ARTICLE

Characteristics of Lower Limb Muscle Strength, Balance, Mobility, and Function in Older Women with Urge and Mixed Urinary Incontinence: An Observational Pilot Study

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ABSTRACT

Purpose: After the age of 65, urinary incontinence (UI) occurs in one of every two women. A positive correlation between falls and urgency UI (UUI) or mixed UI (MUI) has also been identified. However, lower extremity impairments in older women with UUI or MUI have not been thoroughly investigated. The primary goal of this study was to compare lower limb strength, balance, mobility, and function in older women with and without UUI or MUI. The secondary goal was to evaluate the association between these measurements and UI severity. ***Method:*** A total of 40 older women with and without UUI or MUI completed standardized tests for lower limb strength (knee flexor or extensor dynamometry, 30-second sit-to-stand test), balance (single-leg stance test, Four Square Step Test, Activities-specific Balance Confidence questionnaire), mobility (10-metre walk test, 6-minute walk test), and function (Human Activity Profile questionnaire, 12-Item Short Form Health Survey). ***Results:*** Significant differences in balance and mobility were observed between the two groups. Women with UI had shorter single-leg stance times, lower balance confidence scores, and slower gait speeds. ***Conclusions:*** The results from this pilot study suggest that high-functioning older women with UUI or MUI have balance and mobility impairments. More studies are needed to confirm these results. By reporting power calculations for sample size, this pilot study provides a useful basis on which to design and conduct larger studies.

Key Words: mobility limitation; muscle strength; postural balance; urinary incontinence, women's health.

RÉSUMÉ

Objectif : après l'âge de 65 ans, une femme sur deux souffre d'incontinence urinaire (IU). On constate également une corrélation entre les chutes et l'incontinence par urgenturie (IUU) ou l'incontinence urinaire mixte (IUM). Cependant, les déficiences des membres inférieurs chez les femmes âgées qui souffrent d'IUU ou d'IUM n'ont pas fait l'objet d'études approfondies. La présente étude avait comme principal objectif de comparer la force des membres inférieurs, l'équilibre, la mobilité et la fonction générale des femmes âgées présentant ou non une IUU ou une IUM. L'objectif secondaire consistait à évaluer l'association entre ces mesures et la gravité de l'IU. ***Méthodologie :*** au total, 40 femmes âgées présentant ou non une IUU ou une IUM ont effectué des tests standardisés pour mesurer la force de leurs membres inférieurs (mesure dynamométrique de flexion et d'extension du genou, test assis-debout de 30 secondes), leur équilibre (test d'équilibre unipodal, et *Four Square Step Test*, questionnaire sur la confiance en leur équilibre *Activities-Specific Balance Confidence scale*), leur mobilité (test de marche sur 10 mètres, test de marche de six minutes) et leur fonction (*Human Activity Profile questionnaire*, *12-Item Short Form Health Survey*). ***Résultats :*** les chercheurs ont observé des différences d'équilibre et de mobilité importantes entre les deux groupes. Les femmes ayant une IU ont obtenu des temps réduits au test d'équilibre unipodal, présentaient des scores de confiance en leur équilibre plus bas ainsi qu'une vitesse de marche réduite. ***Conclusion :*** d'après les résultats de ce projet pilote, on constate des problèmes d'équilibre et de mobilité chez les femmes âgées hautement fonctionnelles qui présentent une IUU ou une IUM. D'autres d'études sont nécessaires pour confirmer ces résultats. En rendant compte des calculs de puissance de taille échantillonnale, le présent projet pilote représente un point de départ utile pour concevoir et réaliser des études plus vastes.

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After the age of 65, urinary incontinence (UI) occurs in one of every two women, and of this number, 20%–25% complain of severe symptoms (> 10 episodes/wk).[1,2] A majority of them have mixed UI (MUI):[2] urine leakage secondary to coughing, sneezing, physical activity, and urinary urgency. UI is a major public health problem, not only because of its prevalence among older women but also because of its dramatic impact on the women's quality of life and participation in social activities. UI results in decreased participation in activities, isolation, and loss of self-confidence, and it is an independent predictor of increased risk of institutionalization among older women.[1]

Studies have reported a correlation between urgency UI (UUI) or MUI and falls, but so far it has not been thoroughly investigated.[3,4] In the literature, researchers and experts have made some hypotheses about this association, notably by evoking behavioural and environmental components such as rushing to the bathroom[5,6] or making trips to the toilet at night.[3] Other explanations have targeted cognition[7] – especially executive function because of the increased complexity of carrying out dual tasks among women with MUI[8] – or the altered gait pattern associated with a strong desire to void.[9] Deficits in physical function and motor skills were also mentioned as another possible explanation for this increased incidence of falls.[4,10] This latter hypothesis could be of particular relevance to physiotherapy.[3]

