Published in final edited form as:

Female Pelvic Med Reconstr Surg. 2019 ; 25(4): 318–322. doi:10.1097/SPV.0000000000000552.

Physical Activity Patterns and Sedentary Behavior in Older Women with Urinary Incontinence: an accelerometer-based study

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Abstract

Purpose—Objective physical activity data for women with urinary incontinence are lacking. We investigated the relationship between physical activity, sedentary behavior, and the severity of urinary symptoms in older community-dwelling women with urinary incontinence using accelerometers.

Materials and Methods—This is a secondary analysis of a study that measured physical activity (step count, moderate to vigorous physical activity or MVPA time) and sedentary behavior (percentage of sedentary time, number of sedentary bouts per day) using a triaxial accelerometer in older community-dwelling adult women not actively seeking treatment for their urinary symptoms. The relationship between urinary symptoms and physical activity variables was measured using linear regression.

Results—Our cohort of 35 community-dwelling women (median age 71 years) demonstrated low physical activity (median daily step count 2168, range 687 to 5205) and high sedentary behavior (median percentage of sedentary time 74%, range 54 to 89%). Low step count was significantly associated with nocturia ($p=.02$). Shorter duration of MVPA time was significantly associated with nocturia ($p=.001$), nocturnal enuresis ($p=.04$) and greater use of incontinence products ($p=.04$). Greater percentage of time spent in sedentary behavior was also significantly associated with nocturia ($p=0.016$).

Conclusions—Low levels of physical activity are associated with greater nocturia and nocturnal enuresis. Sedentary behavior is a new construct that may be associated with lower urinary tract

symptoms. Physical activity and sedentary behavior represent potential new targets for treating nocturnal urinary tract symptoms.

Keywords

accelerometer; physical activity; sedentary lifestyle; urinary incontinence; aged

INTRODUCTION

With the aging of the U.S. population, the incidence of urinary incontinence (UI) is increasing.¹ Large epidemiologic studies have reported a relationship between low levels of physical activity and UI.^{2–4} Therefore, exercise interventions that increase physical activity could potentially reduce or prevent UI in older women.

To date, most studies that have examined the relationship between physical activity and UI have used self-reported questionnaires to measure physical activity.^{2,3,5} However, the ‘gold standard’ method to measure physical activity, especially in clinical trials of exercise interventions, is an accelerometer, a motion sensor device that measures vertical acceleration of the hip, resulting in a measure of ‘counts per minute’ that has been validated against with energy expenditure.⁶ While self-reported questionnaires have an obvious advantage in large epidemiological studies, in clinical trials, potential limitations of using questionnaires to measure physical activity include significant reporting bias attributed to a combination of the need to give socially desirable responses and the cognitive challenge of estimating frequency and duration of physical activity in older adults.^{7,8} Questionnaire-based physical activity instruments also have limited ability to measure sedentary behavior i.e. activities that are performed in a sitting or reclining position and are low in energy expenditure (< 1.5 METs).⁹ Sedentary activity is a construct that is distinct from physical activity and has emerged as a risk factor independent from physical activity for cardiovascular disease, diabetes, and overall mortality.^{10,11} There is a lack of accelerometer-based data on physical activity and sedentary behavior in adults with UI and this is hampering the development of exercise clinical trials in this population.

The primary aim of this study is to investigate the relationship between physical activity, sedentary behavior, and the severity of urinary symptoms in older community-dwelling women with UI using objective and subjective measures. We also examined the feasibility of measuring physical activity using an accelerometer and the correlation between objective accelerometer-based data and subjective questionnaire-based physical activity measurements in women with UI.

