Published in final edited form as:

J Urol. 2008 March ; 179(3): 1012–1017. doi:10.1016/j.juro.2007.10.058.

Physical activity and incident urinary incontinence in middle-aged women

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Abstract

Purpose—While strenuous, high-impact activity may provoke urinary incontinence (UI), little is known about relations with moderate physical activity. We examined recreational activity and incident UI in middle-aged women.

Materials and Methods—Prospective study of women aged 37 to 54 years in the Nurses' Health Study II. Repeated physical activity reports from 1989 to 2001 were averaged to estimate long-term activity levels. From 2001 to 2003, we identified 4,081 incident cases with at least monthly UI. Incontinence type was further determined among cases with at least weekly UI. Multivariable logistic regression models were used to estimate adjusted relative risks (RRs) of UI across quantiles of physical activity. To determine whether relations were mediated by body mass index, separate models were constructed that excluded and included body mass index as a covariate.

Results—The risk of at least monthly UI decreased with increasing quintiles of moderate physical activity (RR 0.80, 95% CI 0.72–0.89 comparing extreme quintiles). For stress and urge UI, women with the most physical activity had lower rates of incontinence than those with less activity. RRs were 0.75 (95% CI 0.59–0.96, for top versus bottom quartile) for stress UI and 0.53 (95% CI 0.31–0.90) for urge UI. After adjustment for body mass index, the overall association with at least monthly incontinence attenuated, but remained significant (RR 0.89, 95% CI 0.80–0.99 comparing extreme quintiles).

Conclusions—Long-term, moderate physical activity was inversely associated with UI. The role of exercise in weight maintenance may partly explain this association.

Keywords

epidemiology; motor activity; urinary incontinence

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INTRODUCTION

Urinary incontinence (UI) is common in younger women, with prevalence estimates ranging from 20–40% in women less than age 60 years.¹ Incontinence may negatively impact quality of life by causing anxiety, embarrassment, and decreased social participation.^{2, 3} Yet, relatively little is known about modifiable risk factors for UI, especially among younger women.

Exercise has a key role in weight maintenance and obesity prevention. Obesity, an established incontinence risk factor¹, may influence continence status in several ways. Adiposity may cause chronic elevation in intra-abdominal pressure⁴, which weakens the urethral support structures and can lead to stress UI. Alternatively, the neurologic complications of obesity-related conditions, such as type II diabetes, have been implicated in urge UI.⁵ Thus, the avoidance of overweight and obesity through physical activity may be one approach to incontinence prevention. In addition, it also has been hypothesized that exercise may directly reduce the risk of UI, especially stress UI, by strengthening the pelvic floor muscles.⁶

While very high levels of activity, such as in elite athletes, may induce incontinence in some women⁶, further research is needed regarding more moderate activity. Most previous studies of the relation between moderate exercise and UI have been limited by cross-sectional study designs⁶, which are vulnerable to reverse causation bias because women may reduce their participation in physical activity after developing incontinence.^{7, 8} Although we recently reported that moderate physical activity was inversely related to UI incidence in a prospective study of older women⁹, risk factors for UI (e.g., parity) have been found to differ in older and younger women.¹ Thus, we conducted a prospective study of the association between moderate physical activity and the risk of urinary incontinence in a large cohort of middle-aged women.

MATERIALS AND METHODS

Study population

The Nurses' Health Study (NHS) II began in 1989 when 116,671 female nurses aged 25 to 42 years responded to a mailed questionnaire about their medical history. Since enrollment, participants have updated information on biennial questionnaires. Questions about urine leakage were included on the full-length versions of the 2001 and 2003 questionnaires; full-length questionnaires are sent in initial mailings, after which abbreviated versions of the questionnaires are mailed to maximize participation. The Institutional Review Board of Brigham and Women's Hospital approved this study.

We included women who returned the full-length version of the NHS II questionnaire in 2001 and 2003 (n=70,712). Characteristics of this subgroup were similar to participants who did not provide complete information on incontinence, including mean age (46 vs. 47 years, respectively), mean body mass index (BMI) (27 kg/m² in both), and parity (19% vs. 15% nulliparous, respectively). Participants who responded to the full-length questionnaires, but did not provide information on UI (n=349), physical activity (n=121) or parity (n=703), a key potential confounding factor, were also excluded from analyses. Our population for analysis further excluded prevalent cases of UI in 2001, defined as women reporting incontinence at least monthly (n=30,698) or incontinence less than once a month of quantities at least enough to wet the underwear (n=5,713). Because we were particularly interested in adiposity as a potential intermediary in the relation of physical activity with incontinence, we excluded participants missing data on BMI (n=260). Finally, due to the strong potential for confounding by certain medical conditions, we excluded women with neurologic conditions (n=382 with a previous diagnosis of stroke, multiple sclerosis, or Parkinson's disease) and women with

significant functional limitations (n=2,351). Thus, there were 30,135 women at risk for incident incontinence.