To date, only a limited number of studies have focused on the association between UI and lower limb function, and they have used only global measures of strength, balance, mobility, and function.[1,11–13] Therefore, it is highly relevant to expand the analysis of this association and more precisely quantify lower limb muscle strength, balance, mobility, and functional performance among older women with UI and to determine their relationship to severity of UI. Our findings will allow clinicians to develop targeted clinical interventions to better prevent falls among this clientele, a need that recently articulated in the literature.[14]

Therefore, the research objectives of the current study were to (1) compare the specific characteristics of lower limb muscle strength, balance, mobility, and function among older women with and without UUI or MUI and (2) explore the association between the severity of the UI symptoms and these characteristics.

METHODS

Design

This was an observational, cross-sectional pilot study. It was approved by the Institut Universitaire de Gériatrie de Montréal Research Committee, the Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal, Institutions Research Ethics Committee, and the Health and Social Services Centre, University Institute of Geriatrics of Sherbrooke Research on Aging Ethics Committee.

Participants

Participants were recruited at two research centres in Montreal and Sherbrooke, Quebec. Eligible women were community dwellers aged 65 years or older who were able to walk without an assistive device. Incontinent women had to have at least three episodes of UI per week for at least 3 months and continent women had to have had no leakage for at least 3 months. Continence status was first enquired about during a telephone interview and later confirmed by the International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form (ICIQ–UI–SF). Incontinent participants had to present with either UUI or MUI with predominantly urgency symptoms.

Exclusion criteria consisted of previous UI or pelvic organ prolapse surgeries and participation in a previous research project related to UI, balance, falls, or lower limb strength. Participants were also excluded if they presented with medical problems, disabilities, or comorbidities that might interfere with the study (severe or uncontrolled diabetes, active or recent cancer, dementia, severe arthritis, severe cardiovascular disease, psychiatric condition, severe neurological condition, chronic constipation, muscle pain) or if their BMI was higher than 35.[15] Any change in their hormone prescription within the previous 6 months was an additional exclusion criterion. Finally, participants were excluded if they were unable to speak English or French and understand simple instructions.

A research assistant conducted the initial telephone interview to determine a study participant's eligibility and to schedule the individual 4-hour assessment session, where applicable. All study participants gave written informed consent.

From 2011 to 2013 (summer months only), 20 women with UI (8 UUI, 12 MUI) and 20 women without UI were recruited. The women were paired, matching for age (±3 years) and BMI (± 5kg/m^2).[15] Each group included the same number of fallers to limit the influence of falls history on the four domains of strength, balance, mobility, and function.[16]

Variables

All participants underwent a structured interview to collect personal data (age, height, weight, smoking history, etc.), history of falls in the previous 12 months, and health-related information (visual impairment, medication list, self-reported comorbidities, as listed in Appendix 1). Cognition was assessed using the Mini-Mental State Examination (MMSE).[17] The participants also completed standardized questionnaires and tests to gather data on their UI symptoms, lower extremity strength, balance, mobility, and function. The assessment session followed a standardized protocol, and all participants completed the evaluation measures in the same order.

UUI or MUI severity of symptoms

For the purpose of this study, UUI and MUI were defined according to the Questionnaire for Urinary Incontinence Diagnosis.[18] UI severity was assessed using the ICIQ–UI–SF, a four-item questionnaire with good psychometric properties, currently recommended by the International Consultation on Incontinence.[19] The ICIQ–UI–SF provides scores ranging from 0 to 21, where higher scores indicate increased UI symptom severity.

Muscle strength

We measured muscle strength in terms of maximal strength, intra-individual variability in knee strength, and functional performance. The muscle strength of the dominant and non-dominant lower limbs was assessed using a Biodex dynamometer (Biodex Medical Systems, Inc., Shirley, NY). The knee extensors and flexors were selected for measurement because their muscular capacity is important for carrying out several functional activities (such as walking, standing up from a chair, climbing stairs).[20] Measurements of isometric contractions were taken at 30 and 60 degrees of knee flexion because different maximal strength values can be recorded at those two positions.[21,22]

Participants had an initial practice session and were instructed to attain their maximal effort gradually, hold it for 4–5 seconds, and then release. For each knee, participants had three recorded trials each for flexion and extension, in each position (30 and 60 degrees), with a 30-second rest between each maximal effort, for a total of 12 recorded maximal contractions. These knee strength Biodex measurements were then normalized to BMI and analysed.