MATERIALS AND METHODS

This study is a secondary analysis of physical activity data from a prior study that measured falls risk in older adult women with UI, and who were not actively seeking treatment for their current UI and related lower urinary tract symptoms (LUTS).¹² The physical activity data presented here, as measured by accelerometer and questionnaires, has not been previously published. Subjects for the original study were recruited from three local senior community centers from January 2014 to December 2014. Criteria for inclusion were

women aged 65 or older; living independently in the community; ambulatory; and moderate to severe UI as categorized by a score of ≥ 6 on the International Consultation on Incontinence Questionnaire-UI Short Form (ICIQ-UI SF). Exclusion criteria included subjects receiving active treatment for UI. This study was approved by the University of Pennsylvania Institutional Review Board. All participants provided written informed consent.

Participants underwent assessment with validated questionnaires and physical performance testing in their own homes conducted by a trained research assistant. Basic demographic data was collected. The Mini Cog was used to assess mental status.¹³ Impaired cognition is classified as a score of <3 . The Epworth Sleepiness Scale questionnaire was used to assess levels of daytime sleepiness during everyday activities such as watching television, driving, and conversing.¹⁴ Scores range from 0–24, with higher scores indicating greater sleepiness.

Urinary symptoms were assessed using ICIQ-UI SF.¹⁵ This instrument measures frequency, severity, type, and impact of UI on quality of life. Total score ranges from 0–21, with higher scores indicating more severe symptoms. Based on score, the severity of UI can be categorized into mild (0–6), moderate (6–12), severe (13–18), or very severe UI (19–21). The Incontinence Resource Utilization Questionnaire (IRUQ) was used to measure the amount of use of various incontinence products.¹⁶ Questions include the number of menstrual liners and pads, incontinence pads, disposable undergarments, toilet paper, paper towel, or other incontinence protection items used per week.

Nighttime LUTS were measured using the validated Nocturia, Nocturnal Enuresis and Sleep-interruption Questionnaire (NNES-Q)¹⁷. Nocturia was defined as waking to urinate at least once a night, and nocturnal enuresis was defined as loss of urine during sleep, independent of nocturia or urgency UI. The NNES-Q measures frequency and bother of nocturia and nocturnal enuresis. Presence and severity of nocturnal enuresis were identified by the question, “Have you leaked urine while you were sleeping?” Answers included “never,” “once a week or less often,” “2–3 times a week,” “4–6 times a week,” and “every night.”

Physical activity was measured using the Physical Activity Scale of the Elderly (PASE), a validated questionnaire used to measure self-reported activity in healthy, community-dwelling older adults.^{18,19} This questionnaire measures intensity, frequency, and duration of physical activities common among older adults over the course of the previous 7 days. In prior studies, the PASE questionnaire has been shown to have adequate test-retest reliability in older adults¹⁸, and compared favorably to step counts, grip strength, and static balance in the general elderly population^{18,20}. Total PASE score ranges from 0 to 400. PASE weighted score was used to categorize level of physical activity into light (0 to 31.5), moderate (31.6 to 98.5), and vigorous (98.6 to 400) physical activity.

Physical activity was also directly measured using waist-worn, triaxial accelerometers for one week. The Actigraph GT3X accelerometer (Actigraph, Pensacola, FL) has been shown to reliably measure physical activity in community-dwelling adults and older adults^{21,22}. We defined adequate accelerometer wear time as 4 days out of 7, with a minimum of 600

minutes (10 hours) per day⁸. Definitions of various physical activity, sedentary behavior, and energy expenditure variables that we measured are presented in Figure 1.^{8,23}

Baseline demographics, urinary symptoms, physical activity, and sedentary behavior data were described using percentage for categorical variables, and median and range or mean and standard deviation for continuous variables. We examined the relationship between physical activity/sedentary measures and urinary symptoms using univariable linear regression for continuous variables, and t-test and Wilcoxon rank-sum test for categorical variables. We also examined the relationship between physical activity/sedentary behavior and UI severity by comparing severity symptom (ICIQ) scores and incontinence product utilization (IRUQ) scores between women in the lower quartile and upper quartile of activity or sedentary behavior. Finally, we examined the relationship between questionnaire-based physical activity data (PASE total score and weighted activity scores) and accelerometer-based data using Spearman's correlation. Statistical analysis was performed using Stata (version 13, Stata Corp, Texas, USA). A p-value of 0.05 was considered to be the threshold for statistical significance.