Measurement of incident urinary incontinence

In 2001 and 2003, participants were asked, “During the last 12 months, how often have you leaked or lost control of your urine?” Response options were never, less than once per month, once per month, 2 to 3 times per month, about once per week, and almost every day. Those who reported incontinence were then asked, “When you lose your urine, how much usually leaks?” with the following response options: a few drops, enough to wet your underwear, enough to wet your outer clothing, and enough to wet the floor. A reliability study in a similar group of nurses demonstrated high reproducibility of responses to these questions on frequency and quantity of urine leaked.¹⁰

Women who reported never leaking or leaking a few drops less than once per month in 2001 were considered at risk of incident incontinence. Incident incontinence was defined as leaking urine at least once per month in 2003, with occasional incontinence defined as leaking 1 to 3 times per month and frequent incontinence defined as leaking at least once per week. For all analyses, non-cases were defined as those women reporting never leaking or leaking a few drops less than once per month again in 2003.

In 2003, we mailed a supplementary questionnaire containing validated questions¹¹ about precipitants of UI to approximately 98% (n=1,058) of the women who reported incident frequent incontinence. One hundred fifty-seven women did not respond and 59 women returned incomplete questionnaires, leaving 842 women who could be classified according to UI type. Mean age, mean BMI, and parity were similar in those who did and did not provide incontinence type information. Stress UI was defined as leakage occurring most often with coughing and sneezing, lifting, laughing, and exercise. Urge UI was defined as leakage occurring predominantly with a sudden feeling of bladder fullness or when a toilet was inaccessible. Women who reported stress and urge symptoms equally were defined as cases of mixed UI. Women whose leaking patterns met none of these definitions were not included in analyses of incontinence type (n=11).

Measurement of physical activity

In 1989, 1991, 1997, and 2001, participants were asked to report their average time per week spent at each of the following recreational activities during the past year: walking or hiking outdoors; jogging (> 10 minutes/mile); running (≤10 minutes/mile); bicycling (including stationary machine); calisthenics, aerobics, aerobic dance, rowing machine; tennis, squash, or racquetball; lap swimming; and other aerobic recreation (e.g. lawn mowing). Response categories ranged from zero to 11 or more hours. Information on usual outdoor walking pace and number of flights of stairs climbed daily was also requested. Standard metabolic equivalent (MET) scores, where 1 MET represents the amount of energy expended while sitting quietly, were assigned to each activity. Activity-specific MET-hours per week were calculated by multiplying the time spent performing an activity by its MET score. MET-hours per week for all reported activities were summed to derive a total activity score for each participant. To estimate long-term physical activity levels, we averaged MET-hours per week over the four questionnaire cycles, because regular exercise is key in maintaining muscle strength and, thus, lifetime physical activity is a potentially important factor in UI risk.¹²

In a validation study, scores from the physical activity questionnaire administered 2 years apart were moderately reproducible (r=0.59) and there was a strong correlation between physical activity recalled for the previous year and past-week recalls (r=0.79).¹³

Statistical analysis

For analyses of incident UI according to incontinence frequency (e.g., any, occasional, frequent), long-term average physical activity was categorized into quintiles. Because the study sample was smaller for examining incontinence type (i.e., only women with incident frequent incontinence), physical activity quartiles were used in these analyses. Few women regularly participated in high-intensity activities, such as running, jogging, and tennis; thus, we were not able to separately examine vigorous activity. However, we performed secondary analyses excluding women who reported any participation in high-intensity activity, and specifically examined the relation of low-impact activity with incident incontinence.

Relative risks (RRs), estimated by odds ratios, for incident UI across quantiles of physical activity were calculated using multivariable logistic regression. In initial models, we considered adjusting for the following potential confounding factors, based on covariate status in 2001: age, parity, race/ethnicity, cigarette smoking status, oral contraceptive use, and menopausal status. Oral contraceptive use and menopausal status contributed little to the model and, therefore, were not included in final models. In secondary models, we additionally adjusted for body mass index in 2001, a potential intermediate factor in the causal pathway between physical activity and incident incontinence. All data were analyzed using SAS 9.1 (SAS Institute Inc, Cary, NC).

