Archives of Gerontology and Geriatrics 82 (2019) 266–272

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Gender differences in four-year incidence of self-reported and performance-based functional disability: The International Mobility in Aging Study

Mohammad Auais[a,*], Tamer Ahmed[a], Beatriz Alvarado[b], Susan P. Phillips[c], Nicole Rosendaal[d], Carmen-Lucia Curcio[e], Juliana Fernandes[f], Jack Guralnik[g], Maria Victoria Zunzunegui[h]

[a] School of Rehabilitation Therapy, Queen's University, Kingston, ON, Canada
[b] Department of Public Health Sciences, Queen's University, Kingston, ON, Canada
[c] Department of Family Medicine, Queen's University, Kingston, ON, Canada
[d] Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA
[e] Research Group on Geriatrics and Gerontology, Faculty of Health Sciences, Universidad de Caldas, Manizales, Colombia
[f] Department of Physiotherapy, Federal University of Rio Grande do Norte, Natal, Brazil
[g] Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, USA
[h] Department of Social and Preventive Medicine, School of Public Health, Universite de Montreal, Montreal, QC, Canada

ARTICLE INFO

Keywords:
Gender gap
Function
International research
Self reported measures
Performnace-based measures

ABSTRACT

Objectives: To examine differences in incidence of functional disability between older women and men.
Methods: 2002 participants (65–74 years) were recruited in 2012 from Canada, Brazil, Colombia, and Albania, and re-assessed in 2016. Three measures of functional disability were used (1) Difficulty in any of five mobility-related Activities of Daily Living (ADL disability); (2) Self-reported difficulty climbing a flight of stairs or walking 400 m (mobility disability); and (3) Poor physical performance. We estimated the adjusted gender-specific incidence risk ratios (IRR) for each outcome in 2016.
Results: In 2016, 1506 participants (52% women) were re-examined, 80% of the surviving cohort. Among those not disabled in 2012, seventy-four (12.9%) men developed ADL disability, while 105 (19.2%) developed mobility disability, and 97 (16.1%) developed poor physical performance. For women, numbers were higher 120 (21.4%) developed ADL disability, 117 (26.5%) developed mobility disability, and 140 (23.0%) developed poor physical performance. Compared to men, women had a higher adjusted incidence of self-reported ADL disability (IRR 1.4; 95% CI 1.04–1.88) and mobility disability (IRR 1.4; 95% CI 1.06–1.77), but not of poor physical performance (IRR 1.03; 95% CI 0.88–1.32).
Conclusions: Although women have a higher self-reported incidence of ADL and mobility disability than men, there was no significant difference in poor physical performance. Reasons for this discrepancy between self-reported and performance-based measures require further investigation. Understanding gender differences in functional disabilities can provide the basis for interventions to prevent mobility loss and minimize any gender gap.

1. Introduction

Maintaining the ability to move and function independently into older age is central to ongoing involvement in communities, health, and well-being, and poses a major challenge as populations age. Up to one half of adults 65 or older in North America report functional disabilities that affect their mobility, social participation, and quality of life (Webber, Porter, & Menec, 2010). Functional disabilities such as mobility limitations are a precursor of more than half of end-stage disabilities in older adults. Typically, functional disabilities are measured using self-reported outcome measures (e.g. Lower Extremity Functional Scale (Binkley, Stratford, Lott, & Riddle, 1999)) or performance-based measures (e.g. Short Physical Performance Battery (da Camara, Alvarado, Guralnik, Guerra, & Maciel, 2013), and these measurement approaches complement each other and allow for better capturing differences in function (Nielsen et al., 2016; Rodrigues, Facchini, Thume, & Maia, 2009). These disabilities are also associated with gender, since there are differences in proportions of older women and men with disabilities (Fried, Bandeen-Roche, Chaves, & Johnson, 2000).

* Corresponding author at: School of Rehabilitation Therapy, Queen's University, 31 George St, Kingston, ON, K7L 3N6, Canada.
E-mail address: mohammad.auais@queensu.ca (M. Auais).

https://doi.org/10.1016/j.archger.2019.03.002
Received 27 August 2018; Received in revised form 28 January 2019; Accepted 4 March 2019
Available online 06 March 2019
0167-4943/

Although women have longer life expectancies than men, they report greater disability at each age (Mechakra-Tahiri, Freeman, Haddad, Samson, & Zunzunegui, 2012). Gender differences in the prevalence of functional disabilities (e.g. mobility limitations) have been observed consistently in cross-sectional studies worldwide (Leveille, Resnick, & Balfour, 2000; Murtagh & Hubert, 2004), despite that the magnitude of these differences varies widely from place to place. For instance, an analysis of the World Health Survey, a large international database, found gender variations in mobility disability across 70 countries (Mechakra-Tahiri et al., 2012). While the difference between men and women was greatest in the Eastern Mediterranean region and smallest in the Western Pacific region, differences were evident in all WHO defined regions (Mechakra-Tahiri et al., 2012). Longitudinal studies have also detected a gender gap in prevalence of functional disability and, sometimes, in the incidence of disability. For example, the Established Populations for Epidemiologic Studies of the Elderly (EPESE), a large multisite longitudinal study of aging in four U.S. states and one of the first to investigate gender gaps in mobility found a higher incidence of mobility disability in women after 4 years of follow–up (Leveille, Penninx, Melzer, Izmirlian, & Guralnik, 2000).

