MOBILITY IN COMMUNITY-DWELLING ADULTS WITH CHRONIC CONDITIONS

THE RELATIONSHIP BETWEEN GENDER OR SEX AND MOBILITY IN MIDDLE AND OLDER AGED COMMUNITY-DWELLING ADULTS WITH CHRONIC CONDITIONS

By YING XU, B.Sc.

A thesis submitted to the School of Rehabilitation Sciences in partial fulfilment of the requirements for the Degree of Master of Science

MASTER OF SCIENCE (2017) McMaster University

(Rehabilitation Science) Hamilton, Ontario

TITLE: The relationship between gender or sex and mobility in middle and older aged community-dwelling adults with chronic conditions

AUTHOR: Ying Xu, B.Sc.

SUPERVISOR: Dr. Julie Richardson

SUPERVISORY COMMITTEE: Joy MacDermid, Dr. Vanina Dal Bello-Haas

NUMBER OF PAGES: vii, 88

CONTRIBUTIONS

This study is comprised of two studies linked by an introduction and a discussion. The current thesis was formatted according to the requirements of the Journal which will be submitted. The co-author of these studies had the following roles: second reader for the systematic review, assisted with study design and as well as manuscript revision. Ying Xu was responsible for all elements of these studies including: study design, data analyses and writing of the manuscript.

ABSTRACT

The purpose of this thesis was to determine the relationships between gender or sex with mobility in middle aged and older community-dwelling adults with chronic conditions. Study one was a systematic review of published literature on whether gender or sex predict mobility in middle aged and older adults with chronic conditions in community-dwelling setting. Study two was a secondary analysis study (data from a randomized controlled trial where there were no statistically significant differences between rehabilitation intervention group and control group) to determine whether age and sex predict self-reported and performance-based mobility-related outcomes in community-dwelling middle and older aged adults with chronic conditions. This relationship was also examined in the context of sociodemographic and comorbidity variables. The information gained from these studies could be used to inform and guide future research and prevention intervention programs for people with risk of mobility limitation.

ACKNOWLEGEDMENTS

I would like to thank my supervisor Dr. Julie Richardson who provided invaluable advice, support, and guidance through my master studies. Without your guidance and help, I think I couldn't finish this thesis. I have learned a lot from your spirit of pursuing the truth and rigorous attitude when conducting research, and most importantly, thank you for teaching me not only for the knowledge but also how to become a better person because of your generous and warm-hearted personality.

I also like to thank my committee: Dr. Joy MacDermid and Dr. Vanina Dal Bello-Haas for their great support during my master studies. Thank you so much for the vast research knowledge, I really appreciated your advice and help.

I want to thank Linda Nguyen for being my second reviewer for the systematic review.

I also want to express my gratitude to my lovely friends: Silvana, Isabel, Sungha, Bam, Ryan, Steve, Cher, Chenji who gave me so much help, happiness, and encouragements throughout my studies in Canada. Because of you, I had so much good memories here.

Last, I want to thank my mom and dad. No matter how far away from me, they always support me silently.

TABLE OF CONTENTS

Page

LIST OF FIGURES, TABLES AND APPENDICES

Chapter 1: Introduction and Literature review

Outline of thesis

The main objectives of this thesis are to examine the relationships between gender or sex and mobility in community-dwelling adults with chronic conditions. This thesis consists of four chapters. Chapter 1 is the introduction and literature review of this thesis. Chapter 2 is a systematic review that examined whether gender or sex predict mobility in middle and older aged community-dwelling adults with chronic conditions. Chapter 3 is a secondary data analysis which used the data from a previous randomized controlled trial where there were essentially no differences between the rehabilitation interventions and control groups. These data were used to test whether age and sex predict self-reported and performance-based mobility-related outcomes in the same population, and also to test whether other variables such as comorbidity, education and income level, and marital status influence the predictive relationship between age and sex on mobility-related outcomes. Finally, a conclusion and implication for future studies of this thesis was summarized in Chapter 4.

Literature Review

Mobility in aging

One of the significant considerations for public health is maintaining and restoring mobility in aging [1]. For the future aging population, the impact on the health care system and society will be largely due to the loss of independence and the need for long-term care in the oldest ages, both of which are prompted by mobility limitation [2]. Mobility refers to a persons' ability to ambulate and move [3]. The International Classification of Functioning, Disability and Health (ICF) defines mobility in a variety of forms, consisting of changing or maintaining body position, carrying, moving and handling objects, and driving a car, and using other transportation to move around [4]. In Canada (2002), approximately 13% of Canadian community-dwelling people ≥ 60 years have mobility problems and the percentage increases to 30% when people reach 80 years [5]. A variety of studies have demonstrated that mobility limitation is highly linked to large numbers of significant health consequences [6–8]. Mobility limitation is an early marker of disability and institutionalization in older people [9,10]. People with limited mobility, compared to people where mobility is intact, are more likely to engage in sedentary behavior [1], have depression [7], be socially isolated [11], have reduced quality of life [12], and sustain injuries from falls. As well, people with limited mobility have higher rates of mortality [13]. Hence, maintaining mobility and preventing mobility limitation before disability emerges is a crucial task for the aging population.

The following section will address the association between mobility limitation and chronic conditions, and why sex and gender are important to the mobility trajectory people experience. I also included the theoretical framework (Sex and Gender Equity in Research

(SAGER) guidelines) selected for this thesis, and the other factors (sociodemographic) that I used to consider in the papers generated about mobility.

Chronic conditions

Relationship between chronic conditions and mobility limitation

Chronic conditions have a long duration and typically slow progression [14], and it is a leading cause of disability and mortality, and account for 60% of death worldwide [15]. Common types of chronic conditions include diabetes, chronic respiratory diseases, cardiovascular diseases, and cancer [14]. In Canada (2009), 89% of Canadian seniors were affected by at least one chronic condition [16]. The most common chronic conditions are arthritis which affect approximately 44% of Canadian seniors [16]. In addition, many seniors are suffering from a combination of chronic conditions. Approximately, 25% of Canadian older adults (65 to 79 years) reported having more than four chronic conditions [16]. Chronic conditions are associated with mobility limitation. A longitudinal study (N = 6,981; community-dwelling adults ≥ 65 years, USA) demonstrated that heart attack, diabetes, high blood pressure, angina, dyspnea, and exertional leg pain were significantly associated with mobility limitation after a 4 year follow-up [17]. In addition, participants who had no mobility limitation at baseline, but had more than four chronic conditions, were three times more likely to have mobility limitation than persons without chronic conditions at baseline. Another cross-sectional study (N = 11,392, community-living middle-aged adults ≥ 50 years, UK) showed that participants with chronic obstructive lung disease, angina, stroke, cancer, or lower limb and back pain, and comorbidity had two times the odds of mobility limitation [18].

Why sex and gender are important to mobility

Sex and gender are essential determinants of health [19]. Recent studies have often investigated the biological differences in relation to mobility for females and males. Sex refers to biological characteristics in humans and animals such as chromosomes, gene expression, hormone levels and function, and sexual anatomy, and it is usually categorized as female or male [20]. Compared with males, females have a higher prevalence of susceptibility to autoimmune diseases such as multiple sclerosis and rheumatoid arthritis [21,22], which can lead to higher likelihood of mobility limitation in females. Moreover, life expectancy for females is longer than males, which means females experience any associated disability for longer periods than males [23]. In addition, they are more likely to experience comorbidity [24]. The difference in body compositions, such as muscle strength in females and males, also plays an important role in sex-linked differences in relation to mobility. A cross-sectional study (N = 1374; mean age ± SD: 73.4 ± 6.4, Brazil) reported that females had twice the odds of mobility limitation and lower muscle strength related to mobility limitation compared to males [25].

Furthermore, there is also some evidence of reported gender differences in mobility. Gender is defined as socially constructed roles, behaviors, identities of girls, women, boys, men, and gender diverse people [20]. Gender affects how people perceive themselves, how they interact with each other, and the allocation of resources and power in society [20,26]. Gender differences in mobility are associated with varying levels of physical activity in women and men. Studies indicated that women were significantly less active and less likely to participate in leisure time physical activity compared to men [27,28], and were more likely to engage in housework [27]. Traditional social norms and responsibilities assigned to women's roles that involve caregiving of children and family members result in women having less opportunity for leisure time physical activity than men [29,30]. Gender inequality results in women experiencing a greater overall disadvantage in educational and employment opportunities compared to men which has contributed to women being more vulnerable to poverty and restricted access to health services [29]. In addition, women sustain more discrimination, domestic violence, and abuse from other family members which is linked to greater mobility limitations and poorer health compared to men [29,30].

Understanding the role of sex and gender with mobility in community-dwelling adults with chronic conditions may lead to improved future health research interventions based on the specific needs of women and men. It will also guarantee a more comprehensive science, improve health policies, reduce health care costs, and most importantly will address social injustice [31].

Theoretical framework

Sex and Gender Equity in Research (SAGER) guidelines

Sex and gender are two distinct concepts and critical determinants of health, however they are often overlooked and underreported [32]. As well, many studies include sex and gender terms by substituting one with the other, and researchers often use “gender differences” to refer to biological differences [33]. With the aim of enhancing gender health equity and changing these misconceptions, more organizations and institutions have committed resources to gender and sex issues in health. For example, health organizations in Ontario (Canada) have put forward Ontario Women’s health framework (ECHO) to enhance women’s health and well-being through improving quality care and health service delivery for women. Improving women’s health directly strengthens and benefits the overall health of people living in Ontario [34]. Additionally, in order to increase the standardization of reporting sex and gender in research, the Canadian

Institutes of Health Research (CIHR) also endorsed that grant applicants should consider including both gender and sex when appropriate [20]. Integration of sex and gender increases the rigor and ethics of health research, and also addresses different needs of women and men.

Typically, literature does not include an overarching framework to guide health research related to gender and sex. In this thesis, the Sex and Gender Equity in Research (SAGER) guidelines were employed as the framework to support the work [32]. This framework relates well to our overall research purpose to examine the contribution of both gender and sex (females and males; women and men) on mobility. This is applied in the systematic review whether gender or sex predict mobility in community-dwelling adults with chronic conditions (Chapter 2), and also in our secondary data analysis study (Chapter 3). The SAGER guidelines are a comprehensive standard tool developed by European Association of Science Editors (EASE) to conduct an online survey of existing policies and opinions of 716 journal editors; and a literature review to identify the policies on sex and gender in scientific publications [19,32]. The general principles outlined in the SAGER guidelines are to: 1) carefully use the term sex and gender in papers to avoid confusion; 2) differentiate subjects based on sex and gender; and 3) design and conduct research to reveal sex and/or gender differences or similarities adequately in the results, even if not initially expected [32]. In addition, the guidelines proposed several recommendations for each section of the journal article. The recommendations are summarized in **Table 1**:

Table 1: SAGER recommendations according to the sections of the article [32].

Section	Recommendation
Title and abstract	If only one sex is included in the study, or if the results of the study are to be applied to only one sex or gender, the title and the abstract should specify the sex of animals or any cells, tissues and other material derived from these and the sex and gender of human participants.
Introduction	Authors should report, where relevant, whether sex and/or gender differences may be expected.
Methods	Authors should report how sex and gender were taken into account in the design of the study, whether they ensured adequate representation of males and females, and justify the reasons for any exclusion of males or females.
Results	Where appropriate, data should be routinely presented disaggregated by sex and gender. Sex- and gender-based analyses should be reported regardless of positive or negative outcome. In clinical trials, data on withdrawals and dropouts should also be reported disaggregated by sex.
Discussion	The potential implications of sex and gender on the study results/analyses should be discussed. If a gender analysis was not conducted, the rationale should be explained. Authors should further discuss the implications of the lack of such analysis on the interpretation of the results.

Sociodemographic factors and mobility

Studies have found that older adults with lower economic status, less education and living alone have greater mobility limitations than persons who have more favorable socioeconomic status and who are living with their partners [1,35]. A cohort study (N = 1,229, mean age 77.0 years, USA) showed that people with less than 9 years of education had greater mobility limitation in a 4 year follow-up than people with more than 9 years of education [36]. A further study which was a survey (N = 3,950, ≥ 55 years, European research project) demonstrated that older people who live alone and have low income have higher risk of out-of-home mobility limitation [37]. The impact of these sociodemographic variables on mobility might include: social support, walking safety is greater in high-income neighborhoods, with greater selection for transportation. All of these factors may contribute to mobility limitation.

In summary, chronic conditions, sex, and gender are related to health outcomes. Therefore, it is likely they may also impact mobility. Chapter 2 (systematic review) and Chapter 3 (secondary data-analysis study) contribute to the understanding of this relationship.

In order to enhance the reporting clarity of gender and sex terms in this thesis, I used the definition of SAGER guidelines in terms of gender and sex, and indicated gender would be categorized as women and men, and sex would be categorized as females and males. Furthermore, if the gender and sex of the participants' were unsure, women and men would be used.

References

[1] Satariano WA, Guralnik JM, Jackson RJ, et al. Mobility and aging: new directions for public health action. Am. J. Public Health. 2012;102:1508–1515.

[2] Schneider EL, Guralnik JM. The aging of America. Impact on health care costs. JAMA. 1990;263:2335–2340.

[3] Shumway-Cook A, Ciol MA, Yorkston KM, et al. Mobility limitations in the Medicare population: prevalence and sociodemographic and clinical correlates. J. Am. Geriatr. Soc. 2005;53:1217–1221.

[4] World Health Organization. International Classification of Functioning, Disability and Health: ICF. [place unknown]: World Health Organization; 2001.

[5] Mobility Consensus Conference (2002) [Internet]. Ottawa (ON): Canadian Institutes of Health Research; [cited 2017 Sep 25]. Available from: http://www.cihr-irsc.gc.ca/e/43117.html.

[6] Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J. Gerontol. 1994;49:M85-94.

[7] Iezzoni LI, McCarthy EP, Davis RB, et al. Mobility Difficulties Are Not Only a Problem of Old Age. J. Gen. Intern. Med. 2001;16:235–243.

[8] Lawrence RH, Jette AM. Disentangling the disablement process. J. Gerontol. B. Psychol. Sci. Soc. Sci. 1996;51:S173-182.

[9] Guralnik JM, Ferrucci L, Pieper CF, et al. Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. J. Gerontol. A. Biol. Sci. Med. Sci. 2000;55:M221-231.

[10] Penninx BW, Ferrucci L, Leveille SG, et al. Lower extremity performance in nondisabled older persons as a predictor of subsequent hospitalization. J. Gerontol. A. Biol. Sci. Med. Sci. 2000;55:M691-697.

[11] Mezuk B, Rebok GW. Social integration and social support among older adults following driving cessation. J. Gerontol. B. Psychol. Sci. Soc. Sci. 2008;63:S298-303.

[12] Netuveli G, Wiggins RD, Hildon Z, et al. Quality of life at older ages: evidence from the English longitudinal study of aging (wave 1). J. Epidemiol. Community Health. 2006;60:357–363.

[13] Ahmed T, Vafaei A, Auais M, et al. Gender Roles and Physical Function in Older Adults: Cross-Sectional Analysis of the International Mobility in Aging Study (IMIAS). PloS One. 2016;11:e0156828.

[14] Noncommunicable diseases country profiles 2014 [Internet]. [place unknown]: World Health Organization; [cited 2017 Jul 14]. Available from: http://www.who.int/nmh/countries/en/.

[15] Chronic diseases and health promotion [Internet]. [place unknown]: World Health Organization; [cited 2017 Jul 14]. Available from: http://www.who.int/chp/en/.

[16] Chapter 3: The Chief Public Health Officer's Report on The State of Public Health in Canada 2010 – The health and well-being of Canadian seniors [Internet]. Ottawa (ON): Government of Canada; [cited 2017 Sep 25]. Available from: https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/annual-report-on-state-public-health-canada-2010/chapter-3.html.

[17] Guralnik JM, LaCroix AZ, Abbott RD, et al. Maintaining mobility in late life. I. Demographic characteristics and chronic conditions. Am. J. Epidemiol. 1993;137:845–857.

[18] Melzer D, Gardener E, Guralnik JM. Mobility disability in the middle-aged: cross-sectional associations in the English Longitudinal Study of Ageing. Age Ageing. 2005;34:594–602.

[19] De Castro P, Heidari S, Babor TF. Sex And Gender Equity in Research (SAGER): reporting guidelines as a framework of innovation for an equitable approach to gender medicine. Commentary. Ann. Ist. Super. Sanita. 2016;52:154–157.

[20] Sex, Gender and Health Research Guide: A tool for CIHR Applicants [Internet]. Ottawa (ON): Canadian Institutes of Health Research (CIHR); [cited 2017 Jun 6]. Available from: http://www.cihr-irsc.gc.ca/e/32019.html.

[21] Fairweather D, Rose NR. Women and Autoimmune Diseases1. Emerg. Infect. Dis. 2004;10:2005–2011.

