diokno AC, Brock BM, Herzog AR, Bromberg J. Medical correlates of urinary incontinence in the elderly. *Urology* 1990;36:129–38. [PubMed: 2385880]
29. Herzog AR, Fultz NH. Prevalence and incidence of urinary incontinence in community-dwelling populations. *J Am Geriatr Soc* 1990;38:273–81. [PubMed: 2179368]

Table 1

Characteristics of the Nurses' Health Study II population

	TOTAL N (%)	Race / Ethnicity				Asian-American N (%)	Other/Missing N (%)
		Caucasian N (%)	African-American N (%)	Hispanic-American N (%)	Asian-American N (%)		
Leaked Urine in Past 12 Months							
Never or <1 per month	48,648 (57)	44,715 (56)	773 (64)	651 (55)	920 (68)	1,589 (58)	
1-3 times per month	14,959 (17)	13,918 (18)	164 (14)	218 (19)	194 (14)	465 (17)	
1/week to daily	22,063 (26)	20,566 (26)	270 (22)	305 (26)	237 (18)	685 (25)	
Quantity of Urine Leaked*							
A few drops	13,074 (41)	12,208 (41)	126 (35)	164 (36)	165 (47)	411 (40)	
Enough to wet underwear	17,075 (53)	15,867 (53)	225 (62)	265 (58)	174 (49)	544 (53)	
Enough to wet outer clothing/floor	1,836 (6)	1,718 (6)	13 (4)	26 (6)	15 (4)	64 (6)	
Age (mean in years)	44.8	44.8	45.9	44.7	45.0	44.3	
BMI (kg/m²)							
<22	19,998 (23)	18,602 (23)	90 (7)	218 (18)	449 (33)	639 (23)	
22 to 24	21,892 (25)	20,303 (26)	189 (16)	267 (23)	447 (33)	686 (25)	
25 to 29	21,689 (25)	19,982 (25)	385 (32)	341 (29)	274 (20)	707 (26)	
<30	18,748 (22)	17,316 (22)	470 (39)	291 (25)	103 (8)	568 (21)	
Type 2 Diabetes	5,539 (6)	5,021 (6)	117 (10)	116 (10)	130 (10)	155 (6)	
Hysterectomy	13,181 (15)	12,103 (15)	329 (27)	186 (16)	130 (10)	433 (16)	
Parity							
None	15,371 (18)	14,157 (18)	253 (21)	223 (19)	302 (22)	436 (16)	
1 birth	11,724 (14)	10,725 (13)	273 (22)	168 (14)	218 (16)	340 (12)	
2 births	32,906 (38)	30,546 (38)	397 (33)	427 (36)	483 (35)	1,053 (38)	
≥3 births	23,354 (27)	21,753 (27)	225 (18)	284 (24)	274 (20)	818 (30)	
Oral Contraceptive Use							
Never	10,738 (12)	9,712 (12)	126 (10)	150 (13)	386 (28)	364 (13)	
Former	62,124 (72)	57,658 (73)	927 (76)	832 (71)	750 (55)	1,957 (71)	
Current	11,627 (14)	10,818 (14)	121 (10)	166 (14)	145 (11)	377 (14)	
Cigarette Smoking							
Never	56,156 (65)	51,458 (65)	864 (71)	855 (72)	1,154 (85)	1,825 (66)	
Former	22,121 (26)	20,834 (26)	227 (19)	265 (22)	152 (11)	643 (23)	
Current	7,522 (9)	7,018 (9)	122 (10)	57 (5)	52 (4)	273 (10)	

NOTE: percents may not sum to 100% due to missing values.

* Quantity of urine leaked includes only women who reported leaking at least once a month

Table 2

Odds of Urinary Incontinence According to Potential Risk Factors

	OCCASIONAL INCONTINENCE [*]	FREQUENT INCONTINENCE [*]	SEVERE INCONTINENCE [*]
	Cases [§]	Cases [§]	Cases [§]
	OR [†] (95% CI)	OR [†] (95% CI)	OR [†] (95% CI)
Age (years)			
<40	2,270	3,174	1,293
40 to 44	4,664	6,475	3,125
45 to 49	4,949	7,685	4,146
50 to 54	2,623	4,105	2,354
p for trend:	p<0.0001	p<0.0001	p<0.0001
Race / Ethnicity			
Caucasian	13,512	20,011	10,186
African-American	159	254	128
Hispanic-American	207	286	159
Asian-American	184	224	87
BMI (kg/m²)			
<22	2,881	3,623	1,476
22 to 24	3,574	4,703	2,150
25 to 29	3,905	5,651	2,931
≥30	3,547	6,544	3,888
p for trend:	p<0.0001	p<0.0001	p<0.0001
Type 2 Diabetes	987	1,678	990
Hysterectomy	2,295	4,147	2,373
Parity			
None	2,142	3,538	1,587
1 birth	2,038	3,005	1,560
2 births	6,038	8,783	4,566
≥ 3 births	4,288	6,113	3,205
Oral Contraceptive Use			
Never	1,735	2,465	1,252
Former	10,954	16,302	8,556
Current	1,780	2,591	1,071
Cigarette Smoking			
Never	9,629	13,399	6,707
Former	3,743	5,915	3,012
Current	1,115	2,097	1,188

^{*} Occasional incontinence defined as leaking 1-3 times per month; frequent incontinence defined as at least once per week; severe incontinence defined as frequent and at least enough to wet the underwear.

[†] Odds ratios are adjusted for age, race/ethnicity, body mass index, parity, use of oral contraceptives, cigarette smoking, diabetes, hysterectomy, stroke, functional limitations, menopausal status and postmenopausal hormone therapy.

[§] Case numbers may not add up because some participants were missing data for given risk factors.