Despite extensive study of gender differences in functional disability, the existing body of research has limitations. First, while cross-sectional population studies typically find that compared to men, women report worse physical functioning (with one exception (Louie & Ward, 2010)), studying the gap between women and men in incidences of functional disability does not seem to yield consistent findings (Rodrigues et al., 2009). Authors of a systematic review identified conflicting evidence in longitudinal studies about the gap in incident disability (Rodrigues et al., 2009), which they attributed to frequent failure to adjust for important confounders (e.g. education, cognitive state). They noted that once confounders were taken into account, the incidence of functional disability was similar for women and men (Rodrigues et al., 2009). This review included mainly studies from high-income countries and sometimes persons less than 65 years old; furthermore, the review authors' conclusion was based only on a subjective analysis of included studies. A second limitation of the existing literature is that very few studies have used both self-reported and performance-based outcomes to study gender gaps in disability, despite recognized divergence in these measures (Rodrigues et al., 2009). Finally, the majority of relevant studies to date have been conducted in the United States; only a small body of work on gender and disability has included participants from low- and middle-income countries where there greater lifetime social and economic inequality precipitates greater health discrepancies (Onadja, Atchessi, Soura, Rossier, & Zunzunegui, 2013). The few studies that included participants from low- or middle-income countries were all cross-sectional (studying prevalence of disability not incidence rates) (Khadr & Yount, 2012; Merrill, Seeman, Kasl, & Berkman, 1997; Rahman & Liu, 2000; Yount & Agree, 2005; Zeki Al Hazzouri, Mehio Sibai, Chaaya, Mahfoud, & Yount, 2011; Zunzunegui et al., 2015).

The ***main objective*** of this study was to examine gender differences in incidence of functional disability in older adults from five sites in four countries using both self-reported and performance-based measures. We hypothesised that we will find a higher incidence of functional disability among women compared to men in both self-reported and performance-based measures over the study period.

2. Methods

In this study, we use the term *gender* for comparisons of women and men, encompassing both social and biological differences (Zunzunegui et al., 2015).

2.1. Study sample

We used data from the International Mobility in Aging Study (IMIAS), a longitudinal multi-site research project, to examine mobility and disability at an older age. In 2012, 2002 community-dwelling adults (65 to 74 years) agreed to participate in the study. Participants were recruited from primary care settings at five international sites differing in culture, economy, and physical environment: Kingston, Ontario and Saint-Hyacinthe, Quebec, Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil. Approximately 200 women and 200 men were recruited at each site (Zunzunegui et al., 2015). The sample size calculation was done at each site to allow for comparison of mobility disability prevalence of men and women (a prevalence ratio of 1.8, error type I of 0.05 and power of 0.80) see previous publications for details (Zunzunegui et al., 2015). At baseline, participants with scores lower than 4 (severe cognitive impairment) in the orientation scale of the Leganes Cognitive Test (de Yébenes et al., 2003) were excluded from the study since they were considered unable to answer the questionnaire and complete the physical function tests, as well as freely consent to the study. The numbers of excluded participants as a result of their cognitive abilities were zero in Kingston, one in Saint-Hyacinthe and Tirana, two in Manizales, and five in Natal.

Participants were followed to establish the baseline prevalence and the 4-year incidence of functional disability, allowing for the study of both cross-sectional and longitudinal relationships between risk factors and disability. Follow-up assessments were completed in 2014 and 2016. In the 2016 final assessment, which was used for this study, 1554 interviews were completed. Of the 448 participants who did not complete the study process, 205 refused to participate in this third round of data collection, 132 were lost to follow-up, and 111 died (45 women and 66 men). In addition, 48 of the 1554 interviews completed were conducted by a proxy, usually because the participants had moved out of the study area, were sick, or developed severe cognitive impairment. Those 48 interviews were excluded in this study, leaving a sample size of 1506 participants. Finally, since this study focused on the incidence of functional disability, only participants with no disability at baseline assessment (i.e. no ADL disability, mobility disability, or with good physical performance [SPPB ≥ 9] in 2012) were included in the analysis of each outcome measure. Ethics approval was obtained from each site and all participants signed an informed consent form. Further details on IMIAS are available from previous publications (Gomez et al., 2018; Zunzunegui et al., 2015).

2.2. Outcome measures

We used three functional disability measures, which were operationally defined as follows (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995):

- *ADL disability:* self-reported difficulty in any of five mobility-related Activities of Daily Living (ADL) (Zunzunegui et al., 2015). The five activities of the lower extremities were toileting, bathing, dressing, getting out of bed, and walking across a small room. Participants were asked the following question on the selected activities: "Here are a few everyday activities. Please tell me if you have any difficulty with these because of a health or physical problem. Exclude any difficulties that you expect to last less than three months".
- *Mobility disability:* self-reported difficulty climbing a flight of stairs or walking 400 m without assistance (Guralnik et al., 1995). This has been found to be a very good proxy to define major mobility disability in geriatric research (Chang et al., 2004; Pahor, Guralnik, & Ambrosius, 2014). It is considered the first precursor of more than half of end-stage disabilities in older adults (Fried et al., 2000). Further, it was found to have a good approximation for other objective measures of mobility (Chen et al., 2018).
- *Poor objective physical performance:* scoring lower than 9 in the Short Physical Performance Battery (*SPPB)* (Guralnik et al., 1994). The SPPB uses three timed tests to assess physical performance: standing balance for up to 10 s with feet positioned in three ways (together

side-by-side, semi-tandem and tandem), gait speed (for 3-m or 4-m walk), and chair-rising five times tests. For the balance tests, a score is given depending on the ability to maintain balance in each of the positions. For the other two tests, scores are given on the ability to complete the tasks and the time required. Each task is scored out of 4, with the total score is the sum of the three tests (0–12), with higher scores reflecting better physical function. The SPPB has been extensively validated and used in geriatric research and in diverse populations (Freiberger et al., 2012; Freire, Guerra, Alvarado, Guralnik, & Zunzunegui, 2012; Gómez, Curcio, Alvarado, Zunzunegui, & Guralnik, 2013; Guralnik et al., 1994).