[22] Voskuhl R. Sex differences in autoimmune diseases. Biol. Sex Differ. 2011;2:1.

[23] Leveille SG, Resnick HE, Balfour J. Gender differences in disability: evidence and underlying reasons. Aging Milan Italy. 2000;12:106–112.

[24] Guralnik JM. Aging in the eighties : the prevalence of comorbidity and its association with disability [Internet]. Hyattsville (MD): Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics; [cited 2017 Sep 25]. Available from: https://searchworks.stanford.edu/view/10235236

[25] Vasconcelos KS de S, Dias JMD, Bastone A de C, et al. Handgrip Strength Cutoff Points to Identify Mobility Limitation in Community-dwelling Older People and Associated Factors. J. Nutr. Health Aging. 2016;20:306–315.

[26] What a Difference Sex and Gender Make: A Gender, Sex and Health Research Casebook [Internet]. Ottawa (ON): Canadian Institutes of Health Research; [cited 2017 Sep 25]. Available from: http://www.cihr-irsc.gc.ca/e/44734.html.

[27] Azevedo MR, Araújo CLP, Reichert FF, et al. Gender differences in leisure-time physical activity. Int. J. Public Health. 2007;52:8–15.

[28] Martínez-González MA, Varo JJ, Santos JL, et al. Prevalence of physical activity during leisure time in the European Union. Med. Sci. Sports Exerc. 2001;33:1142–1146.

[29] Doyal L. Sex, gender, and health: the need for a new approach. BMJ. 2001;323:1061–1063.

[30] Zunzunegui MV, Alvarado BE, Guerra R, et al. The mobility gap between older men and women: the embodiment of gender. Arch. Gerontol. Geriatr. 2015;61:140–148.

[31] Greaves L, Hankivsky O, Amaratunga C, Ballem P, Chow D, De Koninck M, et al. CIHR 2000: Sex, Gender and Women's Health. Vancouver: Canadian Institutes of Health Research; 1999.

[32] Heidari S, Babor TF, De Castro P, et al. Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. Res. Integr. Peer Rev. 2016;1:2.

[33] Johnson JL, Greaves L, Repta R. Better science with sex and gender: Facilitating the use of a sex and gender-based analysis in health research. Int. J. Equity Health. 2009;8:14.

[34] ECHO: Improving Women's Health in Ontario [Internet]. Toronto (ON): Ministry of Health and Long-term Care; [cited 2017 Sep 25]. Available from: http://www.womenscollegehospital.ca/assets/pdf/echo_improving_womens_health_in_ontario.pdf.

[35] Yeom HA, Fleury J, Keller C. Risk factors for mobility limitation in community-dwelling older adults: a social ecological perspective. Geriatr. Nurs. N. Y. N. 2008;29:133–140.

[36] Blazer DG, Hybels CF, Fillenbaum GG. Metabolic syndrome predicts mobility decline in a community-based sample of older adults. J. Am. Geriatr. Soc. 2006;54:502–506.

[37] Mollenkopf H, Marcellini F, Ruoppila I, et al. Social and behavioural science perspectives on out-of-home mobility in later life: findings from the European project MOBILATE. Eur. J. Ageing. 2004;1:45–53.

Chapter 2: Systematic Review

Title: Gender or sex predict mobility in middle and older aged community-dwelling adults with chronic conditions: a systematic review

*This study has been submitted to Disability and Rehabilitation.

ABSTRACT

Purpose: To determine whether gender or sex predict mobility in middle and older aged community-dwelling adults with chronic conditions.

Methods: A systematic review of cohort studies and cross-sectional studies was conducted. EMBASE, MEDLINE, CINAHL, PubMed, and Cochrane Library and Social Sciences Abstracts were searched from 1998 to May 2017 for studies identifying gender or sex as predictors of mobility in middle and older aged community-dwelling adults with chronic conditions. Search terms included keywords and MeSH terms related to gender or sex, predict, mobility and chronic conditions.

Results: Out of 497 studies, 10 met the inclusion criteria: four cohort studies and six cross-sectional studies. Five cross-sectional studies showed that being a woman is positively associated with reported and performance measures of mobility disability, while, one cross-sectional study indicated that being a woman is negatively associated with a performance-based mobility disability. Three cohort studies reported being a woman positively predicted reported and performed mobility disability. Another cohort study demonstrated being a woman and being a man have similar reported mobility disability.

Conclusions: This systematic review showed that women with chronic conditions have increased rates of mobility disability compared to men. Although the mechanisms are unclear, both sex and gender pathways could be involved.

Introduction

As the global population is aging rapidly, there are increasing numbers of older adults at risk of chronic conditions. Chronic conditions are the leading cause of mortality, responsible for 60% of all deaths worldwide, and 43% of the global burden of disease [1]. The most common chronic conditions are cardiovascular diseases, chronic respiratory diseases, diabetes, and cancers [2]. Each year, approximately 40 million people die from chronic conditions globally [2], 50% are ≤ 70 years old, and 50% are women [1].

The association between chronic conditions and mobility has been established in a number of previous studies [3–5]. Mobility refers to a person's ability to move around. The International Classification of Functioning, Disability and Health (ICF) recognizes mobility as a major focus of health, and defines this construct as "an individual's ability to move by changing body position or location or by transferring from one place to another, by carrying, moving or manipulating objects, by walking, running or climbing, and by using various forms of transportation" p.138 [6]. A cohort study (N = 6981; USA; data from part of the Established Populations for Epidemiologic Studies of the Elderly) demonstrated that heart attack, stroke, dyspnea, exertional leg pain, hypertension were significant predictors for increased odds of mobility loss in community-dwelling adults ≥ 65 years old [3]. Another cross-sectional study (N = 1416; USA; mean age = 72.7 years; data from Framingham Heart Study) showed that older adults with radiographic osteoarthritis with pain was associated with an increased risk of dependence in walking a mile and stair climbing [5].

Research studies often assess the effect of sex (i.e. biological differences between males and females) rather than gender in relation to mobility. Studies which examine differences in mobility according to sex have identified the following issues. Females have a relatively longer life expectancy with a high prevalence of chronic conditions and higher comorbidity than males, such as higher odds of knee osteoarthritis [7], musculoskeletal pain [8,9], obesity [10,11], and depression [12]. This may partly explain sex differences associated with mobility. Females also have less muscle mass compared to males and experience greater losses with age, which place females at greater risk of mobility limitation at old age [13]. Many common mobility tasks are critical for independence, such as walking and climbing stairs, and impairment level issues of a certain threshold such as strength and balance are required to perform functional tasks. However, gender differences associated with mobility are not well understood [14]. Gender refers to the socially constructed roles, norms, behaviors, identities of people, and it influences how people perceive themselves, how they interact with others. Gender can be very fluid and it does not necessarily fit into a binary category, men and women [15–17], but also can include other category, such as transgendered, gender non-conforming, and gender queer. Several issues have been reported as important contributors to gender differences in mobility: 1) the social inequality of men and women in income and wealth make women more vulnerable to poverty, this may limit their access to health services, and result in poorer mobility [18]; 2) women experience higher likelihood of domestic violence, early childhood abuse, and discrimination in their life course that can be related to mobility limitation in later life [18,19]; 3) various social norms such as gender role expectations for women to complete domestic tasks such as housework and childrearing [18,19], which may lead women to have less opportunity for physical activity compared to men; 4) women are socialized to pay attention to and acknowledge discomfort and illness [20–23], while men are socialized to tolerate physical discomfort [20], which may lead to the difference in self-reported mobility.

To our knowledge, no studies to date have systematically reviewed the contribution that gender or sex makes to mobility in adults with chronic conditions in community-dwelling settings. To address this gap, we conducted a systematic review of cohort and cross-sectional studies to examine whether gender or sex are associated with or predict mobility in middle and older aged community-dwelling adults with chronic conditions. Understanding the role of gender or sex in trajectories of mobility has implication for improving prevention and intervention for people at risk of mobility loss before mobility disability is entrenched and irreversible.

Methods

Protocol

This systematic review was conducted in accordance with the preferred reporting items of PRISMA 2009 guidelines [24].

Eligibility criteria

The criteria for study selection were 1) participants' mean age ≥ 44 years old; 2) participants are community dwelling adults; 3) diagnosis included ≥ 1 chronic conditions or samples with a proportion of participants with chronic conditions; we included the following chronic conditions: cancer, cardiovascular disease (heart failure, hypertension, stroke, and angina), Parkinson's disease, chronic respiratory disease (asthma, chronic obstructive pulmonary disease), diabetes, obesity, mental illness, multiple sclerosis, neurological conditions, and musculoskeletal disease (arthritis, osteoporosis, fibromyalgia, low back pain); 4) outcomes are related to mobility defined by International Classification of Functioning, Disability and Health (ICF) framework and data were available for the mobility outcomes; 5) research results address a direct comparison of gender or sex on mobility outcomes; 6) study designs included randomized controlled trial, cohort study, cross-sectional study; 7) papers published between 1998 - 2007. We restricted the search to the most recent 20 years because the relationship between gender/sex and mobility probably was different prior to this time due to physical activity patterns related to gender/sex; 8) English journals; 9) full-text journals are available.

Search Strategy

A systematic literature search was conducted in EMBASE, MEDLINE, CINAHL, PubMed, Cochrane Library, Social Sciences Abstracts. The databases were searched from 1998 to May 2017 using database-specific keywords, synonyms, medical subject headings (MeSH) and index terms of “gender or sex”, “predict”, “mobility”, and “chronic conditions”. We used the Sex and Gender Equity in Research (SAGER) guidelines as a framework to define “gender” and “sex” and guide our systematic review [17]. We defined “gender” as socially constructed roles, norms, behaviors, identities of women, men, and gender diverse people, and “sex” as biological characteristics in humans, and usually categorized as females or males [17]. **Appendix** provides detailed search strategy information performed in EMBASE and MEDLINE databases. The additional search strategies included hand searching of articles from Google Scholar and screening of reference lists of retrieved articles for further potentially relevant articles.

Study selection

First, two reviewers (YX, LN) independently screened potentially eligible articles by title and abstract according to the selection criteria. Then, potentially included articles were compared and any disagreements between the two reviewers were resolved through discussion to reach a consensus. Finally, the two reviewers independently reviewed eligible full-text articles and performed the aforementioned process again. The agreement between the two reviewers was calculated using Cohen's Kappa [25] after the full-text reviewing was completed.

Data extraction

One reviewer (YX) extracted the data of included studies and the second reviewer (LN) checked for accuracy. For each study included in this systematic review, the following data were extracted: first author's name, publication year, study's country, study design, participants' characteristics, research question (purpose), mobility outcomes, covariates, statistical analysis, and main findings in relation to mobility (effect size such as odds ratio (OR), coefficient (β), p value, 95% confidence intervals).

Quality assessment

The methodological quality assessment was performed by the two reviewers independently. The quality of the included studies was determined using the National Institutes of Health (NIH) quality assessment tool for observational cohort and cross-sectional studies [26]. The quality of included articles was rated as good, fair and poor. Discrepancies of the ratings were resolved through discussion between the two reviewers.

Results

Study selection

The initial database search resulted in 497 papers. One additional paper was identified through Google Scholar. After removal of duplicates (n = 254), 244 papers were screened by titles and abstracts. 13 full-text papers were assessed for eligibility, and 3 papers were excluded. A total of 10 papers were included in this review, **Figure 1.** Reasons for exclusion included: full-text article was not available (n =1), research results did not address a direct comparison of gender or sex on mobility outcomes (n = 2). The Cohen's Kappa agreement was calculated as K = 0.95 after full-text review for eligibility.

Study characteristics

The studies included were: four cohort studies, five cross-sectional studies, and one cross-sectional study using data from the last wave of a cohort study. Identified studies were conducted in the United States (n = 5), Canada (n = 2), Brazil (n =1), South Korea (n =1), and the United Kingdom (n = 1). **Table 1** presents the characteristics and main findings of the studies that were included.

Mobility outcomes

Multiple mobility outcomes were used across these studies including self-reported and performance-based outcomes. Self-reported difficulty in walking and climbing stairs were the most commonly used mobility outcomes (5/10 studies; 50.0%). The other mobility outcomes used were: gait speed, gait stride length, chair rise and stair climb time, daily step numbers, difficulty with getting on a bus/in a car, reaching overhead, bending over, lifting 10 pounds, putting on socks, six minute walk test (6MWT), Physical Activity Scale for Elderly (number of walking days in the previous week), and Short Physical Performance Battery (SPPB). Psychometric properties of the mobility outcomes were rarely reported with only half of the included studies (n = 5) reporting reliability and validity of the outcomes they utilized.

Extent of compliance of the included studies with the SAGER guidelines

Table 2 established the extent of compliance of the included studies with SAGER guidelines. Most of the studies (9/10 studies) included in this review failed to use correct terms with regards to gender or sex of the participants. Five studies [19,27–30] (n = 5) used sex to differentiate men and women, four studies [31–34] (n = 4) used gender and sex interchangeably to differentiate males and females (or men and women), one study [35] (n = 1) used gender to differentiate men and women. None of the studies illustrated how they classified participants' gender or sex in their research and all of the included studies used dichotomous classification (males/females and men/women) to report gender and sex. Studies rarely stated whether gender or sex differences might be associated with the mobility outcomes in the introduction section of the paper (2/10 studies reported this association). Similarly, few studies reported whether sex and gender were taken into account in the design of the study or used in the design of the study (1/10 studies reported this association). No study reported whether questionnaires or measurements were used to identify participants' gender or sex. Finally, although studies presented the differences in mobility outcomes by disaggregating by sex or gender in the discussion section, only half the studies (5/10 studies) discussed a gender/sex-linked hypothesis or the implications of sex and gender on the study results.

Quality assessment

Table 3 shows the summary of the methodological qualities of the included studies. Overall, the quality of the included studies was poor to good. There were three studies rated as good quality, four studies were of fair quality, and three studies were of poor quality.

The relationships of gender/sex with mobility

Since gender and sex reflects two different concepts, to enhance the clarity of reporting our findings, we have used gender terms as women and men, and sex terms as females and males. In addition, if the gender and sex of the participants' were unsure, women and men were utilized.

Being a woman is positively associated with reported and performance-based mobility disability compared to being a man (n = 5)

Five cross-sectional studies [19,27,29,32,35] showed that women reported greater mobility disability than men and performed more poorly on mobility tasks. One cross-sectional study [27] compared women and men participants according to three different BMI and waist circumference levels. Women with abdominal obesity (highest quartiles of BMI and waist circumference) were associated with higher odds of self-reported lower extremity mobility disability (OR =4.3, 95% CI: 3.0, 6.2, $p < 0.001$; OR = 4.8, 95% CI: 3.4, 6.9, $p < 0.001$)); however, the associations for men were moderate (OR = 1.5, 95% CI: 1.0, 2.3, $p = 0.01$; OR = 1.8, 95% CI: 1.2, 2.7, $p = 0.001$). Another cross-sectional study [29] investigated mobility differences in women and men with chronic low-back pain and stratified on three different BMI levels. Within the severely obese group women had significantly longer stair climb times (seconds)(men: 4.5 ± 0.7, women 7.3 ± 3.7, $p < 0.05$), slower walking velocity (centimeter/seconds)(men: 113 ± 17; women 97 ± 14, $p < 0.05$), shorter stride length (centimeter) (men: 132 ± 16; women 109 ± 17, $p < 0.05$), and longer double support time (%)(men: 33.5 ± 1.9; women 36.8 ± 4.7, $p < 0.05$) compared to men. A second cross-sectional study [32] reported that women had lower handgrip strength and a slightly higher likelihood of muscle weakness, and had twice the odds of performance mobility limitation than men. Another cross-sectional study [19] looked at the prevalence of physical performance (SPPB) and self-reported mobility disability of women and men in five diverse societies (Natal (Brazil), Manizales (Colombia), Tirana (Albania), Saint-Hyacinthe (Quebec), Kingston (Ontario)). The researchers observed that after adjusting age, the prevalence for low physical performance (SPPB < 8) was higher in women than men in Tirana (PR = 2.38, 95% CI (1.53, 3.69)), Natal (PR = 1.67, 95% CI (1.14, 2.45)), and Manizales (PR = 1.97, 95% CI (1.06, 3.65)), but not in Saint-Hyacinthe (PR = 1.78, 95% CI (0.81, 3.87)) and Kingston (PR = 1.16, 95% CI (0.58, 2.33)). Women also had a higher prevalence of poor self-reported mobility disability compared to men in all sites (Natal (PR = 2.25, 95% CI (1.75, 2.89)), Manizales (PR = 1.51, 95% CI (1.23, 1.87)) and Tirana (PR = 1.70, 95% CI (1.39, 2.08)), Saint-Hyacinthe (PR = 2.43, 95% CI (1.59, 3.70)), but not Kingston (PR = 1.17, 95% CI (0.78, 1.75)). A cross-sectional analysis that used data from the last wave of a cohort study [35] reported that women had greater self-reported mobility disability than men, and that chronic conditions positively associated self-reported mobility disability in women (OR = 1.84, 95% CI: 1.37, 2.47), but not in men (OR = 1.22, 95% CI: 0.81, 1.84).