RESULTS

Accelerometer data was available in 35 of 37 community-dwelling older adult women who participated in the study. The median age of participants was 71 years (range 64 to 97 years), and the majority were obese (median BMI 30.4, range 17.4 to 47.4) (Table 1). The prevalence of poor cognition was high with 11 women (31.4%) scoring less than 3 on the Mini-Cog. Most women had severe UI as indicated by a high median ICIQ score (median score 12.8, range 7 to 19) and 71% of women used incontinence products. The majority of women had mixed UI (50%), while 41.2% described urgency UI only and 8.8% reported stress UI only. The prevalence of episodes of nocturia once nightly or greater, nocturia twice nightly or greater, and nocturnal enuresis was high at 97%, 68% and 50%, respectively.

Mean wear time for accelerometer was 7.9 $\pm$ 1.02 days out of the assigned 7 days (range 4 to 12). Average daily wear time was 694.3 minutes (range 352.8–926.4 minutes), or about 11.6 hours per day with 30 out of 35 women (85.7%) reaching adequate wear time criteria. There was no significant difference in Mini Cog scores in those who reached adequate wear time, compared to those who did not ($p=0.49$).

Physical Activity

Total activity time as measured by accelerometer was about 3 hours daily (183.5 $\pm$ 65 min). Most active time was spent in light intensity activities (median 166.9 min), versus MVPA (median 15.4 minutes). Table 2 shows specific physical activity, sedentary behavior, and energy expenditure variables that were measured. Daily step counts, time spent in MVPA, and energy expenditure (daily kilocalories and daily METS) were low. Physical activity bouts (Freedson bouts) were observed rarely in this study sample.

Median total score on the PASE questionnaire was 98.6 (out of a possible score of 400). Weighted scores for physical activity were also highly skewed towards low intensity activities. Median walking score was 15 (range 0–85.7), while median weighted scores for

light, moderate, and vigorous physical activity were 0 (range: light, 0–31.5; moderate, 0–17.3; vigorous, 0–98.6).

Sedentary Behavior

Sedentary behavior as measured by accelerometer showed a median of 73.9% time daily spent in sedentary activities (Table 2). The median daily sedentary time was over 8 hours per day (493.4 minutes). The accelerometer data indicated that each subject had a median of over 11 sedentary bouts per day, each lasting over 3.5 hours (221 minutes).

Physical Activity and Urinary Symptoms

We noted significant associations between accelerometer measurements and various LUTS. Lower step count was significantly associated with greater number of episodes of nocturia ($p=0.02$). Shorter duration of MVPA was significantly associated with greater number of episodes of nocturia ($p=0.001$), severity of nocturnal enuresis ($p=0.04$), and greater use of incontinence products ($p=0.04$). Shorter duration of light activity and all activity were also associated with greater nocturia ($p=0.045$ and 0.04 , respectively). Lower daily MET rate was significantly associated with worse UI severity scores ($p=0.02$). We did not note any relationship between physical activity measures and the type of UI (stress or urgency UI).

Similarly, when comparing severity of urinary symptoms in subjects with the highest and lowest quartile of activity by accelerometer (above 75th percentile and below 25th percentile respectively), subjects in the highest quartile of MVPA time used significantly fewer incontinence products than subjects in the lowest quartile (5.44 v 22.89 , $p=0.016$). Use of incontinence products was also significantly lower in subjects who had the highest vs. the lowest quartile of step counts per day (2.8 v 19 , $p=0.003$) and highest vs. lowest MET rate (5.9 v 20.8 , $p=0.04$).