The use of multiple measures of functional disability that differ in their administration allows better capture of subtle differences in functional abilities in the elderly population (Rodrigues et al., 2009).

2.3. Confounders

We accounted for a number of variables in analyses that were initially selected based on the literature (Lewinsohn, Seeley, Roberts, & Allen, 1997; Marsh et al., 2015; Zunzunegui et al., 2015; de Yébenes et al., 2003; Ahmed, Vafaei, Belanger, Phillips, & Zunzunegui, 2016, 2018), and then these factors were retained if they had a significant relationship with any outcome variable in bivariate regression analyses (see Table 1 for included confounders and their definitions and see the Appendix, Table 1 for the bivariate regression results used to select confounders).

2.4. Analysis Distributions of baseline characteristics were compared between women and men using independent t-4

Distributions of baseline characteristics were compared between women and men using independent *t*-test for continuous variables, Mood's Median Test for ordinal variabbles, or Chi-square test for categorical variables, as appropriate. A series of Poisson regression models with robust variance were used to estimate gender gaps as incidence rate ratios (IRR) and their 95% confidence intervals (CIs) of disability in 2016 among participants without disability in 2012. Analyses were carried out for each outcome variable separately, and gender was the explanatory variable in all models. The interaction terms between gender and site were also included in all final models. To test the unique effect of confounder groups on the relationship between gender and functional disability, they were added in separate models. Thus, the analysis included four models for each outcome:

Model 1: *Gender + baseline physical function;*

Model 2: Model 1 + *socio-demographic variables* (*age, site, and education)*;

Model 3: Model 2 + *masculinity scores* + *witnessing physical violence in childhood*;

Model 4 (fully adjusted): Model 3 + *health variables* (*BMI, physical activity, depression, comorbidity, and cognitive state)*.

A post hoc analysis was carried out to check for any signs of potential bias in the incidence of poor physical performance analyses. Among all participants included in our study, we tested in a bivariate Poisson regression whether gender or baseline score in the SPPB predicted loss to follow up, refusals to participate in the 2016 assessment, or mortality.

Statistical analyses were performed using STATA v.14 (StataCorp LP, College Station, TX USA)). A p-value < 0.05 was considered statistically significant.

3. Results

Of the 1506 participants who completed the 2016 assessment, 1134 had no ADL disability at baseline and were therefore included in the analysis for incident ADL disability, 990 had no mobility disability at baseline and were included in the analysis for incident mobility disability, and 1214 had a baseline SPPB performance of 9 or greater and were entered into the analysis for the incidence of poor physical performance.

The mean age at baseline for the 1506 participants in this study was 69 years old (SD: 2.8). Table 2 shows the difference in characteristics at baseline between women and men who completed the 2016 assessment and the characteristics for those refused to continue or lost to follow-up. Table 3(A & B) details incident disability in 2016 by site and gender. In all research sites, higher incidences of functional disabilities were observed in women compared to men. Men and women from Tirana showed the highest incidences of disabilities compared to other IMIAS

Table 1
Confounder variables were accounted for in the regression models and their definitions.

Variable	Definition
Age	participants' age in years at the time of baseline assessment (used as continuous variable).
Site	the research location where the participant lived.
Education	years of formal education.
Baseline functional performance	measured using the 2012 SPPB score. This was entered to account for variability in functional abilities at baseline, especially those with borderline scores (close to the cut point).
Physical activity	assessed by the Mobility Assessment Tool-Walk (Marsh et al., 2015). Participants were asked to indicate using animated videos the pace at which they typically walk if there is no rush to get somewhere (metres/second). The participants were then asked to indicate the number of days (0–7) over the past week in which they walked more than 10 minutes at this pace, along with the distance in metres they walked each day. From the previous question, we calculated the amount of walking per day at regular pace in kilometres over the past week. This variable was then transformed, as per the recommendations of the tool creators, using a square root function to normalize the data (Marsh et al., 2015).
Body Mass Index (BMI)— (weight (kg)/height (m2))	height was measured using a stadiometer without shoes. Weight was measured using an electronic scale also without shoes.
Depressive symptoms	assessed using the Center for Epidemiological Studies Depression (CESD) scale (ranges from 0 to 60) (Lewinsohn et al., 1997). A categorical variable was created with scores 16 or greater where indicative of depression (Zunzunegui et al., 2015).
Global cognition	evaluated using the Leganes Cognitive Test (LCT) (ranges from 0 to 32) (de Yébenes et al., 2003).
Comorbidity	recorded as the total number of self-reported, physician diagnosed chronic conditions (ranges from 0 to 8). Conditions included in the study were hypertension, diabetes, cancer, chronic lung diseases, heart diseases (e.g. coronary heart disease, angina, and congestive heart failure), stroke, arthritis, and osteoporosis.
Masculinity and femininity scores	They were calculated using the validated 12 item short form of the Bem Sex Role Inventory (Ahmed et al., 2016). These scores were included because higher masculinity scores have been shown to be associated with lower risk of poor physical performance in older adults (Ahmed et al., 2018).
Witnessed physical violence in childhood	Assessed by asking participants in 2012 if they have witnessed physical violence between those close to them in their childhood (Guedes et al., 2016).

Table 2
Differences in 2012 baseline characteristics of all older women and men who completed the 2016 assessment in means (SD) unless otherwise specified.