We also analysed knee strength measures of dispersion because variability could influence the participants' capacity to avoid falls.[23,24] Dispersion around each individual's knee strength was measured using two indicators: (1) standard deviations of the mean maximal strength value among the three trials and (2) variability coefficients ([SD/mean]/BMI).[21,25]

Lower limb strength was additionally assessed with the 30-second sit-to-stand test, a reliable and valid measure of functional performance related to lower limb strength in older adults.[26] Participants began this test by sitting with their arms crossed over their chest, then standing up and sitting back down as many times as possible in 30 seconds.

Balance

We measured balance in terms of performance and confidence. Balance performance was assessed using the single-leg stance test, a validated indicator of standing balance[27] and the Four Square Step Test (FSST), a valid and reliable measure of dynamic balance in older adults, in which the participants have to step as quickly as possible into four squares following a specific sequence.[28] In addition, we assessed balance confidence using the Activities-specific Balance Confidence Simplified (ABC–S) scale, a validated questionnaire with good psychometric properties.[29,30]

Mobility

We measured mobility in terms of gait speed and functional capacity. We first used the 10-metre walk test, in which participants are timed as they walk as fast as they can for 10 metres; it provides a reliable measure of gait speed.[31] Participants also completed the 6-minute walk test (6MWT), for which they were asked to walk as far as possible in 6 minutes; it has been shown to be a valid and reliable measure of functional capacity.[32]

Function

We assessed function (activity profile and self-perceived health) using the Human Activity Profile (HAP) questionnaire, a valid indicator of the level of physical activity for a wide range of populations.[33] Self-perceived health was assessed using the 12-Item Short Form Health Survey (SF–12), which provides physical and mental health summary scores. The SF–12 is a valid and reliable questionnaire for older adults, with scores ranging from 0 to 100, where higher scores indicate a better health.[34,35]

Data analysis

We compared the demographic variables of both groups of women using Student's t-test (normally distributed continuous variables), Mann–Whitney U-test (non-normally distributed continuous variables), and Fisher's exact test (categorical variables). All variables measuring lower limb strength, balance, and mobility were compared between the groups using the paired Student's t-test (normally distributed continuous variables) and Wilcoxon signed-rank test (non-normally distributed continuous variables). For muscle strength, we produced graphs describing isometric maximal contractions as a function of time using MatLab, Version 6.1 (MathWorks, Inc., Natick, MA). Finally, a Bonferroni correction was added for each domain (muscle strength, balance, mobility, function) to account for the multiplicity of testing. To remain significant, the p-values for the differences between the two groups had to be less than 0.05/(number of assessed variables for the specific domain).

We studied the association between each measurement and the severity of UI in these aging community-dwelling women using Pearson correlation coefficients (normally distributed variables) and Spearman's ρ (non-normally distributed variables). We analysed the data using IBM SPSS Statistics, Version 23.0.0.2 (IBM Corporation, Armonk, NY).

RESULTS

The characteristics of the participants were similar in both groups except that the women with UI had a higher number of comorbidities (see Table 1).

Table 1 Sociodemographic and Health Characteristics of Continent Women and Women with UI

Characteristic	Continent women (n = 20)	Women with UI (n = 20)	p-value*
Sociodemographic			
Age, y, mean (SD)	72 (6)	73 (5)	0.910
BMI (kg/m^2), mean (SD)	25.68 (4.35)	27.45 (3.36)	0.157
Number of pregnancies, mean (SD)	2 (2)	3 (2)	0.209
Mini–Mental State Examination score, median (range)	30 (27–30)	29 (27–30)	0.341
Education, no. (%)			
Elementary school	4 (21)	3 (15)	1.000
High school	4 (21)	5 (25)	
College	4 (21)	5 (25)	
University	7 (37)	7 (35)	
Living alone	11 (58)	11 (55)	1.000
Health			
International Consultation on Incontinence Questionnaire score, mean (SD)	0.00 (0.00)	12.25 (4.44)	0.000*
Falls in previous year, no. (%)	10 (50)	10 (50)	1.000
No. of medications, mean (SD)	4 (3)	4 (2)	0.429
No. of comorbidities, median (range; min–max)	4 (0–7)	5 (3–11)	0.041*
Visual conditions, no. (%)			
Presbyopia	16 (84)	14 (70)	0.451
Myopia	12 (63)	11 (55)	0.748
Retinal detachment	0 (0)	1 (5)	1.000
Cataracts (untreated)	6 (32)	5 (25)	0.731
Glaucoma	1 (5)	5 (25)	0.182
Other, no. (%)	4 (21)	1 (5)	0.182
Smoking habits			
Active smoker, no. (%)	1 (5)	0 (0)	0.629
Former smoker, no. (%)	8 (42)	11 (55)	
Never smoked, no. (%)	10 (53)	9 (45)	