RESULTS

Among this cohort of women aged 37 to 54 years, the mean age was 45.9 years and the median level of physical activity was 17.0 MET-hours per week, roughly equivalent to 5.7 hours per week of walking at an average pace. Walking was the most common activity, accounting for 35% of total average physical activity, followed by other vigorous activities (18%) and calisthenics (15%). Compared with the least active women, those in the higher quintiles of activity were slightly younger, more likely to be nulliparous, and less likely to be current cigarette smokers or overweight (Table 1).

Among women in the highest quintile of physical activity, the relative risk for incident incontinence was 0.80 (95% CI 0.72–0.89) after adjusting for potential confounding factors (Table 2). Associations between physical activity and both occasional and frequent incontinence were very similar to the overall association. For example, for frequent and occasional incontinence, comparisons of extreme physical activity quintiles indicated a significant 19% and 21% decrease in risk, respectively.

Further adjustment for BMI attenuated the relative risks, suggesting that the benefit of physical activity is partly explained by its relation to adiposity. For example, the relative risk of any incontinence comparing women in extreme quintiles of physical activity changed from 0.80 (95% CI 0.72–0.89) to 0.89 (95% CI 0.80–0.99) after adjusting for BMI. Interestingly, the addition of BMI to the model attenuated findings for frequent UI to a greater extent than occasional UI, suggesting that BMI was a more important intermediate factor in the development of frequent than occasional incontinence.

Higher levels of physical activity were related to decreased risks of stress and urge incontinence (Table 3). In the top two quartiles of physical activity, there was a 25–30% reduction in the risk of developing stress incontinence. As expected in this age group, few women developed urge incontinence and, thus, confidence intervals were wide. Nonetheless, among the most active women, there was a significant 47% (95% CI 10% – 69%) decrease in the risk of urge UI. Similar to the overall analysis of incident frequent incontinence, these associations became non-significant after adjustment for BMI. When we examined mixed UI, no relation with physical activity was observed.

In analyses restricted to women who participated only in low-impact activities (n=3,415), findings were similar to those reported above. In addition, results from analyses using only reports of activity from 2001 as the primary exposure variable were also consistent with those reported above. Finally, the association between physical activity and UI risk did not vary across BMI strata (<22, 22–24, 25–29, ≥ 30 kg/m²) (p=0.11).

DISCUSSION

Overall, among these women aged 37 to 54 years, we observed a significant decreased risk of developing UI among the most active women. This relation was attenuated when we included body mass index in statistical models, suggesting that exercise may decrease incontinence, in part, through its role in weight maintenance.

Interestingly, the data suggested that BMI was a stronger intermediate variable for frequent than for occasional incontinence. We have also previously found that BMI was a stronger risk factor for frequent than occasional UI in middle-aged women.¹⁴ Nonetheless, since overall findings remained significant after considering BMI, it is likely that multiple mechanisms are involved in the association between physical activity and UI, and further research exploring these issues is needed.

Most previous studies have examined elite athletes⁶, and found increased UI. This may be due to the impact of strenuous activity on pelvic floor muscles. For example, a recent crossover study of 12 women found that mean maximal voluntary contraction pressure decreased 20% after a strenuous physical activity intervention, suggesting that such exercise may fatigue the pelvic floor muscles and increase the risk of UI.¹⁵ Our findings of decreased UI with moderate activity suggest that lower levels of activity may not have similar, detrimental effects on pelvic function, and clearly, further research is needed to understand the long-term effects of different physical activity intensities on the pelvic floor.

While few previous studies have examined the relation between recreational activity and UI in middle-aged women, and these have been largely cross-sectional, the data also indicate less UI with moderate exercise. Among 27,000 women aged 20 years and older, Hannestad et al reported a 20% (95% CI 10%–30%) decrease in the odds of prevalent incontinence compared with women who participated in low-impact exercise at least 3 hours vs. less than 1 hour per week.¹⁶

Prospective data on the relation between physical activity and incontinence are particularly scarce. Consistent with our findings, one prospective study of 6,424 women age 40 years and older found a 1.34-fold (95% CI 0.99–1.82) increased risk of incident stress UI and a 1.42-fold (95% CI 1.07–1.89) increased risk of urgency with or without UI among participants who described themselves as less active compared with other people their age.¹⁷ In our previous study of older women aged 54–79 years⁹, findings were somewhat stronger than those reported here; however, since parity is an important risk factor for UI in younger women, it is possible that other factors, such as physical activity, are less influential in younger compared with older women.