Variable	Participants completed 2016 follow-up (N = 1506)		
	Men (%) n = 713	Women (%) n = 793	P-value*
Age (years)	69.1 (2.9)	69 (2.8)	0.643
Years of education	10.7 (6.1)	9.5 (5.4)	< 0.01
Study site			0.804
Kingston	133 (44.9%)	163 (55.1%)	
Saint-Hyacinthe	139 (46.8%)	158 (53.2%)	
Tirana	153 (47.1%)	172 (52.9%)	
Manizales	163 (48.1%)	176 (51.9%)	
Natal	125 (50.2%)	124 (49.8%)	
Masculinity score	4.8 (0.04)	4.5 (0.04)	< 0.001
Femininity score	5.6 (0.04)	5.9 (0.03)	< 0.001
Witnessed physical violence in childhood	78 (40.6%)	114 (59.4%)	0.047
BMI			< 0.001
< 18.5	6 (22.2%)	21 (77.8%)	
18.5–24.9	188 (50.9%)	181 (49.1%)	
25–29.9	297 (53.1%)	262 (46.9%)	
30–34.9	108 (44.6%)	134 (55.4%)	
≥ 35	29 (34.9%)	54 (65.1%)	
Physical activity	2.8 (0.07)	2.4 (0.06)	< 0.001
Depressive symptoms	7.6 (0.28)	11.4 (0.36)	< 0.001
Comorbidity (median [IQR])	1 (1)	2 (2)	< 0.001
Physical performance	10.2 (0.07)	9.6 (0.07)	0.005

Notes: Masculinity and femininity scores were calculated using the 12 items short form of the Bem Sex Role Inventory; witnessing physical violence was estimated by asking participants in 2012 if they had witnessed physical violence in childhood between those close to them (Yes/ No). Physical activity assessed by the Mobility Assessment Tool-Walk; Depressive symptoms were assessed using the Center for Epidemiological Studies Depression scale, with higher score means increased symptoms of depression; comorbidity was recorded as total number of chronic conditions; global cognition was evaluated using Leganes Cognitive Test score, where higher scores indicate better cognitive abilities, and physical performance was evaluated using SPBB, where higher scores again indicate better abilities. *P values indicate the significance of the difference between women and men, using an independent *t*-test for continuous variables, a Median Test for ordinal variables, or Chi-square test as appropriate.

sites.

Results from the Poisson regression analysis are presented in Table 4. For the *self-reported measures* (ADL and Mobility disability), women had a significantly higher incidence rate in all models (higher by 40% for ADL disability and by 37% for mobility disability in model 4). For the *performance-based measure (Poor physical performance),* although there was a difference between women and men in the incidence of poor physical performance, the difference was not statistically significant after adjusting for baseline functional performance. Since interaction between gender and site was not significant for all outcomes, we did not stratify by site.

In the post hoc analysis, the relationship between baseline SPPB scores and gender and loss to follow up, refusals, and survival were examined. Neither gender nor the baseline score in the SPPB predicted loss to follow up or refusals to participate from the cohort in 2016 (See the Appendix, Table 2). However, potential survival bias might have existed. Although gender predicted survival (women were more likely to survive to the third wave of IMIAS), baseline scores in the SPPB did not predict mortality.

4. Discussion

Our hypothesis was partially supported as we found that the gender gap remained significant for the two self-reported disability measures, ADL disability and mobility disability, even after adjusting for relevant confounding variables. However, for the performance-based measure, this gap was much smaller and did not reach statistical significance.

Our findings on the gender gap in incident self-reported disability paralleled those from the U.S. National Health Interview Survey (NHIS) (Crimmins, Saito, & Reynolds, 1997), the Longitudinal Study of Aging (LSOA) (Dunlop, Hughes, & Manheim, 1997; Harris, Kovar, Suzman, Kleinman, & Feldman, 1989), and the EPESE study (Leveille, Penninx et al., 2000), among others (Guallar-Castillón et al., 2007) However, there is also substantial disagreement in the literature on whether there is a gender gap in the incidence of self-reported disability. Several longitudinal studies have failed to find gender differences in the incidence of self-reported functional disability (Avlund, Damsgaard, Sakari-Rantala, Laukkanen, & Schroll, 2002; Berlau, Corrada, Peltz, & Kawas, 2012; Chiu, Mau, Tasi, Hsieh, & Liu, 2004; Ferrucci et al., 1996; Murtagh & Hubert, 2004; Strawbridge, Kaplan, Camacho, & Cohen, 1992). A common explanation in the literature for these divergent findings is inadequate adjustment for confounders (Louie & Ward, 2010; Rodrigues et al., 2009). We have included a large number of important and relevant confounders (initially selected based on the literature and retained based on the significance of their statistical relationship with outcomes). Interestingly, we still found significant differences in self-reported incident disability between women and men suggesting that attributing these differences to gender is possible. Gender predisposes individuals to specific health beliefs, perceptions and living conditions that may lead to the observed gap in mobility in old age. As highlighted by Connell (2012) who uses relational theory to argue that gender relationships are based on power imbalance, in which women have less power in society, this gender imbalance presents itself sometimes in discrimination against women at different levels in the society (e.g. in work relationships, intimate life, and /or in homes) (2012). One interesting finding is the high incidence of disabilities in Tirana, Albania compared to other sites. A study conducted by our team found very high prevalence of depression in this site and demonstrated the link with poor physical function, which could explain our results (Ylli et al., 2016).