Being a woman is negatively associated with performance-based mobility disability compared to being a man (n = 1)

One cross-sectional study [33] compared the six-minute walk (6 MWT) distance in women and men participants with chronic conditions living in South Korea; and demonstrated that mobility level was significantly greater in women than men (6MWT distance: women: mean ± SD: 217.85 ± 90.96; men: mean ± SD: 192.66 ± 98.35; $p = 0.023$).

Being a woman positively predicts and is associated with reported and performance-based mobility disability compared to being a man (n = 3)

Three cohort studies [28,30,31] found a positive predictive relationship existed in women with greater reported and performance-based mobility disability compared to men. A longitudinal cohort study [28] showed more severe depressive symptoms predicted less frequent walking in women ($p < 0.01$), however, a significant prospective relationship was not found in men. A further cohort study [31] found that high fat mass predicted greater self-reported mobility-related disability, and that women had higher odds of mobility disability (OR = 2.83, 95% CI: 1.80, 4.46) than men (OR = 1.72, 95% CI: 1.03, 2.85). Low fat-free mass significantly predicted less self-reported mobility disability in women (OR = 0.57, 95% CI: 0.38, 0.88), but not for men (OR = 0.97, 95% CI: 0.58, 1.60). Furthermore, another cohort study [30] showed that women reported greater lower body disability and overall mobility disability than men at baseline, and increased fat mass (FM) and decreased fat-free mass (FFM) predicted lower body mobility disability in both women (OR = 3.9, 95% CI: 1.9, 8.1, $p = 0.001$; OR = 3.6, 95% CI: 1.8, 7.4, $p = 0.0002$) and men (OR = 4.0, 95% CI: 1.5, 10.3, $p = 0.04$; OR = 3.9, 95% CI: 1.5, 10.0, $p = 0.04$). However, FM and FFM only predicted overall mobility disability in women (OR = 3.8, 95% CI: 1.5, 9.6, $p = 0.04$; OR = 4.4, 95% CI: 1.8, 10.9, $p = 0.01$), but not in men (OR = 2.6, 95% CI: 0.9, 7.3, $p = 0.3$; OR = 2.1, 95% CI: 0.8, 6.0, $p = 0.1$).

Being a woman and a man have similar reported mobility disability (n = 1)

One cohort study [34] showed that women and men had a similar annual rate of self-reported mobility disability, and that gender was not predictive of severe decline in mobility (OR = 1.3, 95% CI: 04, 3.4).

Discussion

The purpose of this review was to provide a systematic overview of whether gender or sex predict mobility in middle and older aged community-dwelling adults with chronic conditions. This review showed that women with chronic conditions have increased rates of mobility disability compared to men. There were ten papers included in this review, and three papers were classified as good quality, four were of fair quality and three were of poor quality (NIH quality assessment tool for observational cohort and cross-sectional studies [26]). The poor methodological quality of the included studies was associated with the cross-sectional study design, insufficient time frame to see a relationship between exposure and outcome, no multiple exposure assessments, and insufficient information for determining follow-up rate, and failure to control for potential confounders. In addition, there was insufficient information to determine whether blinded assessors were used to assess the outcome. Therefore, high-quality prediction studies to investigate the role of gender or sex in the trajectories of mobility disability are warranted in the future.

This review found mixed evidence of the associations of gender or sex with mobility in community-dwelling adults with chronic conditions. Overall, being a woman was positively associated with and predicted mobility disability (eight studies) [19,27–32,35]; however, results of two studies [33,34] had different findings. One cross-sectional study showed that women had a higher level of mobility compared to men [33], while the other reported that women and men had similar rates of severe decline in mobility [34]. A possible explanation that women had better mobility might be because women in Korea are more motivated to maintaining mobility function than men [33]. Eight studies reported that women had more chronic conditions such as obesity (high level of BMI, high fat-mass, low fat-free mass), depressive symptoms (depression), chronic low-back pain with obesity (high BMI), heart attack, hip fracture, stroke, as well as lower handgrip strength, all of which were significantly related to a higher likelihood of mobility disability.

The results are consistent with previous literature that confirmed women experience more chronic conditions and worse mobility. Women are more likely to have higher comorbidity compared to men, and that worse mobility for women was associated with a higher prevalence of obesity, musculoskeletal pain, and depression compared to men [8–12]. This finding that women have worse mobility than men has implications for future studies, for example, the need to tailor early prevention and intervention differently for women and men with chronic conditions who are at risk of mobility loss. For instance, future research could test tailored interventions to enhance balance for women and men, since women have more balance problems and higher fall and fracture incidences compared to men.

Psychometric properties of the mobility outcomes were only reported in five studies; hence, more reliable and validated outcomes are warranted for future research. Furthermore, most of the included studies used gender or sex interchangeably and no studies specified how gender or sex of the participants was defined or classified in order to differentiate women/men and females/males. This finding highlights the need for future studies to report gender or sex more accurately and specifically design the questionnaire e.g. Bem Sex Role Inventory to capture the range of how people perceive themselves in terms of gender and sex.

One cross-sectional study integrated gender (i.e. social and economic inequality) and sex to explain the mobility gap in women and men in five diverse societies [19]. The results of this cross-sectional study demonstrated a higher prevalence of poor physical performance in women, partially related to the higher comorbidity and depressive symptoms compared to men. Increased reporting of self-reported mobility disability in women suggests the existence of gender inequality (social and economic inequality) in women compared to men [19]. Therefore, in order to understand the predictive relationship of mobility with gender or sex fully, it is crucial for researchers to integrate gender and sex into health research when appropriate [16] and also to have a clear conceptual model and measurement system which considers both biological and sociological factors that might impact the health of women and men, along with an analysis approach that will elucidate any associated results. Future research concerning mobility also needs to consider the increasing fluidity of both sex and gender with more recent cohorts for which a more diverse classification of both sex and gender is going to be more acceptable to participants and will provide new challenges in understanding mobility trajectories.

Limitations

There are some limitations in this systematic review that warrant attention. First, there is a possibility that we may have missed studies during the literature search phase, because of poor indexing of prediction studies [36]. Second, we only included studies that addressed a direct comparison of gender or sex on mobility outcome; hence, studies such as those that adjusted for gender or sex with other variables were excluded in this review. We chose to exclude these papers because often there was no estimate given for the adjustment according to gender or sex. Finally, we were unable to conduct the meta-analysis of the included studies, given that there were high levels of diversity in the population studied and the way mobility was defined and the way that risks were evaluated, and we concluded that the meta-analysis would not be meaningful.

Conclusion

This systematic review showed that women with chronic conditions have increased rates of mobility disability compared to men. Although the mechanisms are unclear, both sex and gender pathways could be involved. This review highlights the need for future studies to report gender or sex more accurately and specifically design a questionnaire to capture how people perceive themselves in terms of gender and sex, as they are distinct concepts. There is also a need for sex- and gender-based analyses to understand the mechanisms involved in mobility and knowledge to test tailored interventions. The results have implications for improved early preventions and interventions tailored differently for women and men with chronic conditions who are at risk of mobility loss in the future, which may lead to reduced health care costs and economic burden of chronic conditions.

Funding

Joy MacDermid was supported by a Canadian Institutes of Health Research Chair in Gender, Work and Health and the Dr. James Roth Chair in Musculoskeletal Measurement and Knowledge Translation.

Conflict of interest

The authors report no conflicts of interest.

References

[1] Chronic diseases and health promotion [Internet]. [place unknown]: World Health Organization; [cited 2017 Jul 14]. Available from: http://www.who.int/chp/en/.

[2] WHO | Noncommunicable diseases [Internet]. [place unknown]: World Health Organization; [cited 2017 Jul 25]. Available from: http://www.who.int/mediacentre/factsheets/fs355/en/.

[3] Guralnik JM, LaCroix AZ, Abbott RD, et al. Maintaining mobility in late life. I. Demographic characteristics and chronic conditions. Am. J. Epidemiol. 1993;137:845–857.

[4] Melzer D, Gardener E, Guralnik JM. Mobility disability in the middle-aged: cross-sectional associations in the English Longitudinal Study of Ageing. Age Ageing. 2005;34:594–602.

[5] Guccione AA, Felson DT, Anderson JJ. Defining arthritis and measuring functional status in elders: methodological issues in the study of disease and physical disability. Am. J. Public Health. 1990;80:945–949.

[6] World Health Organization. International Classification of Functioning, Disability and Health: ICF. [place unkown]: World Health Organization; 2001.

[7] Ettinger WH, Davis MA, Neuhaus JM, et al. Long-term physical functioning in persons with knee osteoarthritis from NHANES. I: Effects of comorbid medical conditions. J. Clin. Epidemiol. 1994;47:809–815.

[8] Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. Ann. Rheum. Dis. 1998;57:649–655.

[9] Leveille SG, Fried L, Guralnik JM. Disabling symptoms: what do older women report? J. Gen. Intern. Med. 2002;17:766–773.

[10] Whitson HE, Landerman LR, Newman AB, et al. Chronic Medical Conditions and the Sex-based Disparity in Disability: The Cardiovascular Health Study. J. Gerontol. Ser. A. 2010;65A:1325–1331.

[11] Riediger ND, Clara I. Prevalence of metabolic syndrome in the Canadian adult population. Can. Med. Assoc. J. 2011;183:E1127–E1134.

[12] Oman D, Reed D, Ferrara A. Do elderly women have more physical disability than men do? Am. J. Epidemiol. 1999;150:834–842.

[13] Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J. Am. Geriatr. Soc. 2002;50:889–896.

[14] Ahmed T, Vafaei A, Auais M, et al. Gender Roles and Physical Function in Older Adults: Cross-Sectional Analysis of the International Mobility in Aging Study (IMIAS). PloS One. 2016;11:e0156828.

[15] WHO | Gender [Internet]. [place unknown]: World Health Organization; [cited 2017 Jun 6]. Available from: http://www.who.int/gender-equity-rights/understanding/gender-definition/en/.

[16] Sex, gender and health research guide: a tool for CIHR applicants [Internet]. Ottawa (ON): Canadian Institutes of Health Research (CIHR); [cited 2017 Jun 6]. Available from: http://www.cihr-irsc.gc.ca/e/32019.html.

[17] Heidari S, Babor TF, De Castro P, et al. Sex and Gender Equity in Research: rationale for the SAGER guidelines and recommended use. Res. Integr. Peer Rev. 2016;1:2.

[18] Doyal L. Sex, gender, and health: the need for a new approach. BMJ. 2001;323:1061–1063.

[19] Zunzunegui MV, Alvarado BE, Guerra R, et al. The mobility gap between older men and women: the embodiment of gender. Arch. Gerontol. Geriatr. 2015;61:140–148.

[20] Verbrugge LM. Gender and health: an update on hypotheses and evidence. J. Health Soc. Behav. 1985;26:156–182.

[21] Gove WR. Gender differences in mental and physical illness: the effects of fixed roles and nurturant roles. Soc. Sci. Med. 1982. 1984;19:77–91.

[22] Hibbard JH, Pope CR. Gender roles, illness orientation and use of medical services. Soc. Sci. Med. 1982. 1983;17:129–137.

[23] Verbrugge LM. Sex differences in complaints and diagnoses. J. Behav. Med. 1980;3:327–355.

[24] Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLOS Med. 2009;6:e1000097.

[25] Cohen J. A Coefficient of Agreement for Nominal Scales. Educ. Psychol. Meas. 1960;20:37–46.

[26] Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies - NHLBI, NIH [Internet]. Bethesda (MD): National Institutes of Health; [cited 2017 Aug 5].Available from: https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/cohort.

[27] Chen H, Guo X. Obesity and functional disability in elderly Americans. J. Am. Geriatr. Soc. 2008;56:689–694.

[28] Julien D, Gauvin L, Richard L, et al. Longitudinal associations between walking frequency and depressive symptoms in older adults: results from the VoisiNuAge study. J. Am. Geriatr. Soc. 2013;61:2072–2078.

[29] Vincent HK, Seay AN, Montero C, et al. Functional pain severity and mobility in overweight older men and women with chronic low-back pain--part I. Am. J. Phys. Med. Rehabil. 2013;92:430–438.

[30] Broadwin J, Goodman-Gruen D, Slymen D. Ability of fat and fat-free mass percentages to predict functional disability in older men and women. J. Am. Geriatr. Soc. 2001;49:1641–1645.

[31] Visser M, Langlois J, Guralnik JM, et al. High body fatness, but not low fat-free mass, predicts disability in older men and women: the Cardiovascular Health Study. Am. J. Clin. Nutr. 1998;68:584–590.

[32] Vasconcelos KS de S, Dias JMD, Bastone A de C, et al. Handgrip Strength Cutoff Points to Identify Mobility Limitation in Community-dwelling Older People and Associated Factors. J. Nutr. Health Aging. 2016;20:306–315.

[33] Yeom H-A, Baldwin CM, Lee M-A, et al. Factors affecting mobility in community-dwelling older Koreans with chronic illnesses. Asian Nurs. Res. 2015;9:7–13.

[34] Ayis S, Gooberman-Hill R, Bowling A, et al. Predicting catastrophic decline in mobility among older people. Age Ageing. 2006;35:382–387.

[35] Yount KM, Hoddinott J, Stein AD. Disability and self-rated health among older women and men in rural Guatemala: The role of obesity and chronic conditions. Soc. Sci. Med. 1982. 2010;71:1418–1427.

[36] Boogaard S, Heymans MW, de Vet HCW, et al. Predictors of Persistent Neuropathic Pain--A Systematic Review. Pain Physician. 2015;18:433–457.

Figure 1 Flow chart of study selection based on selection criteria.

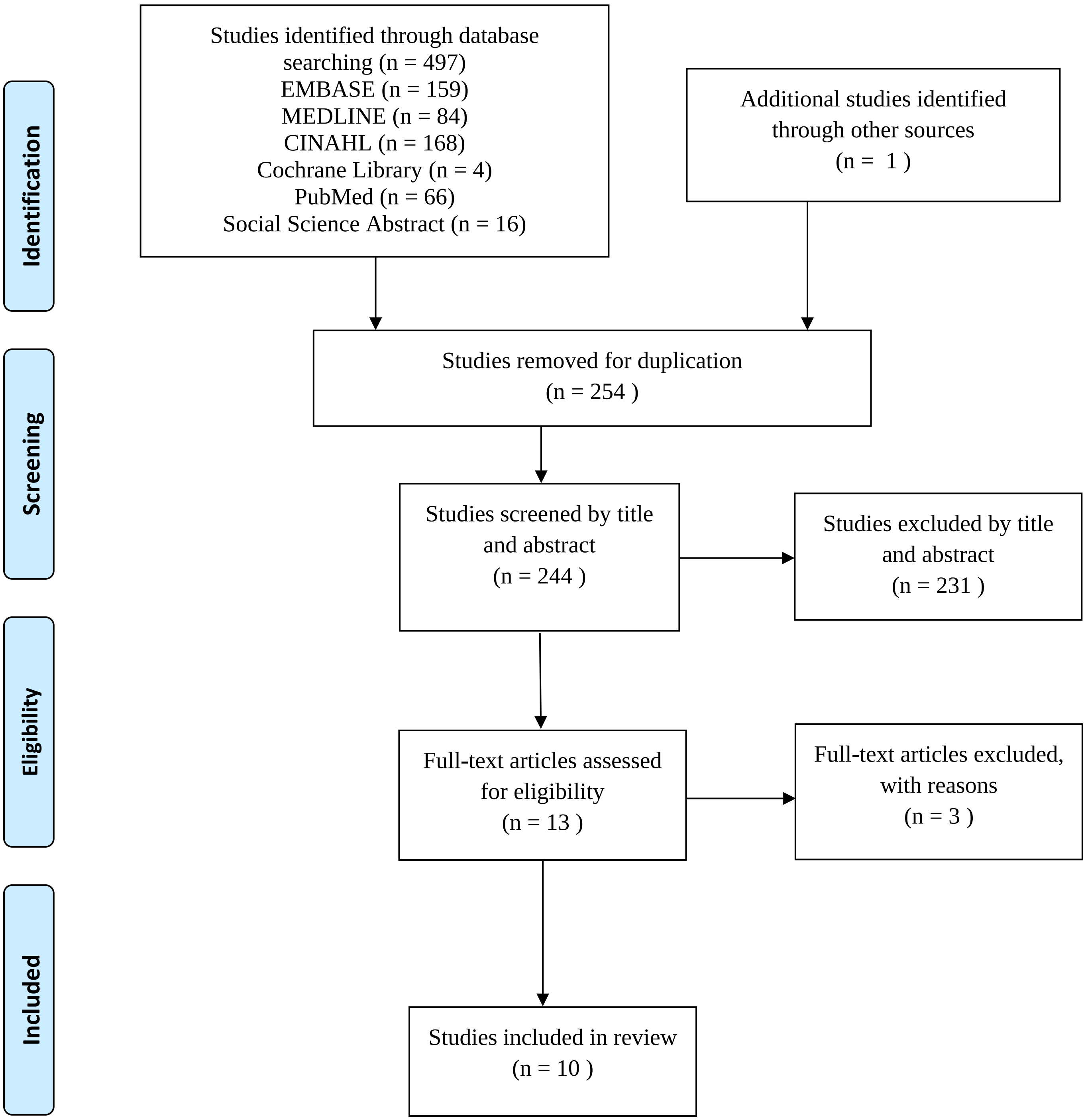

Table 1. Characteristics and main findings of included studies (N = 10).