*α = 0.05.
UI = urinary incontinence

Characteristics of the four domains

Muscle strength

The results for lower limb strength were similar for both groups. The maximal Biodex measurements were not significantly different between the two groups on the dominant or non-dominant side, in flexion or extension, or at 30 or 60 degrees of knee flexion. Figure 1 shows that the isometric maximal contractions as a function of time were similar for both groups, with an overlap of both the mean values and the SDs. Women with UUI or MUI are

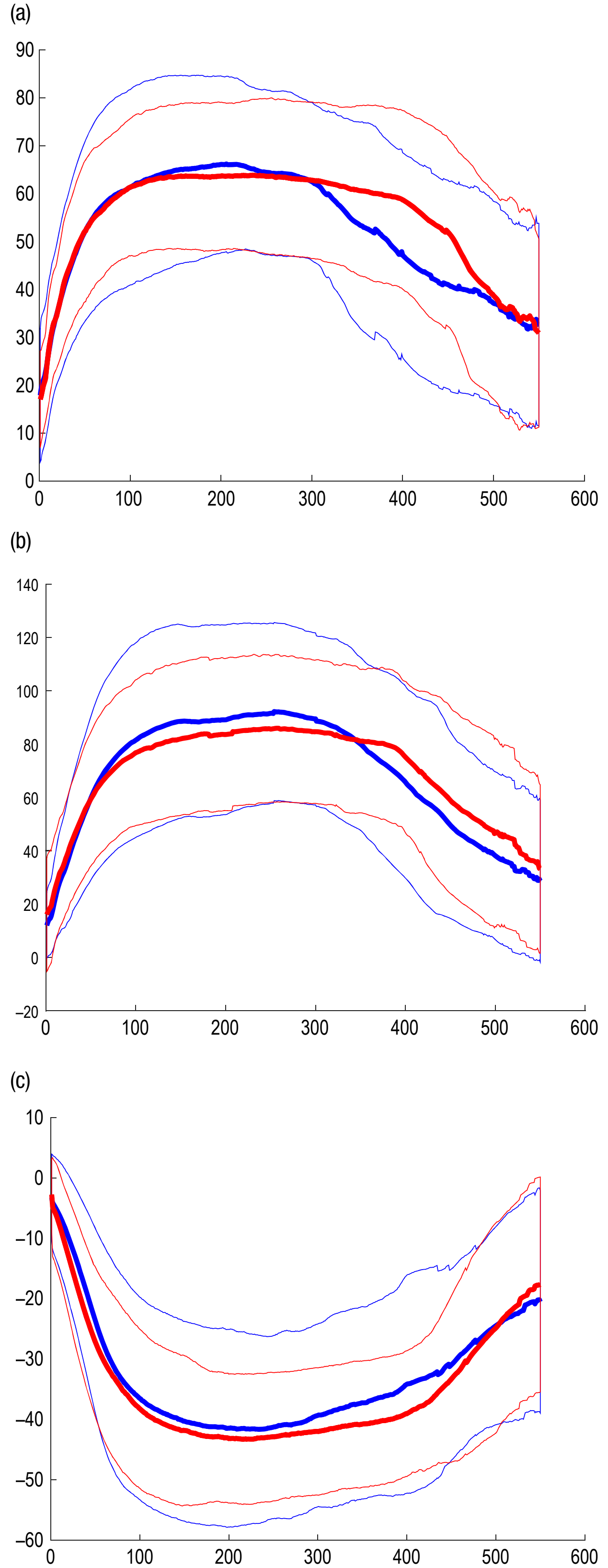

Figure 1 Isometric knee flexion and knee extension maximal contractions (in newton metres) as a function of time (in milliseconds): flexion in the 30-degree position (a); flexion in the 60-degree position (b); extension in the 30-degree position (c); and extension in the 60-degree position (d).