Of particular note, we found no significant gender difference using a performance-based measure, that is, a more objective disability measure. We are aware of only one other study that used a performance-based outcome measure when investigating the gender gap in incident disability (Oman, Reed, & Ferrara, 1999). They, too, found no significant difference between women and men adjusting for confounders (Oman et al., 1999). It has been suggested previously that women may report more disability compared to men as a result of their increased subjective impression of functional loss (Merrill et al., 1997). Nevertheless, some cross-sectional studies reported that actual physical abilities accounted for most of the gender differences in self-reported outcomes measures (Yount & Agree, 2005). Although the difference in measured physical performance was not significant in our study, we should not necessarily reject the possibility of a gender gap in performance-based functioning. In our results, similar to the self-reported measures, there was a higher percentage of women than men with incident poor physical performance in 2016, both in the overall sample and at each site. In the regression models, the difference did not reach statistical significance. The number of participants with incident disability was relatively small, so the gender performance difference might have been significant if we had a larger sample size or if the study had extended over a longer time-period, so that more older adults developed disabilities, increasing the statistical power of the analyses. Therefore, future large studies with long enough follow-up time and also proper adjustment for all potential confounders could confirm whether there is a gender gap in incident disability as measured by performance-based measures.

To our knowledge, no previous longitudinal studies have used both self-reported and performance-based measures when examining incident disability among older adults. However, several cross-sectional studies have done so, (Merrill et al., 1997; Rahman & Liu, 2000; Yount

Table 3
Incidence of disability in 2016 by site and gender: n, %, 95% CI.

A) Women*

	Overall			Kingston			Saint-Hyacinthe			Tirana			Manizales			Natal		
Functional disability	n	%	95% CI	n	%	CI	n	%	CI	n	%	CI	n	%	CI	n	%	CI
ADL disability	120	21.4	18.1–25	23	18.1	11.8–25.9	7	5.30	2.1–10.5	56	56.6	46.2–66.5	20	16.5	10.4–24.4	14	17.3	9.8–27.3
Mobility disability	117	26.5	22.4–30.8	28	21.2	14.6–29.2	15	13.2	7.6–20.8	39	65	51.6–76.9	21	25.9	16.8–36.9	14	25.5	14.7–39
Poor Physical performance (SPPB < 9)	140	23.0	19.7–26.5	22	15.7	9.8–22.1	16	11.7	6.8–18.3	48	42.1	32.9–51.7	30	22.2	15.5–30.2	24	30.4	20.5–41.8

B) Men+

	Overall			Kingston			Saint-Hyacinthe			Tirana			Manizales			Natal		
Functional disability	n	%	95% CI	n	%	CI	n	%	CI	n	%	CI	n	%	CI	n	%	CI
ADL disability	74	12.9	10.3–15.9	10	9.3	4.5–16.3	5	4	1.3–9	35	30.7	22.4–40	12	9.3	4.8–15.7	12	12.5	6.6–20.8
Mobility disability	105	19.2	15.9–22.7	12	10.2	5.4–17.1	12	9.5	5–16	37	37.4	27.9–47.8	23	20.9	13.7–29.7	21	21.1	14.2–31.8
Poor physical performance	97	16.1	13.2–19.2	16	13.1	7.7–20.4	9	7.2	3.3–13.2	26	21.3	14.4–29.6	26	18.8	12.7–26.4	20	20.6	13.1–30

* Note for part B: Only those who completed the 2016 assessment and were free from the same disability in 2012 were included in the analysis. Therefore, the denominator was different for each outcome. In total, 561 women included in the analysis for ADL disability, 442 for mobility disability, and 610 for physical performance. For Kingston, 127 women included in the analysis for ADL disability, 135 for mobility disability, and 145 for physical performance; for Saint-Hyacinthe 133 women included in the analysis for ADL disability, 114 for mobility disability, and 137 for physical performance; for Tirana 99 women included in the analysis for ADL disability, 60 for mobility disability, and 114 for physical performance; for Manizales 121 women included in the analysis for ADL disability, 81 for mobility disability, and 135 for physical performance; for Natal 81 women included in the analysis for ADL disability, 55 for mobility disability, and 79 for physical performance.

+ Note for part A: In total, 573 men included in the analysis for ADL disability, 548 for mobility disability, and 604 for physical performance. For Kingston, 108 men included in the analysis for ADL disability, 118 for mobility disability, and 122 for physical performance; for Saint-Hyacinthe 126 men included in the analysis for ADL disability, 126 for mobility disability, and 125 for physical performance; for Tirana 114 men included in the analysis for ADL disability, 99 for mobility disability, and 122 for physical performance; for Manizales 129 men included in the analysis for ADL disability, 110 for mobility disability, and 138 for physical performance; for Natal 96 men included in the analysis for ADL disability, 95 for mobility disability, and 97 for physical performance.

& Agree, 2005) finding that performance explained the majority of the gender differences in self-reported ADL and mobility disability. This would suggest that the functional problems women participants in these studies reported reflected real functional deficits rather than perceptions of limitation. Others have hypothesized that women may overestimate and self-report more disability than is evident in performance measures, while men may underestimate and report fewer functional problems (Khadr & Yount, 2012; Miller, Chen, & Parker, 2011). Unlike men, women may find it more socially acceptable to report disability, which could increase their subjective impressions of functional loss (Merrill et al., 1997). Thus, differences between men and women in their self-reported disability may arise from differences in objective health and/or from differences in social characteristics, expectations and constraints (Yount & Agree, 2005). In our opinion, using both self-reported and performance-based measures is a robust method for providing a comprehensive picture of individual disability that accounts for people's lived social realities as well as individual physical abilities. Performance-based outcomes offset some bias arising from perceptions of socially acceptable or appropriate responses, and are less influenced by culture, language, and education level (Merrill et al., 1997). On the other hand, self-reported measures of disability combine objective and subjective statuses (Christopher & Chen, 1992), and may reflect overall actual function, wellbeing, social characteristics, and roles in life (Khadr & Yount, 2012).