Yount KM 2010 United States [35]	
Study design	Cross-sectional (data from the last wave of a cohort study)
Participants	N = 604 ; men: n = 255;42.2%; mean age ± SD: 66.5 ± 8.5; women: n = 349; 57.8%; mean age ± SD:62.5 ± 8.0
Research question (purpose)	To identify whether greater mobility disability and poorer self-rated health of older women in rural Guatemala were explained by gender differences in obesity and other chronic conditions.
Mobility outcomes	Difficulty with gross mobility (GM) assessed by self-reported difficulty in walking 500m without resting, standing and sitting for 2 hours, and bending down or kneeling
Covariates	Gender, age, socioeconomic and intellectual capital in childhood, height, social and economic capital in adulthood, BMI, chronic conditions
Statistical analysis	Ordinary least squares regression (OLS), logistic regression
Main Findings (β, OR, *p* value)	The proportion of women (72%) reporting mobility disability was significantly ($p < 0.001$) higher than men (58%). The mean score of mobility disability was also significantly ($p < 0.001$) higher in women (mean: 2.26; SD: 2.28) than in men (mean: 1.49; SD: 1.89). Chronic conditions positively predicted mobility disability in women (OR = 1.84, 95% CI: 1.37, 2.47), but not in men (OR = 1.22, 95% CI: 0.81, 1.84).
Chen H 2008 United States [27]	
Study design	Cross-sectional
Participants	Aged ≥ 60 (women: n = 1684; men: n = 1611)
Research question (purpose)	To examine whether abdominal obesity, defined as body mass index (BMI) and waist circumference, was associated with functional disabilities in elderly American adults, and whether the presence of chronic conditions could explain the associations between obesity and disability.
Mobility outcomes	Self- reported lower extremity mobility (LEM) disability (questionnaire items covered locomotion and transfers)
Covariates	Age, sex, ethnicity, education, physical activity level, smoking, alcohol consumption, chronic conditions
Statistical analysis	Logistic regression
Main Findings (β, OR, *p* value)	BMI and waist circumference was found to be associated with higher prevalence of lower extremity mobility disability in women compared to men. Women with highest quartiles of BMI (≥ 31.4kg/m^2) and waist circumference (≥ 104.2 cm) had an odds ratios of 4.3 (95% CI:3.0, 6.2; $p < 0.001$) and 4.8 (95% CI:3.4, 6.9; $p < 0.001$) in lower extremity mobility disability, respectively. In comparison, moderate relationships were identified in men, in which men with highest quartiles of BMI (≥ 30.1kg/m^2) and waist circumference (≥ 109.7 cm) had odds ratios of 1.5 (95% CI:1.0, 2.3; $p = 0.01$) and 1.8 (95% CI:1.2, 2.7; $p = 0.001$) in lower extremity mobility disability, respectively.

Julien D 2013 Canada [28]	
Study design	Longitudinal cohort; four repeated measures over 5 years
Participants	N = 498; mean age ± SD:74.64 ± 4.08; men: n = 236; 47.4%; mean age ± SD: 74.40 ± 3.97; women: n = 262; 52.6%; mean age ± SD:74.86 ± 4.18
Research question (purpose)	To examine the associations between the two variables of depressive symptoms and walking in urban-dwelling elderly adults and identify the stronger predictor between the variables on each other.
Mobility Outcomes	Number of walking days over a past week (Physical Activity Scale for the Elderly)
Covariates	Age, sex, education, and number of chronic conditions
Statistical analysis	Cross-lagged panel analyses
Main Findings (β, OR, *p* value)	Depressive symptoms significantly predicted walking frequency in women but not in men ($p < 0.01$). In the subsample of women, a severe depression symptom was associated with less walking days ($p < 0.01$).
Visser M 1998 United States [31]	
Study design	Longitudinal cohort; 3-year follow-up
Participants	N = 5201; women: n = 2714;52.2% ; mean age ± SD: 72.4 ± 5.4; men: n = 2095; 40.3%; mean age ± SD:73.4 ± 5.7
Research question (purpose)	To identify whether high fat mass and low fat-free mass are associated with an increased risk of disability.
Mobility outcomes	Mobility-related disability was assessed by self-report on the difficulty of completing two tasks: walking 0.5 miles and walking up 10 steps
Covariates	Physical activity, recent weight loss, education level, smoking, alcohol use, depression, edema, chronic conditions
Statistical analysis	Logistic regression analysis
Main Findings (β, OR, *p* value)	At baseline, fat mass was found to be positively associated with mobility disability. In the highest quintile of fat mass, women were 3.04 times (95% CI: 2.18, 4.25) more likely to be mobility disabled compared to those in the lowest quintile, and men were 2.77 times (95% CI: 1.82, 4.23) more likely, after adjusting for all covariates. Women and men reported similar results for mobility disability in the lowest quintile of fat-free mass compared with being in the highest quintile, with ORs of 0.79 (95% CI: 0.57, 1.08) and 0.79 (95% CI: 0.53, 1.18), respectively. After 3 years, men and women with the greater fat mass (highest quintile) were more likely to develop mobility disability than those with the least fat mass (lowest quintile). Women had an odds ratio of 2.83 (95% CI: 1.80, 4.46) and men had an odds ratio of 1.72 (95% CI: 1.03, 2.85). Being in the lowest quintile of fat-free mass was found to be a predictor of mobility disability for women, but not for men. The odds ratios was 0.57 (95% CI:

	0.38, 0.88) for women and 0.97 (95% CI: 0.58, 1.60) for men.
Vasconcelos KS 2016 Brazil [32]	
Study design	Cross-sectional
Participants	N = 1374; mean age ± SD: 73.4 ± 6.4; women: n = 885; 64.4%; men: n = 489; 35.6%
Research question (purpose)	To identify the best cut-off point of handgrip strength for mobility limitation, and to investigate the factors associated with muscle weakness and mobility limitation in elderly community-dwelling adults.
Mobility outcomes	Mobility limitation assessed by gait speed of ≤ 0.8 m/s)
Covariates	Gender, age, marital status, paid work status, years of education, family income, smoking, consumption of alcohol, physical activity, BMI, waist circumference, percentage of body fat, health conditions, use of health services, disability
Statistical analysis	Receiver operating characteristic curves (ROC), ANOVA, Pearson chi-square tests, multivariate analysis
Main Findings (β, OR, *p* value)	There was two-fold of the odds of mobility limitation (OR = 2.09, 95% CI: 1.27, 3.43, $p = 0.003$) and slightly higher prevalence of muscle weakness related to mobility limitation (OR = 1.55, 95% CI: 1.02, 2.36, $p = 0.039$) in women than men.
Yeom HA 2015 South Korea [33]	
Study design	Cross-sectional
Participants	N = 384; male: n = 94; 24.5%; female: n = 290; 75.5%; mean age ± SD: 74 ± 5.82
Research question (purpose)	To determine the relationships of mobility with sleep patterns, physical activity and symptoms such as fatigue and pain in community-dwelling elderly Koreans with chronic illness as well as to describe their overall levels of mobility.
Mobility outcomes	6-minute walk test distance (6MWT)
Covariates	Sex, age, religion, education, monthly income, number of family members, type and number of chronic conditions
Statistical analysis	Hierarchical regression, Pearson's correlation coefficients
Main Findings (β, OR, *p* value)	Women had a significant greater walking mobility than men (6MWT distance: women: mean ± SD: 217.85 ± 90.96; men: mean ± SD: 192.66 ± 98.35; $p = 0.023$).
Vincent HK 2013 United States [29]	
Study design	Cross-sectional
Participants	N = 55, aged 60-85 years *
Research question (purpose)	To determine whether older men and women with chronic low-back pain had differences in mobility and functional pain, across varying body mass index levels.
Mobility outcomes	Walking endurance, chair rise time, stair climb time, gait analysis (e.g. walking velocity, gait stride length, base of support, double support time), and daily step numbers

Covariates	Age, sex, race, back extensor strength, pain severity, and BMI
Statistical analysis	One-way analysis of variance (ANOVA),univariate analysis of variance, hierarchical regression, Wilcoxon's rank-sum tests, Pearson correlations
Main Findings (β, OR, *p* value)	Frequency of mobility (daily step numbers) was not significantly different between sexes for individuals with high body mass index (BMI > 25). Performance based measure of mobility (walking endurance, chair rise time, stair climb time, walking velocity, stride length, base of support, and double support time) was not significantly different between sexes in overweight and moderately obese groups ($p > 0.05$). However, within the severely obese group, significant difference ($p < 0.05$) was observed between sexes for the following mobility measures: (1) chair rise time in seconds (men: 1.0 ± 0.4; women 1.0 ± 0.3); (2) stair climb time in seconds (men: 4.5 ± 0.7; women 7.3 ± 3.7); (3) walking velocity in centimeter/seconds (men: 113 ± 17; women 97 ± 14); (4) stride length in centimeter (men: 132 ± 16; women 109 ± 17); (5) double support time in % (men: 33.5 ± 1.9; women 36.8 ± 4.7). There was also a significant BMI and sex interaction in base of support measure (men: 15.3 ± 4.8; women 11.0 ± 4.3).
Ayis S 2006 UK [34]	
Study design	Longitudinal cohort; 12 months
Participants	N = 531; mean age ± SD: 73.4 ± 6.4; 46.5% women
Research question (purpose)	To determine if severe decline in mobility in elderly adults can be predicted by chronic conditions, social psychological and environmental factors.
Mobility outcomes	Mobility was assessed by reported dependency in walking 400 yards, climbing up or down stairs, and getting on a bus)
Covariates	Socio-demographic factors and chronic health conditions
Statistical analysis	Logistic regression
Main Findings (β, OR, *p* value)	Mobility level was not significantly different between women and men (OR = 1.3, 95% CI: 04, 3.4) after one year follow up with adjustment for socio-demographic factors and health conditions.
Broadwin J 2001 United States [30]	
Study design	Cohort; baseline: 1988-1992; follow-up: 1992-1996
Participants	N = 1051; men: n = 417; mean age: 70.2; women: n = 634; mean age: 71.1
Research question (purpose)	To investigate whether percentage of mass (FM) and percentage of fat-free mass (FFM) can predict functional disability in elderly community-dwelling adults.
Mobility outcomes	Self-reported overall functional disability (walking two to three blocks, walking down 10 stairs, climbing up 10 stairs, reaching overhead, bending over, lifting 10 pounds, putting on socks, getting in and out of car, gait) and lower body functional disability (walking two to three blocks and climbing up 10 stairs)
Covariates	Age, current smoking, alcohol intake, hormone replacement in women, prevalent chronic disease, education,

	depression, and weight loss ≥10 pounds
Statistical analysis	Multiple logistic regression
Main Findings (β, OR, *p* value)	At baseline, women were more likely to report lower body and overall mobility disability than men (p = 0.001). There were no significant associations with fat-mass and fat-free mass for lower body mobility disability at baseline in both women and men (p > 0.05). However, overall mobility disability was significantly associated with fat-mass and fat-free mass in both sexes (p < 0.05). At follow-up, women in the highest quintile of fat percentage and lowest quintile of fat-free percentages was four times likely to develop overall mobility disability (OR = 3.8, 95% CI: 1.5, 9.6, p = 0.04; OR = 4.4, 95% CI: 1.8, 10.9, p = 0.01) and lower body mobility disability (OR = 3.9, 95% CI: 1.9, 8.1, p = 0.001; OR = 3.6, 95% CI: 1.8, 7.4, p = 0.0002). However, men were found to be four times more likely to develop lower mobility disability (OR = 4.0, 95% CI: 1.5, 10.3, p = 0.04; OR = 3.9, 95% CI: 1.5, 10.0, p = 0.04), but not overall mobility disability (OR = 2.6, 95% CI: 0.9, 7.3, p = 0.3; OR = 2.1, 95% CI: 0.8, 6.0, p = 0.1).
Zunzunegui MV 2015 Canada [19]	
Study design	Cross-sectional
Participants	N = 1995 ; age between 65 and 74 years*
Research question (purpose)	To present the study design and baseline results of the International Mobility in Aging Study (IMIAS) on physical performance and mobility differences based on gender in five radically different societies.
Mobility outcomes	Physical performance assessed by the short physical performance battery (SPPB), and self-reported mobility disability assessed by difficulty in walking 400m or climbing stairs without resting
Covariates	Age, education, income, chronic conditions, depression
Statistical analysis	Poisson regression, chi-square tests
Main Findings (β, OR, *p* value)	After adjusting for age, low physical performance was higher in women compared with men in Natal (PR = 1.67, 95% CI (1.14, 2.45)), Manizales (PR = 1.97, 95% CI (1.06, 3.65)) and Tirana (PR = 2.38, 95% CI (1.53, 3.69)), while there were no differences based on sex in the Saint-Hyacinthe (PR = 1.78, 95% CI (0.81, 3.87)) and Kingston (PR = 1.16, 95% CI (0.58, 2.33)). For all sites, self-reported mobility disability was more prevalent among women compared with men (Natal (PR = 2.25, 95% CI (1.75, 2.89)), Manizales (PR = 1.51, 95% CI (1.23, 1.87)) and Tirana (PR = 1.70, 95% CI (1.39, 2.08)), Saint-Hyacinthe (PR = 2.43, 95% CI (1.59, 3.70)), except Kingston where prevalence was equal among women and men (PR = 1.17, 95% CI (0.78, 1.75)). After adjusting for education and income, gender difference was non-significant for SPPB in Saint-Hyacinthe (PR = 1.50, 95% CI (0.67, 3.35)) and Manizales (PR = 1.87, 95% CI (0.99, 3.53)) (Natal (PR = 1.70, 95% CI (1.15, 2.50)), Tirana (PR = 2.03, 95% CI (1.31, 3.16)), and Kingston (PR = 1.16, 95% CI (0.56, 2.36)). There

	was low self-reported mobility scores in women than men in all sites, (Natal (PR = 2.16, 95% CI (1.68, 2.77)), Manizales (PR = 1.45, 95% CI (1.18, 1.79)) and Tirana (PR = 1.65, 95% CI (1.34, 2.02)), Saint-Hyacinthe (PR = 2.12, 95% CI (1.38, 3.25))), except at Kingston (PR = 1.15, 95% CI (0.76, 1.72)).
Note: SD: standard deviation; OR: odds ratio; β: coefficient; SE: standard error; CI: confidence interval; ANOVA: analysis of variance, PR: prevalence ratios; BMI: body mass index; SPPB: short physical performance battery; * refers to mean age and SD of participants were not reported by original paper.	

Table 2. Extent of compliance of the included studies with the SAGER guidelines**.**

	Title and abstract	Introduction	Methods	Results	Discussion
Yount KM 2010 [35]	+	+	-	+	+
Chen H 2008 [27]	+	-	-	+	-
Julien D 2013[28]	+	-	-	+	+
Visser M 1998 [31]	+	-	-	+	-
Vasconcelos KS 2016 [32]	+	-	-	+	+
Yeom HA 2015 [33]	+	-	-	+	+
Vincent HK 2013 [29]	+	-	-	+	-
Ayis S 2006 [34]	+	-	-	+	-
Broadwin J 2001[30]	+	-	-	+	-
Zunzunegui MV 2015 [19]	+	+	+	+	+

The Sex and Gender Equity in Research (SAGER) guidelines [17]
Title and abstract: Should specify the sex and gender of human participants.
Introduction: Whether sex and/or gender differences is expected.
Methods: Should report how sex and gender were taken into account in the design of the study.
Results: Data should be presented disaggregated by sex and gender.
Discussion: Potential implications of sex and gender on the study results/analyses should be discussed.
Note: + Met the guideline; -: Not met the guideline

Table 3. Summary of the methodological qualities of the included studies.