(d)

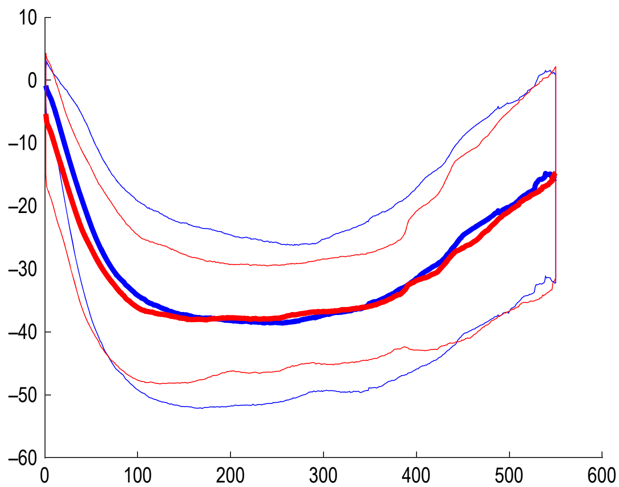

Figure 1 Continued

represented in dark grey and continent women are represented in light grey. Bold lines represent the mean values and the shaded areas represent the related SDs.

There was also no significant difference in intra-individual variability in knee strength between the two groups; the 30-second sit-to-stand test results were also not significantly different (see Table 2).

Balance

Women with UI had significantly shorter single-leg stance times compared with continent women, both on the dominant leg and on the non-dominant leg. We observed no significant differences for the FSST times (see Table 2). Women with UI reported lower balance confidence, as reflected in their ABC–S scores.

Mobility

Women with UI demonstrated a slower gait speed than continent women. We observed no significant differences between the two groups for the 6MWT (shown in Table 2).

Function

We observed no significant differences between the groups in HAP questionnaire adjusted score. Continent women had significantly higher SF–12 physical health summary scores, but we observed no differences in SF–12 mental health summary scores (see Table 2).

Association between severity of UI symptoms and four domains

We found no significant correlations between the severity of UI symptoms reported by women with UI in the ICIQ–UI–SF and the measurements of lower limb muscle strength, balance, mobility, or function (see Appendix 2).

DISCUSSION

Characteristics of the four domains

Our study identified significant differences between women with and without UUI or MUI on some but not all characteristics. In strength, we observed no difference between the two groups in maximal strength, intra-individual variability in knee strength measures, or functional performance. Both balance performance and balance confidence were significantly lower among women with UI. For mobility, gait speed was significantly lower among women with UI, but we observed no difference in functional capacity. Finally, for function, we observed no difference between the two groups on the activity profile, but women with UI reported a significantly lower level of self-perceived health.

The overall profile of this population of women with UI therefore showed that balance and mobility deficits occurred despite no identified strength deficits in the knee flexors or extensors. These findings are in line with most of the previously published literature indicating impaired balance[10,36,37] and mobility[9,10,12,13,38] in the population presenting with UI.

Supporting our findings, a recent study from Kim and colleagues found balance and mobility deficits in older women with UI, but reported no association between UI and sarcopenia (defined as a skeletal muscle index of $< 6.42\,kg/m^2$).[38] However, the same authors did find an association between UI and sarcopenia when looking at the most severe symptoms.[38]

In contrast to our results, Jenkins and Fultz[39] found strength deficits, identified in the answers to four questions posed to incontinent, older community dwellers about difficulty sitting for long periods of time; stooping, kneeling, or crouching; getting up from a chair; and pulling or pushing large objects. Their study, however, looked at an older population than our sample (mean age of 77.7, 78.6, and 80.5 years for the continent, mildly incontinent, and severely incontinent participants, respectively).[39]

Other authors, such as Erekson and colleagues,[40] have found functional limitations, assessed using a questionnaire about activities of daily living, among community-dwelling older women with UI. Yet, 35.5%–49.7% of the sample in that study reported a lower level of self-rated health than their same-age peers, whereas in the present study, the sample would rank above most reported averages.[40] Indeed, the mean SF–12 physical health summary scores for women with UI (46.45) and without UI (54.20) were higher than norms found in the literature for the older population, which usually range from 36.7 to 41.6.[41–44] The participants in the present study therefore represent a healthier, younger, and higher functioning group of older women than found in the previous literature, for whom no deficits in the knee flexor or extensor

Table 2 Lower Limb Muscle Strength, Balance Performance, Balance Confidence, and Mobility in Continent Women and Women with UI