4.1. Future directions and implications

Future research should focus on exploring sources of discrepant self-reporting of incident disability between men and women and examining health and social factors that mediate the relationship between gender and incidence of disability.

Over the middle and high income countries of the world, there is a higher proportion of women than men among older adults, particularly the oldest-old, and this pattern is expected to continue (Leveille, Penninx et al., 2000). Women have not only a higher incidence of self-reported functional disability, but also a lower likelihood of recovery, once disabled, and a higher survival rate (Hardy, Allore, Guo, & Gill, 2008). With the aging population, this could lead in the near future to a higher overall rate of functional disability among older adults whether from loss of physical ability or from limiting activity based on perceived loss. On the other hand, both subjective and objective losses are potentially modifiable by addressing the modifiable factors that could potentially lead to disability. Targeting these risk factors and doing so in tailored ways for men and women might delay or prevent disability in older adults.

Table 4
Functional Disability Incidence Rate Ratios for Women compared to Men: results from the Poisson regression analyses.

Functional disability	Model 1			Model 2			Model 3			Model 4		
	IRR	95% CI		IRR	95% CI		IRR	95% CI		IRR	95% CI	
ADL disability (n = 1134)	**1.52**	**1.16**	**1.98**	**1.61**	**1.24**	**2.08**	**1.57**	**1.21**	**2.04**	**1.40**	**1.04**	**1.88**
Mobility disability (n = 990)	**1.34**	**1.06**	**1.69**	**1.41**	**1.11**	**1.77**	**1.43**	**1.13**	**1.8**	**1.37**	**1.06**	**1.77**
Poor physical performance (n = 1182)*	1.21	0.95	1.53	1.18	0.93	1.49	1.19	0.94	1.52	1.03	0.88	1.32

*32 participants in this sample did not complete the SPPB tests at baseline and were excluded from this analysis.

4.2. Strengths and limitations

This study has several strengths and also some limitations. The vast majority of published studies investigating the gender gap in incident disability were conducted in a single site (mainly a site in the United States), included only high-income countries, and used only self-reported measures. In contrast, we included data from five international sites (including middle income countries) and used both self-reported and performance-based outcome measures. However, there are three limitations to this study that need to be considered. First, the sample sizes of participants with incident cases of disability were not large, which might have resulted in our failure to detect a significant interaction between gender and site. Second, survival bias is inevitable in longitudinal studies of older adults: the participants in this study were likely the most fit individuals in their cohorts, especially in the two Latin American sites where participants had already exceeded national life expectancies (Oliveira et al., 2017). Finally, the performance and self-reported functional outcomes assessed in this study were not measuring identical constructs (i.e. they measured mobility versus overall physical functioning).

In conclusion, older women are at a higher risk of new onset of perceived functional disability over a four-year period, but not of reduced performance-based functioning. Understanding gender differences in functional disabilities can provide the basis for population-based and individual interventions to prevent mobility loss and minimize the gap in self-reported functional abilities between women and men in old age.

Funding

This work was supported by the Canadian Institutes of Health Research (grant #108751).

Conflict of interests

The Authors declare that there is no conflict of interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.archger.2019.03.002.

References

Ahmed, T., Vafaei, A., Auais, M., Phillips, S. P., Guralnik, J., & Zunzunegui, M. V. (2018). Health behaviors and chronic conditions mediate the protective effects of masculinity for physical performance in older adults. *Journal of Aging and Health, 30*(7), 1062–1083. https://doi.org/10.1177/0898264317704750.

Ahmed, T., Vafaei, A., Belanger, E., Phillips, S. P., & Zunzunegui, M. V. (2016). Bem sex role inventory validation in the international mobility in aging study. *Canadian Journal on Aging = La Revue Canadienne Du Vieillissement, 35*(3), 348–360. https://doi.org/10.1017/s0714980816000404.

Avlund, K., Damsgaard, M. T., Sakari-Rantala, R., Laukkanen, P., & Schroll, M. (2002). Tiredness in daily activities among nondisabled old people as determinant of onset of disability. *Journal of Clinical Epidemiology, 55*(10), 965–973. https://doi.org/10.1016/S0895-4356(02)00463-8.

Berlau, D. J., Corrada, M. M., Peltz, C. B., & Kawas, C. H. (2012). Disability in the oldest-old: Incidence and risk factors in the 90+ study. *American Journal of Geriatric Psychiatry, 20*(2), 159–168. https://doi.org/10.1097/JGP.0b013e31820d9295.

Binkley, J. M., Stratford, P. W., Lott, S. A., & Riddle, D. L. (1999). The lower extremity functional scale (LEFS): Scale development, measurement properties, and clinical application. North American orthopaedic rehabilitation research network. *Physical Therapy, 79*(4), 371–383.

Chang, M., Cohen-Mansfield, J., Ferrucci, L., Leveille, S., Volpato, S., De Rekeneire, N., ... Guralnik, J. M. (2004). Incidence of loss of ability to walk 400 meters in a functionally limited older population. *Journal of the American Geriatrics Society, 52*(12), 2094–2098. https://doi.org/10.1111/j.1532-5415.2004.52570.x.

Chen, H., Rejeski, W. J., Gill, T. M., Guralnik, J., King, A. C., Newman, A., ... Study, L. (2018). A comparison of self-report indices of major mobility disability to failure on the 400-m walk test: The LIFE study. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 73*(4), 513–518. https://doi.org/10.1093/gerona/glx153.