	Research question	Study population	Participation rate	Inclusion criteria	Sample size	Exposure prior to outcome	Sufficient timeframe	Different levels of exposure	Exposure measures	Multiple exposure assessment	Outcome measures	Blinding of outcome	Loss to follow-up	Potential confounding	Overall quality
Yount KM 2010 [35]	+	+	+	+	-	-	-	+	+	-	+	?	?	+	Fair
Chen H 2008 [27]	+	+	+	+	-	-	-	+	+	-	+	?	?	+	Fair
Julien D 2013[28]	+	+	+	+	-	-	+	+	+	+	+	?	-	+	Good
Visser M 1998 [31]	+	+	+	+	-	+	+	+	+	-	+	?	+	+	Good
Vasconcelos KS 2016 [32]	+	+	+	+	+	-	-	+	+	-	+	?	?	-	Poor
Yeom HA 2015 [33]	+	+	?	+	+	-	-	+	+	-	+	?	?	-	Poor
Vincent HK 2013 [29]	+	+	-	+	-	-	-	+	+	-	+	?	?	-	Poor
Ayis S 2006 [34]	+	?	+	+	-	+	+	+	+	-	+	?	+	+	Good
Broadwin J 2001[30]	+	+	+	+	-	-	+	+	+	-	+	?	?	+	Fair
Zunzunegui MV 2015 [19]	+	+	+	+	-	-	-	+	+	-	+	?	?	+	Fair

National Institutes of Health (NIH) quality assessment tool for observational cohort and cross-sectional studies

Note: **+**: Yes; **-** : No; **?**: cannot determine; not applicable; not reported

Appendix

EMBASE

1 exp prognosis/ (580677)

2 predict*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (1673975)

3 1 or 2 (2111081)

4 physical mobility/ (1875)

5 physical mobilit*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (2287)

6 ambulat* difficult*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (77)

7 difficult* walk*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (903)

8 mobilit*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (180532)

9 mobilit* limitation*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (1103)

10 walking difficulty/ (8390)

11 4 or 5 or 6 or 7 or 8 or 9 or 10 (187131)

12 exp chronic disease/ (172079)

13 chronic disease*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (208564)

14 chronic condition*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (17510)

15 chronic* ill*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (23112)

16 12 or 13 or 14 or 15 (231172)

17 exp gender/ (198127)

18 exp gender identity/ (14160)

19 gender identit*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (15224)

20 gender.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (429570)

21 gender role*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (2652)

22 gender stereotype*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (483)

23 gender difference*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (36510)

24 two-spirit.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (40)

25 gender-variant.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (72)

26 exp sexual minority/ (9726)

27 sexual minorit*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (1691)

28 transgender.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (3647)

29 man's role.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (28)

30 woman's role.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (47)

31 male.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (7464709)

32 female.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (7556412)

33 man.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (328925)

34 woman.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (296439)

35 exp "gender and sex"/ (828298)

36 sex role/ (4393)

37 sex difference/ (337373)

38 sex.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (869608)

39 sex role*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (5632)

40 sex difference*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word] (346215)

41 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 (10655066)

42 3 and 11 and 16 and 41 (203)

43 limit 42 to (english and last 20 years) (184)

44 limit 43 to (adult <18 to 64 years> or aged <65+ years>) (159)

MEDLINE

1 exp Prognosis/ (1384115)

2 predict*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1342109)

3 1 or 2 (2505183)

4 Mobility Limitation/ (3501)

5 mobilit* limitation*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (4037)

6 ambulat* difficult*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (53)

7 difficult* walk*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (543)

8 mobilit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (145316)

9 physical mobilit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (503)

10 4 or 5 or 6 or 7 or 8 or 9 (145781)

11 exp Chronic Disease/ (247665)

12 chronic disease*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (286077)

13 chronic* ill*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (21041)

14 chronic condition*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (13523)

15 11 or 12 or 13 or 14 (307843)

16 exp Gender Identity/ (17908)

17 gender identit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (18207)

18 gender role*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (2406)

19 gender stereotype*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (480)

20 gender difference*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (27119)

21 gender.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (266670)

22 gender-variant.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (59)

23 exp Sexual Minorities/ (1508)

24 two-spirit.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (29)

25 transgender.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (3169)

26 man's role*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (23)

27 woman's role*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (41)

28 male.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (7821347)

29 female.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (7912815)

30 man.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (273004)

31 woman.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (190327)

32 sexual minorit*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1657)

33 Sex/ (7730)

34 sex.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (725678)

35 sex role*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (1915)

36 sex difference*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (28494)

37 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 (10788261)

38 3 and 10 and 15 and 37 (341)

39 limit 38 to ("middle aged (45 plus years)" and (clinical trial, all or observational study) and last 20 years) (84)

Chapter 3: Secondary data-analysis study

Title: Mobility in community-dwelling adults with chronic Conditions: the contribution of age and sex

*This study will be submitted to European Journal of Aging

Abstract The purpose of this study was to determine whether age and sex predict self-reported and performance-based mobility-related outcomes in community-dwelling middle and older aged adults with chronic conditions; and if sociodemographic and comorbidity variables influences this relationship. Data from a randomized controlled trial that examined a rehabilitation intervention for persons with chronic conditions in primary care that showed no difference was used as the cohort (n =271) for this study. Data of the participants' characteristics at baseline (T1) and mobility outcomes assessed at 9-month follow-up (T3) were used. Independent variables were: age, sex, comorbidity, education level, income level, and marital status, and age and sex interaction term. The dependent variables were: Late Life Function and Disability Instrument (LLFDI) function component score, falls history, Short Form 36 Health Survey Questionnaire (SF-36) physical component score, two-minute walk distance, (Short Physical Performance Battery (SPPB)) balance, chair stand, 8-foot walk, and SPPB total score. Unadjusted regression models and multivariate regression analyses including linear, median, logistic and ordered logistic regression were performed to examine the relationship between independent and dependent variables. Older age and female sex predicted poorer self-reported mobility outcomes (LLFDI and SF-36). However, only older age predicted performance-based mobility-related outcomes including SPPB balance, chair stands, 8-foot walk, and total scores. Participants with more comorbidity, low income, and lived alone had more mobility limitation. The nature of the differences between males and females in self-reported mobility outcomes implicated gender differences, more than sex-differences. Our findings support the need for more mechanistic studies on the impacts of sex and gender on mobility.

Keywords age; sex; chronic conditions; mobility limitation; secondary analysis

Introduction

Chronic conditions are the major cause of disability and death worldwide (World Health Organization n.d.). In Canada, three in every five Canadian adults older than 20 years have a chronic condition and 88% of all Canadian deaths are the result of chronic conditions (World Health Organization n.d.; Betancourt et al. 2014). It has been well documented that chronic conditions such as diabetes, arthritis, stroke, and hypertension are common risk factors for developing mobility limitation (Verbrugge et al. 1991; Guralnik et al. 1993; Raina et al. 1998; Zhu et al. 1998; Volpato et al. 2002; Hung et al. 2012). A Canadian cross-sectional study (Raina et al. 1998) using data from the population-based Health and Activity Limitations Surveys (HALS) in 1986 (n = 2,484,800) and 1991 (n = 2,909,900) showed that approximately 30% of seniors (≥ 65 years old) reported at least one mobility limitation, and that arthritis/rheumatism was the most prevalent chronic conditions reported as the cause of mobility limitation. Heart disease (5.5% and 9.8% in 1986 and 1991), cerebrovascular disease (4.6% and 3.3% in 1986 and 1991), and fractures (2.6% and 5.3% in 1986 and 1991) were the next most prevalent conditions that caused mobility limitation (Raina et al. 1998).

Mobility has been defined as a person’s ability to move around independently, and is an essential characteristic of human functioning (Guralnik and Ferrucci 2003; Shumway-Cook et al. 2005). Mobility limitation typically refers to reporting difficulty in walking one-quarter mile or climbing one flight of stairs, and the inability to ambulate without significant difficulty or assistance (Simonsick et al. 2008). Mobility limitation is closely associated with social isolation, anxiety, depression (Iezzoni et al. 2001), decreased quality of life (Netuveli et al. 2006), falling, disability, institutionalization, and mortality (Guralnik et al. 1995; Ostir et al. 1998; Ahmed et al. 2016). As life expectancy has increased and older adults have the potential to be active for more years, mobility limitation continues to be a serious problem for older people and remains a crucial challenge for public health (Siren and Hakamies-Blomqvist 2009). A priority in the Canadian public health sector is maintaining and restoring mobility in older adults, and prevention is considered important in avoiding negative consequences arising from mobility limitation. In developing preventative interventions, sex should be considered as a factor where programs are tailored interventions for males and females, as there are differences in biological and physiological attributes, such as strength, between males and females. Strength is a major factor that helps explain the differences in mobility status between sexes, where females typically have lower muscle strength compared to males, resulting in females having slower walking and stair climbing speed, which is highly associated with mobility limitations (Leveille et al. 2000). A cross-sectional study (N = 1374) examined the relationships between muscle weakness (handgrip strength) and mobility limitation, and found two times greater odds of mobility limitation (OR = 2.09, 95% CI: 1.27, 3.43) and higher odds of muscle weakness related with mobility limitation (OR = 1.55, 95% CI: 1.02, 2.36) for community-dwelling older females than older males (Vasconcelos et al. 2016). Females live longer than males and often have higher prevalence of chronic conditions in older age, such as osteoarthritis, obesity, musculoskeletal diseases with pain, depression, and cancers of the cervix, which induces greater likelihood of mobility limitation for females (Urwin et al. 1998; Sonnenberg et al. 2000; Doyal 2001; Leveille et al. 2002; Djernes 2006; Yount et al. 2010; Whitson et al. 2010; Riediger and Clara 2011). As well, females also have a lower peak bone mass than males and a higher osteoporosis fracture risk with accelerated bone mineral density loss at menopause, resulting in females being more likely to develop mobility limitation (La Croix et al. 1997).

Additionally, there are other factors known to influence mobility limitation, including age, number of comorbidities, and socio-demographic factors such as level of education and income, and marital status. Mobility limitation is frequently linked to the normal aging process and advanced age is the primary risk factor for differences in mobility between males and females (Mahant and Stacy 2001; Melzer and Parahyba 2004; Allman et al. 2004; Shumway-Cook et al. 2005). The association between older age and diminished mobility function is often the result of biological changes with aging, such as, decreased muscle strength and bone mass, demineralization of bone, and joint erosion (Yeom et al. 2008). Comorbidities also contribute to mobility limitations in older adults and generally older people are often living with more than one chronic condition. A cross-sectional survey (N = 17,272) showed that among older community-dwelling adults with heart disease, those with six or more comorbidities had a significantly increased likelihood of limitations in mobility and activities of daily living (ADL) (Oldridge and Stump 2004). Level of education and income, and marital status have also been identified as influencing mobility limitation. A cross-sectional study (N=1,025; aged ≥ 65 years old) revealed that older adults with ≤ 5 years of total education have slower gait speed (1.16 vs 1.26m/s, $p <$ 0.0001) and lower Short Physical Performance Battery (SPPB) scores (9.55 vs 10.11, $p =$ 0.006) compared persons with ≥ 5 years of total education, after adjusting for age and sex (Coppin et al. 2006). Another cross-sectional analysis of a community survey (N=12,769; ≥ 65 years) showed that increasing mobility limitation was associated with having an annual income below $25,000 (OR=1.35, 95% CI:1.23, 1.47), having education less than high school level (OR=1.25, 95% CI:1.15, 1.36), and being unmarried (married OR=0.71, 95% CI:0.64, 0.80) (Shumway-Cook et al. 2005).

There are a large number of cross-sectional studies that have examined the associations between age and sex in relation to mobility limitation in the community-dwelling population. However, few studies have explored age and sex as predictors of mobility in middle and older aged community-dwelling adults with chronic conditions. Understanding the contribution that age and sex makes to mobility limitation will help researchers and clinicians identify the mobility risk trajectories that people experience and provide the potential for improved interventions tailored to males and females and different age groups.

The current study examined a cohort of community-dwelling participants with chronic conditions who participated in a randomized controlled trial (Richardson et al. 2010) where there were no statistically significant differences between rehabilitation intervention group and control group. The data were used to explore whether sex and age predicted mobility outcomes. The secondary analysis of data from this trial was conducted to examine the following two research questions:

(1) Do age and sex predict self-reported and performance-based mobility-related outcomes in community-dwelling middle and older aged adults with chronic conditions?

(2) Do other variables-comorbidity, education level, income level, and marital status-influence the predictive relationship between age and sex on mobility-related outcomes?

Methods

Sample

The sample included participants (n = 271) who completed a randomized controlled trial comparing a multi-component rehabilitation intervention to no intervention on the effectiveness of improving health status, reducing hospital admissions and emergency room visits in individuals with chronic conditions (Richardson et al. 2010). Further details of the study sample and methods have been described previously (Richardson et al. 2010). The inclusion criteria for participants in the trial were: community-dwelling adults ≥ 44 years, had at least one of the chronic conditions (back pain, diabetes, multiple sclerosis, stroke, Parkinson's disease, cardiovascular disease, chronic obstructive pulmonary disease, asthma, fibromyalgia, cancer, arthritis and obesity), had at least four visits to the family physician in the previous year, did not have dementia, and were not living in a long term care facility (Richardson et al. 2010). Information about the participants' chronic conditions was obtained via a questionnaire detailing a pre-specified list of chronic conditions. Participants were assessed on the outcome measures at three time points: baseline (T1), post intervention (6 months, T2), and at 9-month follow-up (T3). For this study, we used the socio-demographic data from baseline (T1) to describe the participant characteristics, and mobility outcomes assessed at 9-month follow-up (T3).

Measures

We selected only mobility outcomes to examine the predictive association of age and sex on mobility limitation, and the following outcome measures (self-reported and performance-based) were included: function component of the Late Life Function and Disability Instrument (LLFDI) (Boston University n.d.), fall history, physical component of the Short Form 36 Health Survey Questionnaire (SF-36) (Brazier et al. 1992), two-minute walk test (Connelly, DM, Stevenson, TJ, Vandervoort, AA 1996), the Short Physical Performance Battery (SPPB) (Guralnik et al. 1995).

Late Life Function and Disability Instrument (LLFDI)

The LLFDI is an instrument that assesses meaningful change in function and disability in community-dwelling older adults (Boston University n.d.).The function component of the LLFDI consists of 32-items that evaluate an individual's ability to do specific activities in daily routines (Boston University n.d.). Participants rate their difficulty in performing functional tasks on a 5-point Likert scale (5: no difficulty; 4: a little difficulty; 3: some difficulty; 2: quite a lot difficulty; 1: cannot do). Ratings are summed to obtain a total score that can range between 32 and 160, with higher score indicating better function. The LLFDI function component has high test-retest reliability (intra-class correlation coefficient (ICC) = 0.91-0.98) (Haley et al. 2002).

Fall history

Fall history was dichotomized as yes or no for the participants. Participants who indicated they had a fall in the past 9 months were considered to have a positive fall history.

Short Form 36 Health Survey Questionnaire (SF-36)

The SF-36 is a 36-item questionnaire which assess participant's health status in eight health domains: physical functioning, role limitations due to physical health problems, bodily pain, social functioning, general mental health, role limitations because of emotional problems, vitality, general health perceptions (Ware and Sherbourne 1992). Each domain of the SF-36 ranges from 0 (worst health) to 100 (best health) (Brazier et al. 1992). The SF-36 questionnaire has demonstrated good psychometric properties (Cronbach's alpha >0.85, reliability coefficient >0.75 for all domains except social functioning) in the primary care setting (Brazier et al. 1992). We only used the scores of physical functioning sub-scale of SF-36 questionnaire in this study.

Short Physical Performance Battery (SPPB)

The SPPB battery includes three tests: balance test, chair stand test, and 8-foot walk test. All tests are scored from 0 to 4, with a higher score representing higher level of physical performance (Guralnik et al. 1995).Correlations between observers for walking speed (≥ 0.93), and test-retest correlations for walking speed (≥ 0.89), repeated rising from a chair (0.73), and balance (0.97) have been reported in literature (Guralnik et al. 1995) . A summary score is obtained by adding the scores of each individual component test, and ranges from 0 to 12 (Guralnik et al. 1994).

Two-minute walk test

The two-minute walk test is an objective measure of functional mobility, gait, and aerobic capacity (Shirley Ryan AbilityLab 2013). Participants were asked to walk as far as possible (assistive devices can be used) in an obstacle-free environment for two minutes and the total distance walked is measured in meters (Shirley Ryan AbilityLab 2013). Good to high intrarater and interrater reliability (ICC: 0.82-0.89) has been documented in the frail elderly population in the literature (Connelly, DM, Stevenson, TJ, Vandervoort, AA 1996).

Data analysis

All statistical analyses were performed using STATA version 14.0 (StataCorp LLC n.d.). Statistical tests were two-tailed and the level of significance was set at $p < 0.05$.

Participant characteristics

Participant characteristics were summarized as means and standard deviations for continuous variables when normally distributed and as medians (including 1st and 3rd quartiles) when the distributions were skewed. Counts and percentages were used to summarize categorical variables. Chi-square tests of independence were used to assess the difference in the independent variables between sexes. To examine the differences between males and females on all dependent variables, continuous variables were compared using independent t-test or Wilcoxon rank sum test, and categorical variables were compared with Chi-square test.