Domain	Continent women	Women with UI	*p*-value*
Muscle strength: maximal strength, intra-individual variability in knee strength			
30-degree position			
Dominant knee			
Extensor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	2.89 (0.59)	2.60 (0.65)	0.126
Extensor strength SD among the 3 trials, normalized to BMI, median (range, min–max)	0.12 (0.01–0.20)	0.08 (0.00–0.24)	0.204
Extensor strength, normalized to BMI variability coefficient, mean (SD)	0.17 (0.10)	0.15 (0.11)	0.381
Flexor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	1.88 (0.50)	1.76 (0.45)	0.294
Flexor strength SD among the 3 trials, normalized to BMI, median (range, min–max)	0.08 (0.00–0.30)	0.07 (0.02–0.21)	0.191
Flexor strength, normalized to BMI variability coefficient, median (range, min–max)	0.22 (0.02–0.60)	0.15 (0.04–0.32)	0.129
Non-dominant knee			
Extensor strength, normalized to BMI (N-m/kg × m^2), median (min–max)	2.80 (1.63–3.60)	2.49 (1.46–4.52)	0.550
Extensor strength SD among the 3 trials, normalized to BMI, mean (SD)	0.11 (0.07)	0.12 (0.10)	0.662
Extensor strength, normalized to BMI variability coefficient, mean (SD)	0.17 (0.12)	0.18 (0.12)	0.843
Flexor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	1.84 (0.43)	1.73 (0.50)	0.420
Flexor strength SD among the 3 trials, normalized to BMI, median (range, min–max)	0.08 (0.01–0.22)	0.05 (0.01–0.21)	0.044
Flexor strength, normalized to BMI variability coefficient, mean (SD)	0.23 (0.14)	0.13 (0.08)	0.019
60-degree position			
Dominant knee			
Extensor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	4.07 (1.18)	3.66 (1.14)	0.24
Extensor strength SD among the 3 trials, normalized to BMI, mean (SD)	0.25 (0.19)	0.29 (0.23)	0.474
Extensor strength, normalized to BMI variability coefficient, median (range, min–max)	0.23 (0.03–0.76)	0.23 (0.07–1.46)	0.391
Flexor strength, normalized to BMI (N-m/kg × m^2), median (range, min–max)	1.68 (0.94–2.75)	1.61 (0.93–2.17)	0.313
Flexor strength SD among the 3 trials, normalized to BMI, mean (SD)	0.09 (0.08)	0.06 (0.03)	0.148
Flexor strength, normalized to BMI variability coefficient, mean (SD)	0.24 (0.21)	0.15 (0.07)	0.098
Non-dominant knee			
Extensor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	3.81 (1.20)	3.49 (1.07)	0.338
Extensor strength SD among the 3 trials, normalized to BMI, mean (SD)	0.25 (0.16)	0.16 (0.09)	0.048
Extensor strength, normalized to BMI variability coefficient, median (range, min–max)	0.21 (0.05–1.14)	0.15 (0.05–0.60)	0.099
Flexor strength, normalized to BMI (N-m/kg × m^2), mean (SD)	1.62 (0.42)	1.59 (0.42)	0.808
Flexor strength SD among the 3 trials, normalized to BMI, mean (SD)	0.09 (0.04)	0.08 (0.05)	0.457
Flexor strength, normalized to BMI variability coefficient, mean (SD)	0.24 (0.14)	0.18 (0.11)	0.181
30-second sit-to-stand test, no., median (range, min–max)	12.00 (9.00–20.00)	11.50 (8.00–18.00)	0.554
Balance: performance and confidence			
Single-leg stance test (dominant leg), s, median (range, min–max)	23.99 (2.65–60.00)	3.93 (0.85–29.10)	0.003*
Single-leg stance test (non-dominant leg), s, median (range, min–max)	17.97 (1.90–60.00)	5.74 (1.12–60.00)	0.000*
Four Square Step Test, s, mean (SD)	7.86 (1.54)	8.52 (1.96)	0.217
Activities-specific Balance Confidence Scale score, mean (SD)	88.48 (9.26)	76.03 (19.05)	0.011*
Mobility: gait speed and functional capacity			
10-m walk test, m/sec, median (range, min–max)	1.81 (1.16–3.22)	1.61 (1.06–2.11)	0.005*
6-min walk test, m, mean (SD)	463.84 (46.36)	449.06 (58.29)	0.458
Function: activity profile and self-perceived health			
Human Activity Profile questionnaire adjusted score, median (range, min–max)	74 (3–82)	67 (43–81)	0.344
SF–12 physical health summary score, median (range, min-max)	57.00 (44.00–61.00)	48.50 (29.00–59.00)	0.007*
SF–12 mental health summary score, mean (SD)	55.05 (6.78)	51.40 (7.29)	0.072

*α = 0.002 for strength, 0.01 for balance, 0.03 for mobility, and 0.02 for function.
UI = urinary incontinence; N-m = newton metre; SF–12 = 12-item Short Form Health Survey.

strength were associated with UI but for whom balance and mobility impairments can still be observed.