Chiu, H.-C., Mau, L.-W., Tasi, W.-L., Hsieh, Y.-H., & Liu, H.-W. (2004). Chronic medical conditions as predictors of functional disability in an older population in Taiwan. *Australasian Journal on Ageing, 23*(1), 19–24. https://doi.org/10.1111/j.1741-6612.2004.00004.x.

Christopher, J. L. M., & Chen, L. C. (1992). Understanding morbidity change. *Population and Development Review, 18*(3), 481–503. https://doi.org/10.2307/1973655.

Connell, R. (2012). Gender, health and theory: Conceptualizing the issue, in local and world perspective. *Social Science & Medicine, 74*(11), 1675–1683. https://doi.org/10.1016/j.socscimed.2011.06.006.

Crimmins, E. M., Saito, Y., & Reynolds, S. L. (1997). Further evidence on recent trends in the prevalence and incidence of disability among older Americans from two sources: The LSOA and the NHIS. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences, 52*(2), S59–71.

da Camara, S. M., Alvarado, B. E., Guralnik, J. M., Guerra, R. O., & Maciel, A. C. (2013). Using the Short Physical Performance Battery to screen for frailty in young-old adults with distinct socioeconomic conditions. *Geriatrics & Gerontology International, 13*(2), 421–428.

de Yébenes, M. J. G., Otero, A., Zunzunegui, M. V., Rodríguez-Laso, A., Sánchez-Sánchez, F., & Del Ser, T. (2003). Validation of a short cognitive tool for the screening of dementia in elderly people with low educational level. *International Journal of Geriatric Psychiatry, 18*(10), 925–936. https://doi.org/10.1002/gps.947.

Dunlop, D. D., Hughes, S. L., & Manheim, L. M. (1997). Disability in activities of daily living: Patterns of change and a hierarchy of disability. *American Journal of Public Health, 87*(3), 378–383. https://doi.org/10.2105/ajph.87.3.378.

Ferrucci, L., Guralnik, J. M., Simonsick, E., Salive, M. E., Corti, C., & Langlois, J. (1996). Progressive versus catastrophic disability: A longitudinal view of the disablement process. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 51*(3), M123–130.

Freiberger, E., de Vreede, P., Schoene, D., Rydwik, E., Mueller, V., Frändin, K., ... Hopman-Rock, M. (2012). Performance-based physical function in older community-dwelling persons: A systematic review of instruments. *Age and Ageing, 41*(6), 712–721. https://doi.org/10.1093/ageing/afs099.

Freire, A. N., Guerra, R. O., Alvarado, B., Guralnik, J. M., & Zunzunegui, M. V. (2012). Validity and reliability of the short physical performance battery in two diverse older adult populations in Quebec and Brazil. *Journal of Aging and Health, 24*(5), 863–878. https://doi.org/10.1177/0898264312438551.

Fried, L. P., Bandeen-Roche, K., Chaves, P. H., & Johnson, B. A. (2000). Preclinical mobility disability predicts incident mobility disability in older women. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 55*(1), M43–52.

Gomez, F., Zunzunegui, M. V., Alvarado, B., Curcio, C. L., Pirkle, C. M., Guerra, R., ... Guralnik, J. (2018). Cohort profile: The international mobility in aging study (IMIAS). *International Journal of Epidemiology*. https://doi.org/10.1093/ije/dyy074 dyy074–dyy074.

Gómez, J. F., Curcio, C.-L., Alvarado, B., Zunzunegui, M. V., & Guralnik, J. (2013). Validity and reliability of the Short Physical Performance Battery (SPPB): A pilot study on mobility in the Colombian Andes. *Colombia Medica (Cali, Colombia), 44*(3), 165–171.

Guallar-Castillón, P., Sagardui-Villamor, J., Banegas, J. R., Graciani, A., Fornés, N. S., García, E. L., ... Rodríguez-Artalejo, F. (2007). Waist circumference as a predictor of disability among older adults. *Obesity, 15*(1), https://doi.org/10.1038/oby.2007.532 233–233.

Guedes, D. T., Vafaei, A., Alvarado, B. E., Curcio, C. L., Guralnik, J. M., Zunzunegui, M. V., ... Guerra, R. O. (2016). Experiences of violence across life course and its effects on mobility among participants in the International Mobility in Aging Study. *BMJ Open, 6*(10), e012339. https://doi.org/10.1136/bmjopen-2016-012339.

Guralnik, J. M., Ferrucci, L., Simonsick, E. M., Salive, M. E., & Wallace, R. B. (1995). Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *The New England Journal of Medicine, 332*(9), 556–562. https://doi.org/10.1056/nejm199503023320902.

Guralnik, J. M., Simonsick, E. M., Ferrucci, L., Glynn, R. J., Berkman, L. F., Blazer, D. G., ... Wallace, R. B. (1994). A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology, 49*(2), M85–M94.

Hardy, S. E., Allore, H. G., Guo, Z., & Gill, T. M. (2008). Explaining the effect of gender on functional transitions in older persons. *Gerontology, 54*(2), 79–86. https://doi.org/10.1159/000115004.

Harris, T., Kovar, M. G., Suzman, R., Kleinman, J. C., & Feldman, J. J. (1989). Longitudinal study of physical ability in the oldest-old. *American Journal of Public Health, 79*(6), 698–702. https://doi.org/10.2105/ajph.79.6.698.

Khadr, Z., & Yount, K. (2012). Differences in self-reported physical limitation among older women and men in Ismailia, Egypt. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences, 67*(5), 605–617. https://doi.org/10.1093/geronb/gbs066.

Leveille, S. G., Penninx, B. W., Melzer, D., Izmirlian, G., & Guralnik, J. M. (2000). Sex differences in the prevalence of mobility disability in old age: The dynamics of incidence, recovery, and mortality. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences, 55*(1), S41–50. https://doi.org/10.1093/geronb/55.1.S41.