PASE total score was not significantly associated with any urinary symptom including severity of UI as measured by ICIQ ($p=0.1$), frequency of nocturia ($p=0.4$), number of episodes of nocturnal enuresis ($p=0.75$), or use of incontinence products ($p=0.57$). The association between lower severity of urgency UI with higher total PASE score reached borderline significance ($p=0.06$).

Sedentary Activity and Urinary Symptoms

When comparing severity of urinary symptoms in subjects with high and low sedentary behavior by accelerometer (above 75th percentile and below 25th percentile respectively), those in the highest quartile displayed higher ICIQ scores indicating more bothersome incontinence (15 vs 10 , $p=0.02$), greater use of incontinence products (14 vs 2 , $p=0.005$), and greater number of episodes of nocturia ($p=0.005$).

Greater percentage of time spent in sedentary behavior was significantly associated with greater number of episodes of nocturia ($p=0.016$). This was not significant when factoring daily average step count into the model ($p=0.28$). Increased frequency of sedentary bouts was associated with greater use of incontinence products ($p=0.038$), but this was not significant after adjusting for daily step count ($p=0.12$).

Correlation between Questionnaire-based and Accelerometer-based physical activity data

Correlation between total PASE score and accelerometer measurements of physical activity (including daily kcal, daily MET rate, daily step count, Freedson bout frequency and duration, and MVPA time) was weak, with Spearman's correlation coefficients ranging from 0.04 to 0.26 ($p>0.05$). When comparing measurements of various physical activity intensities (light, MVPA), accelerometer data also showed no correlation with corresponding weighted scores on the PASE questionnaire (Spearman's coefficient range -0.11 to 0.15 , $p>0.05$).

DISCUSSION

Our study shows that community-dwelling older adult women with UI have low levels of physical activity and are highly sedentary. Low levels of three physical activity measures on the accelerometer (step count, MVPA time, light activity time) were significantly associated with greater nocturia and nocturnal enuresis and greater use of incontinence products. Lower MET rate was associated with greater severity of UI. While prior studies have reported that low physical activity is a risk factor for urinary incontinence,²⁻³ our finding that low levels of physical activity are associated with greater nocturia and greater use of incontinence products is new and has not been previously reported.

This is the first study to report sedentary behavior data in women with urinary incontinence. Women with the greatest sedentary behavior displayed significantly greater bother from nocturia and incontinence than those displaying the least sedentary behavior. Large epidemiologic studies have shown that sedentary behavior is an independent risk factor for several health conditions such as cardiovascular disease, diabetes, and overall mortality.¹⁰ A systematic review and meta-analysis reported that sedentary behavior is a risk factor for insomnia and sleep disturbances.²⁴ Given that insomnia and sleep disturbances are also risk factors for nocturia, these findings suggest that sedentary behavior is a new construct that may be related to lower urinary tract symptoms and merits further investigation in larger studies.

Our findings are clinically important. The prevalence of nocturia (2 or greater episodes) and nocturnal enuresis in our community-based cohort was high being 68% and 50% respectively. Unfortunately, currently treatment options for nocturia/nocturnal enuresis are limited. Our findings potentially open the door for new treatment interventions for this condition. The median daily step count of our cohort (2168.5 steps per day) was similar to that reported for older adults in a population based NHANES study⁸, and well below the recommended step count of 7,000 to 10,000 steps per day for this population.²⁵ Though, in our population, time spent in MVPA (median 15 minutes) was slightly higher than that reported by Troiano et al for this age group, MVPA for our population was still well below published recommendation of 30 minutes per day for older adults²⁶. A small randomized clinical trial in older adults has shown that improving physical activity can reduce UI.²⁷ If similar clinical trials show that increasing physical activity can improve nocturia and/or nocturnal enuresis, treatment options for this difficult to treat condition would increase.