Although this study produced valuable and useful findings, being the first to evaluate the four domains of strength, balance, mobility, and function so thoroughly in this population, it was also a pilot study with a relatively small sample size. This pilot work will nevertheless provide useful benchmarks from which to project the sample size required for a larger, full-scale cross-sectional study.[45] We therefore ran power calculations from the current data. To achieve 80% power with an α error of 0.05, a sample of 128 participants would potentially allow significant differences to be identified between groups in the maximal extensor strength of the dominant knee, at both 30 degrees and 60 degrees, and in all normally distributed variables of balance, mobility, and function.

Further recommendations for future larger studies include assessing additional muscle groups (such as around the hip and ankle)[46,47] and using the Montreal Cognitive Assessment (MoCA) rather than the MMSE to assess cognition because the MoCA looks at higher executive functions not assessed by the MMSE.[48]

Association between severity of UI symptoms and domains

Our study did not identify significant correlations between knee strength, balance, mobility, or function and the severity of UI in women. Fritel and colleagues,[10] in a large cross-sectional study of older women (n = 1,942, mean age of 79 years), however, found a significant correlation between gait speed and severity of UI using logistic regression. Yet, this association was seen only in the last two quartiles of the ICIQ–UI–SF score distribution (ICIQ–UI–SF scores of 8–11 and > 12) and was not observed for the full range of scores.

Women in our sample (mean ICIQ–UI–SF scores of zero for continent women and 12.25 for women with UI) had more favourable results in both sit-to-stand testing and gait speed than those in the study by Fritel and colleagues.[10] Also, although women with UI in our study achieved a performance on the single-leg stance test similar to the participants in that study,[10] women without UI showed even higher scores, indicating greater balance. Thus, it is possible that among younger, healthier, and higher functioning aging women, as in our sample, there is no correlation between UI severity and knee strength, balance, mobility, or function.

This study has several advantages. The lower limb strength (knee dynamometry and functional 30-second sit-to-stand test), balance, mobility, and function of our participants were measured more extensively and thoroughly than in previous studies, using diverse tools to reflect the different aspects of each domain.[7,9–13,36–40] Also, previously published studies assessed UI inconsistently, limiting their generalizability. In this study, UI was assessed using the ICIQ–UI–SF, a standardized symptom questionnaire with good psychometric properties that is currently recommended by the International Consultation on Incontinence.[19] In addition, most authors investigating older women with UI for their lower limb muscle strength, balance, mobility, or function recruited an older population than in our study. Our sample consisted of younger, healthier, and higher functioning aging women, thereby widening the scope of knowledge on this topic. This difference in the population could explain the different profile of our sample. Indeed, old age is not a homogeneous phase of life. Age-group subdivisions have already been proposed in the literature, with health-related outcomes varying according to these subdivisions.[49] At least two age groups are distinguished with advancing age: “young-old” and “old-old”, using age 75 years as a cut-off between the two.[50] Therefore, previous studies looking at older women with UI and lower limb muscle strength, balance, mobility, or function have tended to include old-old women.[7,10,12,38,39] In contrast, our study population included young-old women.

However, our sample did show some degree of impairment in balance, mobility, and function. These characteristics in our participants in the “young-old” age group could constitute an intermediate profile between adult women and old-old women. Because impairment may worsen with advancing age, early intervention could prevent this impairment as well as a further decline in physical function. More research on UI and lower limb muscle strength, balance, mobility, or function, taking these old age groups into account, is needed to confirm our results.

This study also presents some limitations. First, it may have been relevant to use additional parameters when comparing the two groups. Although we assessed gait using the 10-metre walk test and the 6MWT, we did not undertake a formal gait analysis. Because a previous study showed that the variability of gait increased with a strong desire to void in middle-aged women without UI,[9] a more qualitative analysis of gait in women with UI with and without the need to void would merit further research. Second, the number of participants recruited for this pilot was limited. We were, however, able to provide a more comprehensive profile of each participant than previously available in the literature, and we thoroughly examined a diversity of domains: lower limb strength, balance, mobility, and function.

Finally, although the two groups of women were similar in most baseline characteristics we evaluated, we cannot exclude the possibility that they differed in physical health, outside of continence status, related to additional comorbidities. To reduce the bias related to any difference in comorbidities between the groups, we excluded participants with conditions that were most likely to have an impact on UI or falls and those with conditions at more severe stages.[51–60] We also used paired analyses to further reduce the possibility of this bias.

CONCLUSIONS

The results of this pilot study suggest that, compared with continent older women, high-functioning older women with UUI or MUI have balance and mobility impairments . However, more studies are needed to confirm these results. The assessment of additional muscle groups (such as around the hip and ankle) should be included in future research evaluating this clientele.[46,47] By reporting power calculations for sample size, this pilot study provides a useful basis on which to design and conduct larger studies.