Leveille, S., Resnick, H. B. J., & Balfour, J. (2000). Gender differences in disability: Evidence and underlying reasons. *Aging (Milan, Italy), 12*(2), 106–112.

Lewinsohn, P. M., Seeley, J. R., Roberts, R. E., & Allen, N. B. (1997). Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and Aging, 12*(2), 277–287. https://doi.org/10.1037/0882-7974.12.2.277.

Louie, G. H., & Ward, M. M. (2010). Gender disparities in self-reported physical functioning: True differences, reporting Bias, or incomplete adjustment for confounding?

Journal of the American Geriatrics Society, 58(6), 1117–1122. https://doi.org/10.1111/j.1532-5415.2010.02858.x.

Marsh, A. P., Janssen, J. A., Ip, E. H., Barnard, R. T., Ambrosius, W. T., Brubaker, P. R., ... Rejeski, W. J. (2015). Assessing walking activity in older adults: Development and validation of a novel computer-animated assessment tool. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 70*(12), 1555–1561.

Mechakra-Tahiri, S. D., Freeman, E. E., Haddad, S., Samson, E., & Zunzunegui, M. V. (2012). The gender gap in mobility: A global cross-sectional study. *BMC Public Health, 12*, 598. https://doi.org/10.1186/1471-2458-12-598.

Merrill, S. S., Seeman, T. E., Kasl, S. V., & Berkman, L. F. (1997). Gender differences in the comparison of self-reported disability and performance measures. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 52*(1), M19–26.

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging: Moving toward a model of behavioral and biological mechanisms. *Psychological Bulletin, 137*(6), 959–997. https://doi.org/10.1037/a0024768.

Murtagh, K. N., & Hubert, H. B. (2004). Gender differences in physical disability among an elderly cohort. *American Journal of Public Health, 94*(8), 1406–1411.

Nielsen, L. M., Kirkegaard, H., Østergaard, L. G., Bovbjerg, K., Breinholt, K., & Maribo, T. (2016). Comparison of self-reported and performance-based measures of functional ability in elderly patients in an emergency department: Implications for selection of clinical outcome measures. *BMC Geriatrics, 16*, 199. https://doi.org/10.1186/s12877-016-0376-1.

Oliveira, B. S., Zunzunegui, M. V., Quinlan, J., Batistuzzo de Medeiros, S. R., Thomasini, R. L., & Guerra, R. O. (2017). Lifecourse adversity and telomere length in older women from Northeast Brazil. *Rejuvenation Research, 19*(10).

Oman, D., Reed, D., & Ferrara, A. (1999). Do elderly women have more physical disability than men do? *American Journal of Epidemiology, 150*(8), 834–842.

Onadja, Y., Atchessi, N., Soura, B. A., Rossier, C., & Zunzunegui, M.-V. (2013). Gender differences in cognitive impairment and mobility disability in old age: A cross-sectional study in Ouagadougou, Burkina Faso. *Archives of Gerontology and Geriatrics, 57*(3), 311–318. https://doi.org/10.1016/j.archger.2013.06.007.

Pahor, M., Guralnik, J. M., Ambrosius, W. T., Blair, S., Bonds, D. E., Church, T. S., et al. (2014). Effect of structured physical activity on prevention of major mobility disability in older adults: The life study randomized clinical trial. *JAMA, 311*(23), 2387–2396. https://doi.org/10.1001/jama.2014.5616.

Rahman, M. O., & Liu, J. (2000). Gender differences in functioning for older adults in rural Bangladesh. The impact of differential reporting? *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 55*(1), M28–33.

Rodrigues, M. A., Facchini, L. A., Thume, E., & Maia, F. (2009). Gender and incidence of functional disability in the elderly: A systematic review. *Cadernos de Saude Publica, 25*(3), S464–476.

Strawbridge, W. J., Kaplan, G. A., Camacho, T., & Cohen, R. D. (1992). The dynamics of disability and functional change in an elderly cohort: Results from the alameda county study. *Journal of the American Geriatrics Society, 40*(8), 799–806. https://doi.org/10.1111/j.1532-5415.1992.tb01852.x.

Webber, S. C., Porter, M. M., & Menec, V. H. (2010). Mobility in older adults: A comprehensive framework. *Gerontologist, 50*(4), 443–450. https://doi.org/10.1093/geront/gnq013.

Ylli, A., Miszkurka, M., Phillips, S. P., Guralnik, J., Deshpande, N., & Zunzunegui, M. V. (2016). Clinically relevant depression in old age: An international study with populations from Canada, Latin America and Eastern Europe. *Psychiatry Research, 241*, 236–241. https://doi.org/10.1016/j.psychres.2016.04.096.

Yount, K. M., & Agree, E. M. (2005). Differences in disability among older women and men in Egypt and Tunisia. *Demography, 42*(1), 169–187. https://doi.org/10.1353/dem.2005.0009.

Zeki Al Hazzouri, A., Mehio Sibai, A., Chaaya, M., Mahfoud, Z., & Yount, K. M. (2011). Gender differences in physical disability among older adults in underprivileged communities in Lebanon. *Journal of Aging and Health, 23*(2), 367–382. https://doi.org/10.1177/0898264310385454.

Zunzunegui, M. V., Alvarado, B. E., Guerra, R., Gómez, J. F., Ylli, A., Guralnik, J. M., ... Group, I. R. (2015). The mobility gap between older men and women: The embodiment of gender. *Archives of Gerontology and Geriatrics, 61*(2), 140–148. https://doi.org/10.1016/j.archger.2015.06.005.