Though we observed several significant relationships between accelerometer-based physical activity measurements and LUTS, we did not observe any relationship between questionnaire-based physical activity data and various LUTS. This was likely due to small sample size. However, our ability to detect meaningful relationships between physical activity variables and LUTS even in this small cohort suggests that accelerometer is a more sensitive measure of physical activity than questionnaires. Other studies have also reported that questionnaires may not be an accurate measure of physical activity in older adults because subjects may provide socially desirable responses and estimating the duration and frequency of physical activity may be cognitively challenging.^{8,28,29} Additionally, self-reported questionnaire may be measuring a construct different from physical activity such as perception of physical ability and limitations or self-efficacy, rather than actual activity itself.³⁰ Using the accelerometer, we were able to obtain objective data on several clinically meaningful objective measurements of physical activity and sedentary behavior including step count, MVPA time, and MET rate. Though step counts can be measured using pedometers, an advantage of accelerometer is that it also allows measurement of energy expenditure using MET rate. The MET rate is a particularly useful measurement as older subjects may expend more energy with a given task than younger subjects.^{31,32} Our findings suggest that the accelerometer is a useful objective and sensitive measure of physical activity in older community dwelling women with UI and could be used to measure clinically relevant outcomes in clinical trials of UI, especially those investigating physical activity interventions.

Our study also demonstrates the feasibility of using accelerometer to measure physical activity in older adult women with UI, a high-proportion (31%) of whom had neurocognitive dysfunction. A prior study has reported on the difficulties of obtaining accurate accelerometer measurements in older populations due to improper monitor placement, inadequate wear time and low compliance³³. Valid wear time that provides meaningful data has been previously defined as 4 or more days of wear time per week with 10 or more hours per day.⁸ Majority of women in our study wore the accelerometer for at least four out of prescribed seven days with a median daily wear time of 12.9 hours. Neurocognitive function also did not impact wear time of the accelerometer. These findings will be useful for investigators designing clinical trials to investigate physical activity outcomes or interventions in older adult women with UI.

Our study is limited by its small sample size, which may limit generalizability of our findings. A potential source of selection bias is that all women were home-dwelling and not seeking treatment for their urinary symptoms. The relationship between physical activity, nocturia, and insomnia is likely complex such that poor sleep and daytime fatigue may increase sedentary behavior. Our cross-sectional design does not allow us to determine whether sedentary behavior is the cause or the result of urinary symptoms. However, our study is unique in its approach to measurement of physical activity with both validated questionnaires and accelerometers, as well as our population of community-dwelling older ambulatory women. Future studies with larger cohorts would help to delineate the relationships of physical activity and sedentary behavior paradigms with LUTS, and examine the effect of intervention in those behaviors on LUTS and use of incontinence products.

CONCLUSIONS

Low levels of physical activity are significantly associated with more severe urinary incontinence, greater nocturnal symptoms, and more incontinence product use in community-dwelling older adult women with urinary incontinence and lower urinary tract symptoms. Physical activity questionnaires correlate poorly with accelerometer data, and likely capture a separate construct of physical activity. Randomized clinical trials that examine the effect of physical activity interventions on LUTS should use using objective measures of physical activity and sedentary behavior.

Acknowledgments

Supported by a Perelman School of Medicine PCOR-Pilot Grant, and National Institutes of Health Grants 1R01NR012011-01 (DKN) and U54-CA155850 (KHS).

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Abbreviations and acronyms

ICIQ-UI SF	International Consultation on Incontinence Questionnaire–Urinary Incontinence Short Form
IRUQ	Incontinence Resource Use Questionnaire
LUTS	Lower urinary tract symptoms
METs	metabolic equivalent of task
MVPA	moderate-and-vigorous physical activity
NNES-Q	Nocturia, Nocturnal Enuresis, and Sleep Interruption Questionnaire
PASE	Physical Activity Scale of the Elderly questionnaire
UI	urinary incontinence