KEY MESSAGES

What is already known on this topic

After age 65 years, urinary incontinence (UI) occurs in one of every two women; of this number, 20%–25% complain of severe symptoms (>10 episodes/wk).[1,2] A positive correlation between urgency UI (UUI) or mixed UI (MUI) and falls has been reported in the literature,[3,4] but possible lower extremity impairments (strength, mobility, balance, function) in older women with UUI or MUI have not been thoroughly investigated.

What this study adds

The results of this pilot study suggest that, compared with continent older women, high-functioning older women with UUI or MUI have balance and mobility impairments. By reporting power calculations for sample size, this study provides a useful basis on which to design and conduct larger studies.

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APPENDIX 1: LIST OF COMORBILITIES

Comorbidity	Yes	No	Comorbidity	Yes	No
AIDS			Kidney failure		
Breast cancer			Liver failure		
Colitis			Lung disease/asthma		
Depression			Migraine		
Diabetes			Osteoarthritis		
Epilepsy			Osteoporosis		
Gastric ulcer			Parkinson's disease		
Glaucoma			Rheumatoid arthritis		
Gout			Stroke		
Hearing loss			Thyroid gland disorder		
Heart disease			Transplantation		
Hip fracture			Tuberculosis		
Hypercholesterolemia			Vascular disorder		
Hypertension			Visual impairment		
Other cancer					
Details: ____________					
Other condition ____________					
Details: ____________					

APPENDIX 2: CORRELATIONS BETWEEN THE SEVERITY OF UI SYMPTOMS AND LOWER LIMB MUSCLE STRENGTH, BALANCE, MOBILITY, AND FUNCTION

Domain	Correlation coefficients	*p*-value*
Muscle strength: maximal strength, intra-individual variability in knee strength		
30-degree position		
Dominant knee		
Flexor torque, normalized to BMI	0.190	0.42
Flexor torque SD among the 3 trials, normalized to BMI	0.087	0.72
Flexor torque, normalized to BMI variability coefficient*	0.089	0.71
Extensor torque, normalized to BMI	0.191	0.42
Extensor torque SD among the 3 trials, normalized to BMI	0.161	0.50
Extensor torque, normalized to BMI variability coefficient	0.198	0.40
Non-dominant knee		
Flexor torque, normalized to BMI	0.180	0.45
Flexor torque SD among the 3 trials, normalized to BMI	0.210	0.37
Flexor torque, normalized to BMI variability coefficient	0.211	0.37
Extensor torque, normalized to BMI†	0.379	0.10
Extensor torque SD among the 3 trials, normalized to BMI	0.092	0.70
Extensor torque, normalized to BMI variability coefficient	0.184	0.44
60-degree position		
Dominant knee		
Flexor torque, normalized to BMI†	0.270	0.25
Flexor torque SD among the 3 trials, normalized to BMI	0.074	0.76
Flexor torque, normalized to BMI variability coefficient	0.147	0.54
Extensor torque, normalized to BMI	0.140	0.56
Extensor torque SD among the 3 trials, normalized to BMI	0.029	0.90
Extensor torque, normalized to BMI variability coefficient†	0.088	0.71
Non-dominant knee		
Flexor torque, normalized to BMI	0.174	0.46
Flexor torque SD among the 3 trials, normalized to BMI	0.025	0.92
Flexor torque, normalized to BMI variability coefficient	0.041	0.86
Extensor torque, normalized to BMI	0.344	0.14
Extensor torque SD among the 3 trials, normalized to BMI	0.215	0.36
Extensor torque, normalized to BMI variability coefficient	0.057	0.81
30-second sit-to-stand test	0.338	0.15
Balance: performance and confidence		
Single-leg stance test (dominant leg)†	−0.024	0.92
Single-leg stance test (non-dominant leg)†	0.125	0.60
Four Square Step Test	−0.237	0.31
Activities-specific Balance Confidence Scale score	−0.356	0.12
Mobility: gait speed and functional capacity		
10-metre walk test	−0.101	0.67
6-minute walk test	0.378	0.10
Function: activity profile and self-perceived health		
Human Activity Profile questionnaire adjusted score	−0.333	0.15
SF–12 physical health summary score	−0.169	0.48
SF–12 mental health summary score	−0.379	0.10

*α = 0.05.
†The variable was not normally distributed, so Spearman's ρ was used instead of Pearson correlation.UI = urinary incontinence; SF–12 = 12-item Short Form Health Survey.