Independent variables

We used the following independent variables: age, sex, comorbidity, level of education, income level, and marital status. Age was classified into four categories: between 44 and 53 years, between 54 and 63 years, between 64 and 73 years, and between 74 and 100 years. A comorbidity score was given by summing up the numbers of chronic conditions that participants had. Income level was categorized as less than $10k, $10 – $20k, $20 – $30k, $30 – $40k, $40 – $50k, ≥ $50k, ‘do not know’, and ‘declined to answer’.

Dependent variables

All mobility outcome measures were used as dependent variables. For each outcome measure, regression models were constructed. The dependent variables were as follows: LLFDI function component score, falls history, SF-36 physical component score, distance walked (two-minute walk test), balance score (SPPB), chair stand score (SPPB), 8-foot walk score (SPPB), and SPPB total score.

Unadjusted regression models

Unadjusted regression models were performed to determine if age and sex predicted mobility-related outcomes and the independent variables of age and sex and their interaction term (e.g. age*sex) were used. For all analysis, we used a backward selection strategy where the analysis began with a full model (age, sex and age*sex) and removed variables with $p > 0.05$

For continuous dependent variables (LLFDI function component score and two-minute walk distance), simple linear regression was conducted. We employed a natural logarithm transformation of the LLFDI function score due to violation of normality assumption. Linear regression assumptions of normality and homoscedasticity of variances were checked using the Shapiro-Wilk test and Breusch-Pagan test for heteroscedasticity, respectively. Regression diagnostics were performed using distributional diagnostic plots and Cook's distance > 4/n (Rule of thumb guideline). Multicollinearity between age and sex was checked using the variance inflation factor (VIF) and VIF > 10 indicated presence of multi-collinearity (O'brien 2007). Outliers were identified through regression diagnostics and three outliers were dropped for two-minute walk distance because of the violation of homogeneity assumption. Median regression analyses were used for the two other continuous dependent variables (SF-36 physical component score and SPPB total score) due to violations of skewness of data and the assumptions of linear regression. For categorical (fall history) and ordinal (SPPB balance, chair stands, and 8-foot walk scores) dependent variables, logistic regression was employed.

Multivariate analyses

To determine whether other variables (comorbidity, education level, income level, and marital status) influenced the predictive relationship between age and sex on mobility-related outcomes, multivariate regression analyses were performed. The independent variables used were age, sex, comorbidity, education, income, marital status, and the interaction term between age and sex (e.g. age*sex). For all analyses, we used a backward selection strategy where we started with a full model (all independent variables included) and removed variables with $p > 0.05$.

We used linear regression for the natural logarithm of LLFDI function component score, and the two-minute walk distance. Regression diagnostics as described earlier were computed to assess for assumptions. Median regression analyses for the SF-36 physical component score and the SPPB total score were conducted. For categorical (fall history) and ordinal (balance, chair stands, and 8-foot walk scores) dependent variables, multivariate logistic regression was conducted.

Results

Participant characteristics

Participant characteristics at baseline (T1) (N = 271) are shown in **Table 1**. The mean age for females was 63.79 years (standard deviation; SD =11.48 years), and 64.39 years (SD = 11.46 years) for males. Education and income level and marital status were statistically different between males and females (p <0.05), females had lower education and income level, and more females were lived alone compared to males. Sex differences on mobility-related outcomes at T3 are displayed in **Table 2**.

Table 1 Baseline participant characteristics by sex (N = 271)

Variables	Female (n; %)	Male (n; %)	χ2	P value
Sex	178 (65.68%)	93 (34.32%)		
Age group				
44 - 53	47 (26.40%)	20 (21.51%)		
54 - 63	52 (29.21 %)	29 (31.18%)	0.91	0.82
64 - 73	33 (18.54%)	17 (18.28%)		
74 - 100	46 (25.84%)	27 (29.03%)		
Comorbidity (number of chronic conditions)				
0	2 (1.12%)	1 (1.08%)		
1	14 (7.87%)	9 (9.68%)		
2	26 (14.61%)	16 (17.20%)		
3	46 (25.84%)	15 (16.13%)		
4	27 (15.17%)	14 (15.05%)		
5	26 (14.61%)	12 (12.90%)	9.19	0.52
6	17 (9.55%)	11 (11.83%)		
7	7 (3.93%)	9 (9.68%)		
8	6 (3.37%)	1 (1.08%)		
9	4 (2.25%)	4 (4.30%)		
10	3 (1.69%)	1 (1.08%)		
Education				
Some elementary	7 (3.93%)	1 (1.08%)		
Completed elementary	18 (10.11%)	2 (2.15%)		
Some secondary	41 (23.03%)	21 (22.58%)		
Completed secondary	44 (24.72%)	13 (13.98%)		
Some college	18 (10.11%)	14 (15.05%)	17.93	0.01*
Completed college	25 (14.04%)	18 (19.35%)		
Some university	12 (6.74%)	9 (9.68%)		
Completed university	13 (7.30%)	15 (16.13%)		
Income				
< 10k	2 (1.12%)	1 (1.08%)		
10k - 20k	28 (15.73%)	7 (7.53%)		
20k - 30k	31 (17.42%)	9 (9.68%)		
30 - 40k	19 (10.67%)	12 (12.90%)	18.41	0.01*
40 - 50k	17 (9.55%)	9 (9.68%)		
> 50k	44 (24.72%)	42 (45.16%)		
Do not know	25 (14.04%)	5 (5.38%)		
Declined to answer	12 (6.74%)	8 (8.60%)		
Marital Status				
Married once	82 (46.07%)	59 (63.44%)		
Living together	4 (2.25%)	2 (2.15%)		
Separated	6 (3.37%)	2 (2.15%)	16.04	0.01*
Divorced	22 (12.36%)	3 (3.23%)		
Widowed	46 (25.84%)	12 (12.90%)		
Remarried	15 (8.43%)	12 (12.90%)		
Never remarried	3 (1.69%)	3 (3.23%)		

*p values are significant ($p < 0 .05$)

Table 2. Differences in mobility related outcomes at 9-month follow-up (T3) by sex.

	Females				Males				
Outcome measure	n	Mean (SD)	Median (1st, 3rd quartile)	Min, Max	n	Mean (SD)	Median (1st, 3rd quartile)	Min, Max	p-value
LLFDI (function component)	178	58.95 (12.05)	58.55 (49.10, 66.16)	37.99, 90.34	93	67.37 (16.30)	63.97 (53.48, 77.50)	38.34, 100.00	< 0.001*
SF-36 (physical component)	177	61 (28)	65 (40, 85)	5, 100	93	69 (29)	80 (45, 95)	5, 100	0.02*
2-minute walk test	166	119.7 (38.8)	119.8 (90.6, 143.1)	28.3, 236.4	83	136.7 (42.0)	136.4 (107.0, 157.0)	36.6, 252.5	< 0.001*
SPPB Total score	177	9.12 (3.13)	10 (7, 12)	0, 12	93	9.33 (3.39)	11 (8, 12)	0, 12	0.36
Balance score (SPPB)	177	3.37 (1.11)	4 (3,4)	0, 4	93	3.35 (1.17)	4 (3, 4)	0, 4	0.40
Chair stands score (SPPB)	177	2.41 (1.50)	3 (1, 4)	0, 4	93	2.70 (1.44)	3 (2, 4)	0, 4	0.57
8-foot walk score (SPPB)	177	3.34 (1.04)	4 (3, 4)	0, 4	93	3.28 (1.19)	4 (3, 4)	0, 4	0.78
Falls history, n (%)									
Yes	53				19				0.10
No	122				72				

LLFDI: Late life function disability instrument; SF-36: Short Form 36 health survey questionnaire; SPPB: Short physical performance battery; SD: standard deviation
**p* values are significant *(p <0 .05)*

Unadjusted regression models

Table 3 shows the unadjusted regression models results for continuous dependent variables. For regression Model 1 to Model 4, the interaction term between age and sex (e.g. age*sex) was not significant predictor. Age and sex were significant predictors of LLFDI function component score [Model 1, F (4, 266) = 15.29, $p < 0.0001$, $R^2 = 0.19$], however, only the age category of 74-100 years was statistically significant. Three outliers were removed for two-minute walk distance since the homogeneity assumption was not met. After removing outliers, age category of 64-73 years, 74-100 years and sex were predictors for two-minute walk distance [Model 2, F (4, 241) = 18.66, $p < 0.0001$, $R^2 = 0.24$]. For SF-36 physical component score, age category of 74-100 years and sex were statistically significant predictors [Model 3, $R^2 = 0.11$]. Only age category 74-100 years was the variable to significantly predict SPPB total score [Model 4, $R^2 = 0.11$].

Table 4 shows the unadjusted regression models results for categorical and ordinal dependent variables. For regression Model 5 to Model 8, there was no interaction detected between age and sex (e.g. age*sex). Neither age nor sex were significant predictors for fall history [Model 5, $\chi2 = 3.01$, $p = 0.56$ with $df = 4$]. Age predicted balance score (SPPB) [Model 6, $\chi2 = 33.95$, $p < 0.0001$ with $df = 4$], and the age category of 64-73 years and 74-100 years were significant predictors. For chair stands (SPPB) [Model 7, $\chi2 = 30.15$, $p < 0.0001$ with $df = 4$], age category of 74-100 years was the only significant predictor. Age category of 54-63 and 74-100 years significantly predicted 8-foot walk (SPPB) score [Model 8, $\chi2 = 37.80$, $p < 0.0001$ with $df = 4$].

Multivariate analyses

Multivariate analyses shows that different variables influenced the predictive relationship between age and sex on mobility-related outcomes (**Table 5** and **Table 6**). For LLFDI function component score, sex, comorbidity, and marital status (widowed) were significant predictors [Model 9, $F (4, 266) = 37.45$, $p < 0.0001$, $R^2 = 0.36$]; a significant ($p <0.001$) age and sex interaction (age*sex: age category 74-100 years with male) was also found. Persons who were female sex had more comorbidity, widowed, and older males had lower LLFDI function score. Age category 74-100 years, sex, comorbidity, income level ($20k-$30k and 'do not know'), and marital status (never married) were predictors for two-minute walk distance [Model 10, $F (7, 241) = 17.76$, $p < 0.0001$, $R^2 = 0.34$]; the interaction between age and sex (age*sex: age category 64-73 years with male) was found to be significant ($p = 0.008$). Older participants with female sex, had more comorbidity, low income, never married, and older males walked shorter in two-minute walk distance. The predictors for SF-36 physical component score were sex, comorbidity, income level ($10k-$20k) and education level (some university) [Model 11, $R^2 = 0.22$]. People with female sex, had more comorbidity, low income, and high education level (some university) had a poorer SF-36 physical component score. Age category 74-100 years, comorbidity, and income level ($10k-$20k) were the variables that predicted SPPB total score [Model 12, $R^2 = 0.19$]. Older participants had more comorbidity, and low income had poorer SPPB total score.

The age and sex interaction (age*sex) term was not significant for any of the four dependent variables (fall history, balance score (SPPB), chair stands score (SPPB), and 8-foot walk score (SPPB)). None of the independent variables were strong predictors for fall history [Model 13, (result was not shown here)]. Females and males had similar fall history in the past 9 months. Age categories 64-73 years and 74-100 years, comorbidity, and income level ($10k-$20k, $20k-$30k and 'declined to answer') were the variables which predicted balance score (SPPB) [Model 14]. For chair stands score (SPPB), age category 74-100 years, comorbidity, and income level ($10k-$20k, $20k-$30k) were statistically significant predictors. Age category 74-

100 years, comorbidity, income level ($20k-$30k and 'do not know') were three significant variables in predicting 8-foot walk score (SPPB) [Model 15]. Older people had more comorbidity, low income had poorer performance in balance (SPPB), chair stands (SPPB), and 8-foot walk (SPPB).

Table 3. Unadjusted regression models of continuous dependent variables.

Dependent variable	Independent variable	β	95% CI	SE	*p*-value
ln (LLFDI function component score) <u>Model 1</u>	**Age 44-53 (reference)**				
	54-63	-0.01	-0.08, 0.05	0.03	0.73
	64-73	-0.05	-0.13, 0.02	0.04	0.18
	74-100	-0.19	-0.25, -0.12	0.03	< 0.001*
	Sex	0.13	0.08, 0.18	0.03	< 0.001*
	F (4, 266) = 15.29, $p < 0.0001$, $R^2 = 0.19$				
Two Minute walk test <u>Model 2</u>	54-63	-6.63	-18.21, 4.95	5.88	0.26
	64-73	-19.76	-32.76, -6.77	6.60	0.003*
	74-100	-43.84	-55.90, -31.78	6.12	< 0.001*
	Sex	18.99	9.81, 28.17	4.66	< 0.001*
	F (4, 241) = 18.66, $p < 0.0001$, $R^2 = 0.24$				
SF-36 (physical component score) <u>Model 3</u>	54-63	5	-8.97, 18.97	7.10	0.48
	64-73	0	-15.79, 15.79	9.02	1.00
	74-100	-30	-44.31, -15.69	7.27	< 0.001*
	Sex	15	4.20, 25.80	5.48	0.007*
	$R^2 = 0.11$				
SPPB Total score <u>Model 4</u>	54-63	0	-1.18, 1.18	0.60	1.00
	64-73	0	-1.34, 1.34	0.68	1.00
	74-100	-4	-5.22, -2.78	0.62	< 0.001*
	Sex	0	-0.92, 0.92	0.47	1.00
	$R^2 = 0.11$				

LLFDI: Late life function disability instrument; SF-36: Short form 36 health survey questionnaire; SPPB: short physical performance battery; β: standardized regression coefficient; CI: confidence interval ; SE: standard error
**p* values are significant *(p <0 .05)*

Table 4. Unadjusted regression models of categorical and ordinal dependent variables.

Dependent variable	Independent variable	Odds ratio	95% CI	SE	*p*-value
Fall history	**Age 44-53 (reference)**				
Model 5	54-63	1.15	0.55, 2.42	0.44	0.71
	64-73	1.04	0.45, 2.41	0.45	0.93
	74-100	1.18	0.55, 2.54	0.46	0.66
	Sex	0.60	0.33, 1.10	0.18	0.10
	$\chi 2 = 3.01$, $p = 0.56$ with $df = 4$				
Balance score (SPPB) Model 6	54-63	0.67	0.27, 1.64	0.31	0.38
	64-73	0.31	0.12, 0.76	0.14	0.01*
	74-100	0.14	0.06, 0.32	0.06	< 0.001*
	Sex	0.98	0.56, 1.71	0.28	0.95
	$\chi 2 = 33.95$, $p < 0.0001$ with $df = 4$				
Chair stands score (SPPB) Model 7	54-63	0.72	0.39, 1.31	0.22	0.28
	64-73	0.62	0.31, 1.21	0.21	0.16
	74-100	0.22	0.12, 0.40	0.07	< 0.001*
	Sex	1.55	0.98, 2.47	0.37	0.06
	$\chi 2 = 30.15$, $p < 0.0001$ with $df = 4$				
8-foot walk score (SPPB) Model 8	54-63	0.46	0.21, 0.99	0.18	0.046*
	64-73	0.48	0.20, 1.15	0.21	0.10
	74-100	0.12	0.06, 0.27	0.05	<0.001*
	Sex	1.00	0.59, 1.68	0.27	0.99
	$\chi 2 = 37.80$, $p < 0.0001$ with $df = 4$				

SPPB: short physical performance battery; OR: odds ratio; CI: confidence interval ; SE: standard error
**p* values are significant *(p <0 .05)*

Table 5. Multivariate regression analyses of continuous dependent variables.

Variables	ln (LLDFI)	Two-minute walk distance	SF-36	SPPB Total score
	Model 9	Model 10	Model 11	Model 12
Age 44-53 (reference)				
74-100		-26.68		-2
β (95%CI)		(-37.22, -16.15)		(-2.85, -1.15)
SE		5.35		0.43
p-value		< 0.001*		< 0.001*
Sex				
Male	0.16	21.57	11.67	
β (95%CI)	(0.11, 0.22)	(11.82, 31.32)	(4.15, 19.18)	
SE	0.03	4.95	3.82	
p-value	< 0.001*	< 0.001*	0.002*	
Comorbidity				
β (95%CI)	-0.04	-6.23	-6.67	-0.5
	(-0.05, -0.03)	(-8.36, -4.11)	(-8.34, -4.99)	(-0.68, -0.32)
SE	0.005	1.08	0.85	0.09
p-value	< 0.001*	< 0.001*	< 0.001*	< 0.001*
Income < 10k (reference)				
10k-20k			-16.67	-2
β (95%CI)			(-27.39, -5.94)	(-3.09, -0.91)
SE			5.45	0.55
p-value			0.002*	< 0.001*
20k-30k		-12.78		
β (95%CI)		(-25.32, -0.25)		
SE		6.36		
p-value		0.046		
Do not know		-15.28		
β (95%CI)		(-29.15, -1.41)		
SE		7.04		
p-value		0.031*		
Education some elementary (reference)				

Some university			-13.33	
β (95%CI)			(-26.60, -0.07)	
SE			6.74	
p-value			0.049*	
Marital status married once (reference)				
Widowed	-0.09			
β (95%CI)	(-0.15, -0.04)			
SE	0.03			
p-value	0.001*			
Never married		-31.73		
β (95%CI)		(-59.13, -4.33)		
SE		13.91		
p-value		0.023		
Interaction (age*sex)				
64-73*male		-25.34		
β (95%CI)		(-44.06, -6.63)		
SE		9.50		
p-value		0.008*		
74-100*male	-0.15			
β (95%CI)	(-0.24, -0.07)			
SE	0.04			
p-value	< 0.001*			
Overall model				
R^2	0.36	0.34	0.22	0.19
Adjusted R^2	0.35	0.32		
F statistics	F (4, 266) = 37.45	F(7, 241) = 17.76		
p-value	< 0.0001*	< 0.0001*		

LLFDI: Late life function disability instrument; SF-36: Short form 36 health survey questionnaire; SPPB: short physical performance battery; β: standardized regression coefficient; CI: confidence interval ; SE: standard error

**p* values are significant *(p <0 .05)*

Table 6. Multivariate regression analyses of categorical and ordinal dependent variables.