Several limitations of our study should be noted. Firstly, all data were self-reported. However, the reliability and validity of self-reported UI have been established.^{10, 18} In addition, Sandvik et al¹⁹ found that, compared to a clinical diagnosis, self-reported stress and urge UI symptoms were highly specific (84% for stress, 96% for urge), which is most important for valid inferences from prospective epidemiologic studies.²⁰ Furthermore, to increase the specificity of the UI type classifications in our study, we only asked for additional details about UI among cases with at least weekly incontinence, a group that is likely better able to describe the precipitants of their incontinence than women with less frequent symptoms. In an observational

study, it is impossible to eliminate confounding. However, we had data on a large variety of potential confounding variables and, in this homogeneous cohort of nurses, some sources of confounding may be minimized (e.g., access to healthcare and health knowledge). Finally, the NHS II cohort is a predominantly Caucasian group of health professionals; thus, it is possible that our findings do not apply to non-Caucasian women, and further research should be done in minority populations.

CONCLUSIONS

In conclusion, exercise appeared to modestly reduce the risk of developing incontinence among generally healthy women aged 37 to 54 years, an age group in whom limited prospective data on UI risk factors are available. While some of this reduction in risk appeared attributable to the role of exercise in weight maintenance and obesity prevention, our results suggest that exercise may affect UI risk through alternate pathways as well. Confirmation of these results in future studies is needed; however, given the national priority to encourage exercise, women might be assured that moderate exercise does not increase risk of becoming incontinent in middle-age.

Acknowledgments

FINANCIAL SUPPORT: Supported by grants DK62438, CA50385 from the National Institutes of Health (NIH).

Key of Definitions for Abbreviations

BMI	body mass index
CI	confidence interval
MET	metabolic equivalent
RR	relative risk
UI	urinary incontinence

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Table 1
Age-standardized* characteristics of study population in 2001 by quintile of average total physical activity[†]

Characteristics	Quintile of Average Energy Expended, 1989–2001 (MET-hours/wk [‡])				
	1 (< 7.5)	2 (7.5 – 13.5)	3 (13.6 – 20.9)	4 (21.0 – 34.0)	5 (> 34.0)
Persons	5,682	5,686	5,683	5,682	5,687
Mean age (years)	46.4	46.1	46.0	45.8	45.3
Race/ethnicity (%)					
White	92.2	93.2	93.8	92.8	93.1
Black	1.9	1.1	0.9	0.9	1.0
Hispanic	1.0	1.1	1.2	1.3	1.1
Asian	2.1	1.7	1.3	1.8	1.3
Other/missing	2.8	2.9	2.8	3.2	3.5
Body mass index (kg/m ² , %)					
< 22	24.1	25.1	28.1	30.3	38.1
22–24	26.0	29.6	30.0	32.8	29.9
25–29	27.0	27.3	26.8	24.5	21.9
≥30	22.9	18.0	15.1	12.4	10.1
Parity (%)					
0	17.8	18.8	19.7	22.8	27.9
1–2	52.6	52.8	52.5	52.1	48.8
≥3	29.6	28.4	27.8	25.1	23.3
Cigarette smoking (%)					
Never	69.4	69.2	67.4	67.6	65.3
Former	22.1	23.0	24.6	25.8	27.3
Current	8.5	7.8	8.0	6.6	7.4
Current oral contraceptive use (%)	8.2	8.8	8.7	9.4	9.5
Postmenopausal hormone use (%)					
Premenopausal	68.4	69.0	69.7	69.6	69.6
Unknown menopausal status	8.0	8.1	8.1	8.2	8.4
Never	6.4	5.7	6.0	5.9	5.7
Former	3.2	3.0	3.1	3.1	3.5
Current	14.0	14.2	13.1	13.2	12.8

Characteristics	Quintile of Average Energy Expended, 1989–2001 (MET-hours/wk [‡])				
	1 (< 7.5)	2 ($7.5 - 13.5$)	3 ($13.6 - 20.9$)	4 ($21.0 - 34.0$)	5 (> 34.0)

* All characteristics except age were age-standardized in 5-year intervals

[†] Women whose continence status was unclear in 2003 (i.e., women with incontinence less than once per month of quantities at least enough to wet the underwear) are not included in tables (n=1,715)