Measure	Explanation	Definition
PHYSICAL ACTIVITY †		
Step count	Total number of steps per day	
Light activity time	Time spent in light intensity activities	Time spent per day in activities of < 2020 counts per minute
Moderate to Vigorous Physical Activity (MVPA) time (minutes)	Time spent in moderate and vigorous activities	Time spent per day in moderate activity (2020 -5999 counts per minute) and vigorous activity (> 5999 counts per minute)
Frequency of Freedson bouts (bouts of physical activity)	allows measurement of short bouts of physical activity	Daily number of bouts (at least 10 minutes spent in activity ≥ 1952 counts per minute)
Duration of Freedson bouts (minutes)	Total time spent in short bouts of physical activity	Total length of time of Freedson bouts per day
SEDENTARY BEHAVIOR		
Daily sedentary time (minutes)	Time spent in sedentary behavior	Time spent in sedentary behavior per day (≤ 99 counts per minute)
% sedentary time per day	Proportion of daily time spent in sedentary behavior	% of wear time spent in sedentary behavior (≤ 99 counts per minute)
Frequency of sedentary bouts	Daily number of bouts of sedentary behavior	Daily number of bouts of at least 10 minutes spent in activity of ≤ 99 counts per minute
Duration of sedentary bout (minutes)	Total time spent in sedentary behavior per day	Total length of sedentary bouts per day
ENERGY EXPENDITURE		
Daily kilocalories	Total daily kilocalories expenditure	
Daily MET rate (kcal/kg*hour)	Daily metabolic equivalent of task Sedentary activity: < 1.5 METs Moderate activity: equivalent to 3 METs Vigorous activity: equivalent to 6 METs	

† Only Physical activity can be measured using a questionnaire (see text)

FIGURE 1.

Physical Activity and Sedentary Behavior Variables as measured by Accelerometer

Table 1

Baseline Demographics and Urinary Symptoms of 35 community dwelling older women with urinary incontinence

BASELINE CHARACTERISTICS (n = 35)	
Age	71 (64–97)
BMI	30.4 +/- 7.47
Race	
White	2 (60%)
Black	12 (34.3%)
Other	2 (5.7%)
Number of medical comorbidities	4 (0–7)
ESS score	7 (0, 21)
Mini Cog scores	
3	24 (68.6%)
<3	11 (31.4%)
URINARY SYMPTOMS BASELINE	
Nocturia	Never: 1 (2.9%) Once: 10 (28.57%) Twice: 8 (22.9%) Three times: 9 (25.7%) Four or more: 7 (20%)
Nocturnal enuresis	
Never	17 (50%)
1×/wk	9 (26.5%)
2–3×/wk	3 (8.8%)
4–6×/wk	0 (0%)
Daily	5 (14.7%)
UI	37 (100%)
Incontinence subtypes	3 (8.8%)
SUI	14 (41.2%)
UUI	17 (50%)
MUI	
IRUQ Number of incontinence products used	7 (0–73)
ICIQ score	12.8 +/- 3.37
Total PASE score	98.61 (8.21, 318.64)

Table 2

Physical Activity and Sedentary Behavior in Older Women with Urinary Incontinence (n =35)

Measures of Physical and Sedentary activity	Median +/- range
PHYSICAL ACTIVITY	
Daily step count	2168.5 (686.8, 5205.1)
MVPA time (minutes)	15.4 (3, 58.2)
Frequency of Freedson bouts	0 (0–0.4)
Duration of Freedson bouts (minutes)	0 (0, 0.4)
PASE Questionnaire total score	98.6 (8.2, 318.6)
SEDENTARY BEHAVIOR	
Daily sedentary time (minutes)	493.3 (312.7, 719.1)
% sedentary time per day	73.9% (53.9, 88.7)
Frequency of sedentary bouts	11.3 (4.3, 20.9)
Duration of sedentary bouts (minutes)	221.1 (22.4, 436.9)
ENERGY EXPENDITURE	
Daily Kcals	154.1 (41.8, 315.8)
Daily MET rate (kg/kg*h)	1.05 (1, 1.2)

MVPA: Moderate to Vigorous Physical Activity