Variables	Balance (SPPB) Model 13	Chair stands (SPPB) Model 14	8-foot walk (SPPB) Model 15
Age 44-53 (reference)			
64-73 OR (95%CI)	0.45 (0.21, 0.96)		
SE	0.17		
p-value	0.04*		
74-100 OR (95%CI)	0.32 (0.16, 0.61)	0.47 (0.28, 0.80)	0.39 (0.22, 0.69)
SE	0.11	0.13	0.11
p-value	0.001*	0.005*	0.001*
Comorbidity OR (95%CI)	0.74 (0.65, 0.85)	0.73 (0.65, 0.81)	0.71 (0.63, 0.82)
SE	0.05	0.04	0.05
p-value	< 0.001*	< 0.001*	< 0.001*
Income < 10k (reference)			
10k-20k OR (95%CI)	0.37 (0.17, 0.78)	0.37 (0.19, 0.71)	
SE	0.14	0.12	
p-value	0.009	< 0.001*	
20k-30k OR (95%CI)	0.45 (0.21, 0.97)	0.43 (0.22, 0.81)	0.34 (0.17, 0.68)
SE	0.18	0.14	0.12
p-value	0.04*	0.01*	0.002*
Do not know OR (95%CI)			0.34 (0.16, 0.71)
SE			0.13
p-value			0.004*
Declined to answer OR (95%CI)	0.34 (0.14, 0.85)		

SE	0.16		
p-value	0.02*		
Overall model			
$\chi 2$	63.62	71.02	73.36
df	6	4	4
Pseudo R^2	0.12	0.09	0.12
p-value	< 0.0001*	< 0.0001*	< 0.0001*

SPPB: short physical performance battery; OR: odds ratio; CI: confidence interval ; SE: standard error
**p* values are significant *(p <0 .05)*

Discussion

This study determined that community-dwelling older females (ages 74-100 years) with chronic conditions had poorer two-minute walk distance, self-reported SF-36 physical function subscale score and LLFDI function component score. However, only older age (ages 74-100 years) was associated with performance-based mobility-related outcomes SPPB balance, chair stands, 8-foot walk, and SPPB total score. Socio-demographic and comorbidity variables also influenced the predictive relationship between age and sex on different mobility-related outcomes in varying degrees. People who had more comorbidity, low income, and lived alone (widowed or never married) had more mobility limitation. Furthermore, females had poorer self-reported mobility functions (i.e. LLFDI and SF-36), but had similar mobility function in performance-based outcomes such as fall history, balance, chair stands, 8-foot walk, SPPB total score than males.

A possible explanation for why females had poorer self-reported outcomes, but were not as dissimilar on physical performance measures may relate to reporting differences. Women more frequently acknowledge and report pain and discomfort than men (Verbrugge 1980; Hibbard and Pope 1983; Gove 1984; Verbrugge 1985), which may be due to differences in gender-expectations. However, men are more likely to tolerate physical discomfort (Verbrugge 1985) and have more difficulty in acknowledging their mobility limitation because of the social construction of masculinity (Doyal 2001). This can contribute to women overestimating and reporting more functional problems; while, men underestimate and report fewer functional problems (Merrill et al. 1997). In addition, perceptional differences for mobility limitations may be divergent depending on the person. One person's perception of "a lot' of difficulty for performing mobility activities may be another's perception of "some" difficulty and these disparities may result in the sex differences in self-reported mobility limitation (Merrill et al.

1997). The greater opportunity for lifetime physical activity for males may also result in higher level of functioning compared to females, which might lead to sex related differences in mobility limitation. Sociological factors such as roles traditionally carried out by women like caring for family members and doing domestic house work (Doyal 2001; Zunzunegui et al. 2015), may result in women having less opportunity for physical activity and exercise, which may subsequently result in poorer mobility function for women. The other possible explanation is that differences in self-reported mobility limitations between females and males may actually be due to different constructs and dimensions being measured in self-reported and performance-based measures (Reuben et al. 1995).The self-reported mobility outcomes used in this study not only measured mobility limitations, it also included limitations in activities of daily living, for example, the LLFDI functional component score (self-reported) included questions about difficulties in putting on and taking off long pants, and carrying something in both arms when climbing a flight of stairs. In contrast, the SPPB (performance-based) only measures lower extremity performance such as balance and walking speed. Therefore, the self-reported measures used are much broader and more inclusive of the various components of mobility than physical performance outcomes tested in a 'laboratory environment'.

The results of this study are consistent with a cross-sectional study (Established Populations for the Epidemiologic Study of the Elderly (EPESE), N = 1458) that compared self-reported (difficulty in doing heavy housework, walk up and down stairs, walk half a mile without help) and performance measures (balance, gait, chair stands, ability to rotate shoulders) of mobility limitations (Merrill et al. 1997). There was an increased risk for women compared to men in self-reported mobility limitations, unadjusted OR = 1.95 (95% CI: 1.66 - 2.27) (Merrill et al. 1997). Conversely, the results of participants with high education level (some university) had more mobility limitation are inconsistent with previous literature. However, the difference is marginally significant with $p = 0.049$, this result may be due to the high education participants have higher expectations in terms of their health status and mobility, therefore, they reported more mobility limitation which tested by SF-36 physical component score.

Our study showed older age and females had increased risk of self-reported mobility limitations, while increased age was the only predictor for performance-based mobility limitations. The fact that increasing age was consistently associated with poorer mobility outcomes suggests that exercise programs should adjust for age-related changes. The differences between males and females in mobility were not consistent across outcomes. Further the nature of the differences implicated gender differences, more than sex-differences. However, sex and gender are difficult to disentangle. Our findings support the need for more mechanistic studies on the impacts of sex and gender on mobility. Additionally, future studies should design prevention interventions for middle and older aged participants (more than 44 years), since persons more than 64 years old are the high risk group for developing mobility limitation. This will help those with chronic conditions to prevent and avoid mobility-loss risks to live a healthier life in their later life.

Study Limitations

First, a limitation associated with this secondary data analyses was that we could only stratify participants based on sex, and not gender. Recently, there is evidence to support that gender and sex are two distinct concepts, and gender also has influence on physical function in community-dwelling populations (Zunzunegui et al. 2015; Ahmed et al. 2016). A recent Canadian cross-sectional study (N= 1995) (Ahmed et al. 2016) examined the relationships between physical function and gender roles in community-dwelling older adults. The gender roles were classified using the 12-item Bem Sex Role Inventory (BSRI) into four categories which are: ‘androgynous’ (people who endorse high masculinity and femininity), ‘masculine’ (high in masculinity and low in femininity), ‘feminine’ (high in femininity and low in masculinity), and ‘undifferentiated’ (low in both) (Ahmed et al. 2016). Persons endorsing feminine (prevalence rate ratios (PRR) = 1.35, 95% CI: 1.15, 1.58) and undifferentiated gender roles (PRR) = 1.34, 95% CI: 1.15, 1.56) have higher prevalence of performance-based mobility disability (SPPB score < 8) compared to persons with androgynous role. There is no significant prevalence rate difference between people with masculine and androgynous roles in performance-based mobility disability. Future studies need to consider the influence of gender on mobility limitation and more assessment tools to identify participants’ characteristics in future rehabilitation research is warranted. Both sex and gender should be used as key variables whenever appropriate in research (Canadian Institutes of Health Research (CIHR) 2006). Secondly, in this study, we treated missing data as random and didn’t impute missing data. Further, there is a possibility of survivor bias that less healthy males had died. This may have affected the observed relationships.

Strengths

Despite the limitations, there are some strengths of this study. Although we only examined the sex differences in mobility, we also included some socially constructed variables such as participants’ income level, education level, and marital status which are reflective of gender, e.g. a set of socially constructed features and concepts of women and men (World Health Organization n.d.). Furthermore, there are limited studies that have used longitudinal data to examine whether age and sex and other socio-demographic variables are predictors for mobility limitation in adults with chronic conditions. Cross-sectional design studies cannot identify causation and the direction of the relationships of these variables with mobility limitation (Chen and Guo 2008; Vincent et al. 2013; Yeom et al. 2015; Vasconcelos et al. 2016).

Conclusion

Older age and female sex predicted poorer self-reported mobility-related outcomes, but there were no sex differences in mobility for most of the performance outcomes and only older age predicted performance-based mobility outcomes in community-dwelling middle and older aged adults with chronic conditions. People who had more comorbidity, low income level, and were widowed or never married had greater mobility limitations. Further the nature of the differences between males and females in self-reported mobility outcomes implicated gender differences, more than sex-differences. Our findings support the need for more mechanistic studies on the impacts of sex and gender on mobility. In addition, future studies can design prevention interventions for people more than 44 years old, since persons aged 64 years and older are the high risk group for developing mobility limitation.

Funding

Joy MacDermid was supported by a Canadian Institutes of Health Research Chair in Gender, Work and Health and the Dr. James Roth Chair in Musculoskeletal Measurement and Knowledge Translation.

Conflict of interest

The authors report no conflicts of interest.

References

Ahmed T, Vafaei A, Auais M, et al (2016) Gender Roles and Physical Function in Older Adults: Cross-Sectional Analysis of the International Mobility in Aging Study (IMIAS). PloS One 11:e0156828 . doi: 10.1371/journal.pone.0156828

Allman RM, Baker PS, Maisiak RM, et al (2004) Racial Similarities and Differences in Predictors of Mobility Change over Eighteen Months. J Gen Intern Med 19:1118–1126 . doi: 10.1111/j.1525-1497.2004.30239.x

Betancourt MT, Roberts KC, Bennett T-L, et al (2014) Monitoring chronic diseases in Canada: the Chronic Disease Indicator Framework. Chronic Dis Inj Can 34 Suppl 1:1–30

Boston University (n.d.) Late-Life Function & Disability Instrument™ | SPH | Boston University. In: Sch. Public Health. http://www.bu.edu/sph/about/school-wide-centers/health-and-disability-research-institute/outcome-measures/llfdi/. Accessed 17 Jul 2017

Brazier JE, Harper R, Jones NM, et al (1992) Validating the SF-36 health survey questionnaire: new outcome measure for primary care. BMJ 305:160–164

Canadian Institutes of Health Research (CIHR) (2006) Sex, gender and health research guide: a tool for CIHR applicants. In: Sex Gend. Health Res. Guide Tool CIHR Appl. http://www.cihr-irsc.gc.ca/e/32019.html. Accessed 6 Jun 2017

Chen H, Guo X (2008) Obesity and functional disability in elderly Americans. J Am Geriatr Soc 56:689–694 . doi: 10.1111/j.1532-5415.2007.01624.x

Connelly, DM, Stevenson, TJ, Vandervoort, AA (1996) Between- and within-rater reliability of walking tests in a frail elderly population. Physiother Can 48:47–51

Coppin AK, Ferrucci L, Lauretani F, et al (2006) Low socioeconomic status and disability in old age: evidence from the InChianti study for the mediating role of physiological impairments. J Gerontol A Biol Sci Med Sci 61:86–91

Djernes JK (2006) Prevalence and predictors of depression in populations of elderly: a review. Acta Psychiatr Scand 113:372–387 . doi: 10.1111/j.1600-0447.2006.00770.x

Doyal L (2001) Sex, gender, and health: the need for a new approach. BMJ 323:1061–1063

Gove WR (1984) Gender differences in mental and physical illness: the effects of fixed roles and nurturant roles. Soc Sci Med 1982 19:77–91

Guralnik JM, Ferrucci L (2003) Assessing the building blocks of function: utilizing measures of functional limitation. Am J Prev Med 25:112–121

Guralnik JM, Ferrucci L, Simonsick EM, et al (1995) Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med 332:556–561 . doi: 10.1056/NEJM199503023320902

Guralnik JM, LaCroix AZ, Abbott RD, et al (1993) Maintaining mobility in late life. I. Demographic characteristics and chronic conditions. Am J Epidemiol 137:845–857

Guralnik JM, Simonsick EM, Ferrucci L, et al (1994) A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 49:M85-94

Haley SM, Jette AM, Coster WJ, et al (2002) Late Life Function and Disability Instrument: II. Development and evaluation of the function component. J Gerontol A Biol Sci Med Sci 57:M217-222

Hibbard JH, Pope CR (1983) Gender roles, illness orientation and use of medical services. Soc Sci Med 1982 17:129–137

Hung WW, Ross JS, Boockvar KS, Siu AL (2012) Association of chronic diseases and impairments with disability in older adults: a decade of change? Med Care 50:501–507 . doi: 10.1097/MLR.0b013e318245a0e0

Iezzoni LI, McCarthy EP, Davis RB, Siebens H (2001) Mobility Difficulties Are Not Only a Problem of Old Age. J Gen Intern Med 16:235–243 . doi: 10.1046/j.1525-1497.2001.016004235.x

La Croix AZ, Newton KM, Leveille SG, Wallace J (1997) Healthy aging. A women’s issue. West J Med 167:220–232

Leveille SG, Fried L, Guralnik JM (2002) Disabling symptoms: what do older women report? J Gen Intern Med 17:766–773

Leveille SG, Resnick HE, Balfour J (2000) Gender differences in disability: evidence and underlying reasons. Aging Milan Italy 12:106–112

Mahant PR, Stacy MA (2001) Movement disorders and normal aging. Neurol Clin 19:553–563, vi

Melzer D, Parahyba MI (2004) Socio-demographic correlates of mobility disability in older Brazilians: results of the first national survey. Age Ageing 33:253–259 . doi: 10.1093/ageing/afh075

Merrill SS, Seeman TE, Kasl SV, Berkman LF (1997) Gender differences in the comparison of self-reported disability and performance measures. J Gerontol A Biol Sci Med Sci 52:M19-26

Netuveli G, Wiggins RD, Hildon Z, et al (2006) Quality of life at older ages: evidence from the English longitudinal study of aging (wave 1). J Epidemiol Community Health 60:357–363 . doi: 10.1136/jech.2005.040071

O’brien RM (2007) A Caution Regarding Rules of Thumb for Variance Inflation Factors. Qual Quant 41:673–690 . doi: 10.1007/s11135-006-9018-6

Oldridge NB, Stump TE (2004) Heart disease, comorbidity, and activity limitation in community-dwelling elderly. Eur J Cardiovasc Prev Rehabil Off J Eur Soc Cardiol Work Groups Epidemiol Prev Card Rehabil Exerc Physiol 11:427–434

Ostir GV, Markides KS, Black SA, Goodwin JS (1998) Lower body functioning as a predictor of subsequent disability among older Mexican Americans. J Gerontol A Biol Sci Med Sci 53:M491-495

Raina P, Dukeshire S, Lindsay J, Chambers LW (1998) Chronic conditions and disabilities among seniors: an analysis of population-based health and activity limitation surveys. Ann Epidemiol 8:402–409

Reuben DB, Valle LA, Hays RD, Siu AL (1995) Measuring physical function in community-dwelling older persons: a comparison of self-administered, interviewer-administered, and performance-based measures. J Am Geriatr Soc 43:17–23

Richardson J, Letts L, Chan D, et al (2010) Rehabilitation in a primary care setting for persons with chronic illness – a randomized controlled trial. Prim Health Care Res Amp Dev 11:382–395 . doi: 10.1017/S1463423610000113

Riediger ND, Clara I (2011) Prevalence of metabolic syndrome in the Canadian adult population. Can Med Assoc J 183:E1127–E1134 . doi: 10.1503/cmaj.110070

Shirley Ryan AbilityLab (2013) 2 Minute Walk Test. In: AbilityLab. https://www.sralab.org/rehabilitation-measures/2-minute-walk-test. Accessed 12 Nov 2017