[‡] MET, metabolic equivalent

Table 2
Physical activity and relative risk of incident urinary incontinence (2001 – 2003) by incontinence frequency*

Physical activity (MET-hrs/wk)	Non-cases	Any Incontinence [†]			Occasional Incontinence [†]			Frequent Incontinence [†]		
		Cases	Without BMI adjustment [‡]	RR (95% CI)	Cases	Without BMI adjustment [‡]	RR (95% CI)	Cases	Without BMI adjustment [‡]	RR (95% CI)
Quintile 1 (< 7.5)	4782	900	1.00	1.00	649	1.00	1.00	251	1.00	1.00
Quintile 2 (7.5 – 13.5)	4787	899	1.00 (0.90, 1.11)	1.03 (0.93, 1.14)	675	1.04 (0.93, 1.17)	1.06 (0.95, 1.19)	224	0.89 (0.74, 1.07)	0.95 (0.79, 1.15)
Quintile 3 (13.6 – 20.9)	4906	777	0.84 (0.76, 0.94)	0.89 (0.80, 0.99)	567	0.85 (0.76, 0.96)	0.89 (0.79, 1.00)	210	0.82 (0.68, 0.99)	0.91 (0.75, 1.10)
Quintile 4 (21.0 – 34.0)	4901	781	0.86 (0.77, 0.95)	0.93 (0.84, 1.04)	596	0.91 (0.80, 1.02)	0.96 (0.85, 1.08)	185	0.73 (0.60, 0.89)	0.86 (0.70, 1.04)
Quintile 5 (>34.0)	4963	724	0.80 (0.72, 0.89)	0.89 (0.80, 0.99)	521	0.79 (0.70, 0.90)	0.85 (0.75, 0.97)	203	0.81 (0.67, 0.98)	1.00 (0.83, 1.22)

* BMI, body mass index; CI, confidence interval; MET, metabolic equivalent; RR, relative risk

[†] Any incontinence defined as leaking at least once per month; occasional incontinence defined as leaking 1 to 3 times per month; frequent incontinence defined as leaking at least once per week

[‡] Adjusted for age (36–40, 41–45, 46–50, 51–55 years), parity (0, 1–2, ≥ 3 livebirths), race/ethnicity (white, black, Hispanic, Asian, other/missing), smoking (never, past, current)

[§] Adjusted for body mass index in addition to the variables listed above

Table 3

Physical activity and relative risk of incident, frequent urinary incontinence (2001 – 2003) by incontinence type^{*}

Physical activity (MET-hrs/wk)	Non-cases	Stress Incontinence			Urge Incontinence			Mixed Incontinence		
		Cases	Without BMI adjustment [‡]		Cases	Without BMI adjustment [‡]		Cases	Without BMI adjustment [‡]	
			RR (95% CI)	With BMI adjustment [‡]		RR (95% CI)	With BMI adjustment [‡]		RR (95% CI)	With BMI adjustment [‡]
Quartile 1 (< 8.9)	5954	156	1.00	1.00	36	1.00	1.00	54	1.00	1.00
Quartile 2 (8.9 – 16.9)	6052	138	0.87 (0.69, 1.10)	0.95 (0.75, 1.19)	42	1.12 (0.72, 1.75)	1.26 (0.80, 1.98)	44	0.81 (0.54, 1.20)	0.90 (0.60, 1.34)
Quartile 3 (17.0 – 29.6)	6145	111	0.70 (0.54, 0.89)	0.78 (0.61, 1.01)	28	0.72 (0.44, 1.19)	0.85 (0.51, 1.40)	43	0.78 (0.52, 1.17)	0.91 (0.61, 1.37)
Quartile 4 (>29.6)	6188	118	0.75 (0.59, 0.96)	0.90 (0.70, 1.15)	21	0.53 (0.31, 0.90)	0.66 (0.38, 1.15)	40	0.75 (0.50, 1.14)	0.94 (0.61, 1.43)

^{*} BMI, body mass index; CI, confidence interval; MET, metabolic equivalent; RR, relative risk

[‡] Adjusted for age (36–40, 41–45, 46–50, 51–55 years), parity (0, 1–2, ≥ 3 livebirths), race/ethnicity (white, black, Hispanic, Asian, other/missing), smoking (never, past, current)

[#] Adjusted for body mass index in addition to the variables listed above