Shumway-Cook A, Ciol MA, Yorkston KM, et al (2005) Mobility limitations in the Medicare population: prevalence and sociodemographic and clinical correlates. J Am Geriatr Soc 53:1217–1221 . doi: 10.1111/j.1532-5415.2005.53372.x

Simonsick EM, Newman AB, Visser M, et al (2008) Mobility limitation in self-described well-functioning older adults: importance of endurance walk testing. J Gerontol A Biol Sci Med Sci 63:841–847

Siren A, Hakamies-Blomqvist L (2009) Mobility and Well-being in Old Age: Top Geriatr Rehabil 25:3–11 . doi: 10.1097/TGR.0b013e31819147bf

Sonnenberg CM, Beekman AT, Deeg DJ, van Tilburg W (2000) Sex differences in late-life depression. Acta Psychiatr Scand 101:286–292

StataCorp LLC (n.d.) Stata 14 | Stata. http://www.stata.com/new-in-stata/. Accessed 25 May 2017

Urwin M, Symmons D, Allison T, et al (1998) Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. Ann Rheum Dis 57:649–655

Vasconcelos KS de S, Dias JMD, Bastone A de C, et al (2016) Handgrip Strength Cutoff Points to Identify Mobility Limitation in Community-dwelling Older People and Associated Factors. J Nutr Health Aging 20:306–315 . doi: 10.1007/s12603-015-0584-y

Verbrugge LM (1980) Sex differences in complaints and diagnoses. J Behav Med 3:327–355

Verbrugge LM (1985) Gender and health: an update on hypotheses and evidence. J Health Soc Behav 26:156–182

Verbrugge LM, Lepkowski JM, Konkol LL (1991) Levels of disability among U.S. adults with arthritis. J Gerontol 46:S71-83

Vincent HK, Seay AN, Montero C, et al (2013) Functional pain severity and mobility in overweight older men and women with chronic low-back pain--part I. Am J Phys Med Rehabil 92:430–438 . doi: 10.1097/PHM.0b013e31828763a0

Volpato S, Blaum C, Resnick H, et al (2002) Comorbidities and impairments explaining the association between diabetes and lower extremity disability: The Women's Health and Aging Study. Diabetes Care 25:678–683

Ware JE, Sherbourne CD (1992) The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 30:473–483

Whitson HE, Landerman LR, Newman AB, et al (2010) Chronic Medical Conditions and the Sex-based Disparity in Disability: The Cardiovascular Health Study. J Gerontol Ser A 65A:1325–1331 . doi: 10.1093/gerona/glq139

World Health Organization (n.d.) WHO | Chronic diseases and health promotion. In: Noncommunicable Dis. http://www.who.int/chp/en/. Accessed 4 Aug 2017a

World Health Organization (n.d.) WHO | Noncommunicable diseases country profiles 2014. In: WHO. http://www.who.int/nmh/countries/en/. Accessed 14 Jul 2017b

World Health Organization (n.d.) WHO | Gender. In: Gend. Equity Hum. Rights. http://www.who.int/gender-equity-rights/understanding/gender-definition/en/. Accessed 5 Aug 2017c

Yeom H-A, Baldwin CM, Lee M-A, Kim S-J (2015) Factors affecting mobility in community-dwelling older Koreans with chronic illnesses. Asian Nurs Res 9:7–13 . doi: 10.1016/j.anr.2014.09.005

Yeom HA, Fleury J, Keller C (2008) Risk factors for mobility limitation in community-dwelling older adults: a social ecological perspective. Geriatr Nurs N Y N 29:133–140 . doi: 10.1016/j.gerinurse.2007.07.002

Yount KM, Hoddinott J, Stein AD (2010) Disability and self-rated health among older women and men in rural Guatemala: The role of obesity and chronic conditions. Soc Sci Med 1982 71:1418–1427 . doi: 10.1016/j.socscimed.2010.06.046

Zhu L, Fratiglioni L, Guo Z, et al (1998) Association of stroke with dementia, cognitive impairment, and functional disability in the very old: a population-based study. Stroke 29:2094–2099

Zunzunegui MV, Alvarado BE, Guerra R, et al (2015) The mobility gap between older men and women: the embodiment of gender. Arch Gerontol Geriatr 61:140–148 . doi: 10.1016/j.archger.2015.06.005

Chapter 4: Discussion and implications

Summary

The objective of this thesis was to determine whether gender or sex predict mobility outcomes in community-dwelling persons with chronic conditions. This thesis consists of two major studies. The first study was a systematic review which examined whether gender or sex predicts mobility in middle and older aged community dwelling adults with chronic conditions. The findings from this study showed that women/females with chronic conditions have more mobility disability compared to men/males counterparts. Most studies also had looked at differences in mobility by stratifying sex and utilized gender and sex terms interchangeably to report participant's characteristics. The second study was a secondary data analysis which used data from a randomized control trial of rehabilitation intervention that showed no difference. This data was used to determine whether age and sex predict self-reported and performance-based mobility-related outcomes in community-dwelling middle and older aged adults with chronic conditions, and if sociodemographic and comorbidity variables also influence this relationship. The results established that older age (≥ 64 years) and female sex had a negative impact on two self-reported mobility outcomes (Late-Life Function and Disability Instrument (LLFDI) function component score and Short Form 36 Health Survey Questionnaire (SF-36) physical functioning sub-scale) and one performance-based outcome (two-minute walk distance). Only older age (≥ 74 years) had a negative impact on performance-based mobility-related outcomes, specifically Short Physical Performance Battery (SPPB) balance, chair stands, 8-foot walk, and SPPB total score. Socio-demographic variables, for example, comorbidity, education level, income level, and marital status, also influenced the predictive relationship between age and sex on mobility outcomes in varying degrees. Persons with comorbidity, less income, and higher education level, and without a partner (widowed or never married) reported greater mobility limitation.

Main contributions

This thesis has made several contributions concerning how gender or sex impact mobility in people with chronic conditions. To our knowledge, this is the first study which systematically investigated the relationships of gender or sex with mobility in community-dwelling adults with chronic conditions. Furthermore, few studies have used a framework such as the Sex and Gender Equity Research (SAGER) guidelines to clearly define and differentiate gender and sex terms, nor have many studies complied with and reported findings based on gender or sex differences. Since gender and sex are two different concepts, future studies should report gender or sex more accurately and specifically design questionnaires to capture how people perceive themselves in terms of gender and sex. Second, not many studies have explored sex and age as predictors of mobility outcomes in people with chronic conditions. The knowledge of how sex and age impact mobility limitations will help rehabilitation researchers and clinicians identify the mobility risk trajectories that people experience and provide the potential for improved interventions for persons with chronic conditions to prevent mobility limitation. Future studies can design interventions tailored for different age groups, especially older age participants ≥ 64 years since they are the high risk group for developing mobility limitation. This will help those with chronic conditions to prevent and avoid mobility-loss risks before mobility disability is entrenched.

Extent of compliance of the included studies with the SAGER guidelines: systematic review (Chapter 2)

This thesis (Chapter 2) highlighted that most of the studies (8/10 studies) included in the systematic review report differences of mobility based on sex differences (i.e. females and males); however, they utilized the terms gender and sex interchangeably and failed to use correct terms with regards to gender or sex of the participants. Studies rarely stated whether gender or sex differences might be associated with the mobility outcomes in the introduction section of the paper (2/10 studies reported this association). Similarly, few studies reported whether sex and gender were taken into account in the design of the study or used in the design of the study (1/10 studies reported this association). No study reported whether questionnaires or measurements were used to identify participants' gender or sex. Finally, although studies presented the differences in mobility outcomes by disaggregating the data by sex or gender in the result section, only half the studies (5/10 studies) discussed a gender/sex-linked hypothesis or the implications of sex and gender in their discussion. Hence, researchers and clinicians need clear conceptual models and need to define and use gender and sex terms accurately. Future studies should also integrate gender and sex into health research when appropriate [1], and use measurement tools to help distinguish gender and sex, which would best fit the perception and the acceptance of the participants to better understand mobility differences in women and men. This thesis highlights the need for future studies to account for sex and gender-based analyses to understand the mechanisms in relation to mobility; and the utilization of this knowledge to test tailored prevention interventions for people with a risk of mobility disability.

Women have more mobility disability compared to men

This thesis (Chapter 2) indicated that women have more mobility disability (8/10 studies) than men. Women had chronic conditions such as obesity (high level of BMI, high fat-mass, low fat-free mass), depressive symptoms, chronic low-back pain with obesity (high BMI), heart attack, and stroke, all of which were significantly related to a higher likelihood of mobility disability in comparison with men. In addition, women also had a body composition disadvantage, for example, decreased muscle strength (handgrip strength) compared to men, which could also result in a greater mobility disability. This finding was in concordance with other previous published studies found that women experience more chronic conditions, for example, obesity, musculoskeletal pain, depression, as well as poorer mobility than men [2–6].

The contributions of age, sex, other socio-demographic factors and comorbidity on self-reported and performance-based mobility

The results of this thesis (Chapter 3) demonstrated that older age (≥ 64 years) significantly predicted both self-reported and performance-based mobility-related outcomes in people with chronic conditions. Similar to the results of multiple studies [7–10], increased age was a risk factor for increased mobility limitation. However, sex only predicted self-reported mobility outcomes, but not performance-based outcomes. Females had greater mobility limitations than male peers in terms of two self-reported mobility outcomes (i.e. LLFDI function component score and SF-36 physical functioning subscale), however, there was no difference between females and males on performance-based mobility limitation (i.e. SPPB balance, chair stands, 8-foot walk, SPPB total scores). The results of this difference in self-reported mobility limitation may implicate gender differences, more than sex differences. There are a number of possible explanations to elucidate our findings.

First, the reason that females had poorer self-reported outcomes, while there were no differences in physical performance measures compared to males may be associated with reporting differences. Females are socialized to acknowledge and report pain and discomfort more than males [11–14]; males, however, are more likely to tolerate physical discomfort [11] and only acknowledge their severe mobility limitations [15], possibly due to the social construction associated with masculinity [16]. This might result in females overestimating and reporting more functional problems, while, males underestimating and reporting fewer functional problems [17].

Next, the differences in self-reported mobility limitations between females and males may actually be due to different constructs and dimensions being measured in self-reported and performance-based measures [18]. Self-reported mobility-related outcomes (LLFDI and SF-36) not only measured mobility limitations, but also included limitations in activities of daily living are much broader and more inclusive of the various components of mobility than physical performance outcomes (SPPB) tested in a 'laboratory environment'.

Finally, females may have had more self-reported mobility limitation due to sociological factors such as the roles females are expected to undertake, for example, domestic house work, and caring for family members [16,19], which could provide less opportunity for leisure time physical activity and exercise than males. This pattern overtime, may subsequently result in poorer mobility function and poorer health for females.

Furthermore, our study suggested that socio-demographic factors and comorbidity also contributed to mobility limitation in people with chronic conditions. People with less income, and without a partner (widowed or unmarried), and comorbidity are more likely to have poorer mobility. This is supported by the literature which reports that mobility limitations are influenced by these factors [7,20–22]. People who have higher levels of income may have more opportunity to access health care services, and greater awareness of the need to engage in physical activity, and high income neighbourhoods, walking is often safer and people have more choices for transportation. Additionally, people who live with their partner or spouse could get more support and care. All of these factors might explain differences in mobility status of females and males in later life.

Strengths and limitations

To our knowledge, this is the first study which conducted a systematic review to investigate the contribution that gender or sex makes to mobility in middle aged and older community-dwelling adults with chronic conditions. In Chapter 2, we might have missed studies during the literature search phase of the systematic review, because of poor indexing of prediction studies [23]. We only included studies that addressed a direct comparison of gender or sex on mobility outcomes; hence, studies such as those that adjusted for gender or sex with other variables were excluded in this review. We chose to exclude these papers because often there was no estimate given for the adjustment according to gender or sex. In addition, we were unable to conduct a meta-analysis of the included studies in the systematic review because of the heterogeneity of the studies. This included the high level of diversity in the population studied, the way that mobility was defined and how the risks were evaluated; therefore, we concluded that the meta-analysis would not be meaningful. For the secondary data-analysis paper (Chapter 3), we could only stratify participants based on sex, not gender.

Future directions and concluding thoughts

Sex and gender are essential determinants of mobility and health. This thesis highlights the results that women with chronic conditions have greater likelihood of mobility problems than men. Rehabilitation researchers and clinicians should take into consideration both sex and gender when appropriate in order to better understand mobility trajectories of people with chronic conditions. Studies which more clearly report gender or sex and specifically design questionnaires or measurement tools to capture how people perceive themselves in terms of gender and sex are warranted. Moreover, as sex and gender are difficult to disentangle with regard to mobility, our results support the need for more mechanistic studies on the impacts of sex and gender on mobility.

References

[1] Sex, gender and health research guide: a tool for CIHR applicants [Internet]. Ottawa (ON): Canadian Institutes of Health Research (CIHR); [cited 2017 Jun 6]. Available from: http://www.cihr-irsc.gc.ca/e/32019.html.

[2] Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. Ann. Rheum. Dis. 1998;57:649–655.

[3] Leveille SG, Fried L, Guralnik JM. Disabling symptoms: what do older women report? J. Gen. Intern. Med. 2002;17:766–773.

[4] Whitson HE, Landerman LR, Newman AB, et al. Chronic Medical Conditions and the Sex-based Disparity in Disability: The Cardiovascular Health Study. J. Gerontol. Ser. A. 2010;65A:1325–1331.

[5] Riediger ND, Clara I. Prevalence of metabolic syndrome in the Canadian adult population. Can. Med. Assoc. J. 2011;183:E1127–E1134.

[6] Oman D, Reed D, Ferrara A. Do elderly women have more physical disability than men do? Am. J. Epidemiol. 1999;150:834–842.

[7] Shumway-Cook A, Ciol MA, Yorkston KM, et al. Mobility limitations in the Medicare population: prevalence and sociodemographic and clinical correlates. J. Am. Geriatr. Soc. 2005;53:1217–1221.

[8] Allman RM, Baker PS, Maisiak RM, et al. Racial Similarities and Differences in Predictors of Mobility Change over Eighteen Months. J. Gen. Intern. Med. 2004;19:1118–1126.

[9] Melzer D, Parahyba MI. Socio-demographic correlates of mobility disability in older Brazilians: results of the first national survey. Age Ageing. 2004;33:253–259.

[10] Mahant PR, Stacy MA. Movement disorders and normal aging. Neurol. Clin. 2001;19:553–563, vi.

[11] Verbrugge LM. Gender and health: an update on hypotheses and evidence. J. Health Soc. Behav. 1985;26:156–182.

[12] Gove WR. Gender differences in mental and physical illness: the effects of fixed roles and nurturant roles. Soc. Sci. Med. 1982. 1984;19:77–91.

[13] Hibbard JH, Pope CR. Gender roles, illness orientation and use of medical services. Soc. Sci. Med. 1982. 1983;17:129–137.

[14] Verbrugge LM. Sex differences in complaints and diagnoses. J. Behav. Med. 1980;3:327–355.

[15] Rahman MO, Liu J. Gender differences in functioning for older adults in rural Bangladesh. The impact of differential reporting? J. Gerontol. A. Biol. Sci. Med. Sci. 2000;55:M28-33.

[16] Doyal L. Sex, gender, and health: the need for a new approach. BMJ. 2001;323:1061–1063.

[17] Merrill SS, Seeman TE, Kasl SV, et al. Gender differences in the comparison of self-reported disability and performance measures. J. Gerontol. A. Biol. Sci. Med. Sci. 1997;52:M19-26.

[18] Reuben DB, Valle LA, Hays RD, et al. Measuring physical function in community-dwelling older persons: a comparison of self-administered, interviewer-administered, and performance-based measures. J. Am. Geriatr. Soc. 1995;43:17–23.

[19] Zunzunegui MV, Alvarado BE, Guerra R, et al. The mobility gap between older men and women: the embodiment of gender. Arch. Gerontol. Geriatr. 2015;61:140–148.

[20] Oldridge NB, Stump TE. Heart disease, comorbidity, and activity limitation in community-dwelling elderly. Eur. J. Cardiovasc. Prev. Rehabil. Off. J. Eur. Soc. Cardiol. Work. Groups Epidemiol. Prev. Card. Rehabil. Exerc. Physiol. 2004;11:427–434.

[21] Blazer DG, Hybels CF, Fillenbaum GG. Metabolic syndrome predicts mobility decline in a community-based sample of older adults. J. Am. Geriatr. Soc. 2006;54:502–506.

[22] Mollenkopf H, Marcellini F, Ruoppila I, et al. Social and behavioural science perspectives on out-of-home mobility in later life: findings from the European project MOBILATE. Eur. J. Ageing. 2004;1:45–53.

[23] Boogaard S, Heymans MW, de Vet HCW, et al. Predictors of Persistent Neuropathic Pain--A Systematic Review. Pain Physician. 2015;18:433–457.