

Master Thesis

Gender and Falls
**The influence of gender on the risk factors of falls: A
systematic review**

submitted by

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in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

at the

Medical University Graz

executed at the

Institute of Nursing Science

under supervision of

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Graz, 27.07.2023

Declaration of Academic Integrity

I hereby confirm that the present master thesis is the result of my own independent scholarly work. I also confirm that in all cases where material from the work of others (in books, articles, essays, dissertations, and on the internet) is acknowledged, quotations and paraphrases are clearly indicated. No material other than that cited in the reference list has been used. I have read and understood the Medical University's regulations and procedures concerning plagiarism.

Graz, 27.07.2023

Lea Joanne Reiter m.p.

Acknowledgements

First and foremost, I would like to thank Professor Dr. Christa Lohrmann and Dr. Daniela Schoberer for their valuable support and patience throughout this thesis and for kindly nudging me to keep going.

I would also like to thank my lecturers – and now colleagues – from the Institute of Nursing Science that have provided me with the necessary knowledge and skills to write this thesis.

Thank you to Matthäa Haas and Sandra Winter who were involved in the appraisal of the included studies.

A special thanks goes to my friends for reading my thesis and for their constructive input.

Finally, I want to express my deepest gratitude to my family that was always there for me throughout my studies. Without your encouragement and kind words, I would not have gotten this far.

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List of Abbreviations

25OHD	25-hydroxy vitamin D
ADL	activities of daily living
AMTS	Abbreviated Mental Test Score
BMI	Body Mass Index
CI	confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COPD	chronic obstructive pulmonary disorder
EE	energy expenditure
g/dL	gram per deciliter
GDS	Geriatric Depression Scale
HAAS	Harvard Alumni Activity Survey
IADL	instrumental activities of daily living
IRR	incident rate ratio
kcal/d	calories per day
LSNS	Lubben Social Network Scale
MCS	Mental Summary Score
MeSH	medical subject heading
METs	metabolic equivalents
nmol/L	nanomols per liter
Ng/ml	nanogram per milliliter
NOS	Newcastle-Ottawa Scale
OLST	one-leg standing test
OR	odds ratio
PADL	personal activities of daily living
PASE	Physical Activity Scale for the Elderly
PCS	Physical Component Score
PrCS	prospective cohort study
RCS	retrospective cohort study
RCT	randomized controlled trial
RR	risk ratio
SAGER	Sex and Gender Equity in Research

SD	standard deviation
TUGT	time-up and go test
VR-12	Veterans RAND 12-Item Health Survey
WHO	World Health Organization
yr.	year
yrs.	years

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Zusammenfassung

Hintergrund: In der Literatur wurden bisher mehrere Risikofaktoren von Stürzen ermittelt. Ältere Erwachsene gelten als einer der Bevölkerungsgruppen mit dem höchsten Sturzrisiko. Obwohl die Forschung zeigt, dass das Geschlecht die Sterblichkeitsrate und die Art der Verletzungen bei Stürzen beeinflusst, gibt es bisher keine Literaturübersicht, die den Einfluss des Geschlechts auf die Risikofaktoren von Stürze untersucht. Daher wurde eine systematische Übersichtsarbeit mit dem Ziel durchgeführt, geschlechtsspezifische Sturzrisikofaktoren bei älteren Erwachsenen zu ermitteln.

Methode: Im Mai 2022 wurde eine systematische Literatursuche in PubMed, CINAHL, Google Scholar sowie GreyLit.org durchgeführt. Darüber hinaus wurden Referenzlisten relevanter Übersichtsarbeiten zu den Risikofaktoren von Stürzen durchsucht. Eine aktualisierte Suche wurde im Juni 2023 durchgeführt. Die Einschlusskriterien waren prospektive oder retrospektive Kohortenstudien, die geschlechtsspezifische Analysen zu Sturzrisikofaktoren bei Erwachsenen über 65 Jahren durchführten. 53 Risikofaktoren waren von Interesse. Diese basierten auf dem WHO-Risikofaktorenmodell für Stürze im Alter sowie auf signifikante Risikofaktoren, die in der Übersichtsarbeit von Sousa et al. (2017) gefunden wurden. Die Ergebnisse wurden nach dem WHO-Modell kategorisiert. Eingeschlossene Studien wurden von zwei unabhängigen Prüfer*innen anhand der Newcastle-Ottawa-Skala bewertet.

Ergebnisse: 24 Studien wurden eingeschlossen. 12 Studien untersuchten nur Frauen, sieben nur Männer und fünf über Frauen und Männer. Es wurden 16 Risikofaktoren ermittelt, die sowohl bei Frauen als auch bei Männern signifikant waren (z.B. Komorbidität, eingeschränkte körperliche Funktion). Bei 14 dieser Faktoren handelte es sich um biologische Faktoren. 12 biologische Faktoren waren nur bei Frauen signifikant (z. B. Diabetes) und zwei nur bei Männern (z. B. Harndrang). Hinsichtlich der Umgebungsfaktoren wurden bei Frauen und Männern keine signifikanten Risikofaktoren festgestellt. Während Bildung der einzige signifikante sozioökonomische Faktor bei Frauen war, wurde bei Männern kein signifikanter sozioökonomischer Risikofaktor gefunden.

Schlussfolgerung: Dies ist die erste systematische Übersichtsarbeit über den Einfluss des Geschlechts auf die Risikofaktoren von Stürzen. Die Ergebnisse dieser

Übersichtsarbeit können als Anregung für künftige Studien zu diesem Thema gesehen werden, da noch weitere Forschung erforderlich ist, um die bisherigen Daten zum Einfluss des Geschlechts auf Stürze zu verifizieren.

Schlüsselwörter: systematische Übersichtsarbeit, Stürze, Risikofaktoren, soziales Geschlecht

Abstract

Background: Several fall risk factors have been identified in international literature so far. Older adults are considered to be among the population groups with the highest risk of falls. Despite research showing that gender influences the mortality rate and type of injury of falls, no literature synthesis is yet available that explores the influence of gender on the risk factors of falls. Therefore, a systematic review was conducted, aiming to identify gender-specific fall risk factors in older adults.

Methods: In May 2022 a systematic literature search was conducted in PubMed, CINAHL, Google Scholar as well as GreyLit.org. Furthermore, reference lists of relevant reviews on the risk factors of falls were screened. An update search was conducted in June 2023. The inclusion criteria were prospective or retrospective cohort studies which performed gender-specific analyses on fall risk factors in adults over the age of 65. 53 risk factors were of interest. These were based on the WHO risk factor model of falls in older age as well as significant risk factors found in the review by Sousa et al. (2017). Results were categorised according to the WHO model. Included studies were appraised by two independent appraisers using the Newcastle Ottawa Scale.

Results: 24 studies were eligible for inclusion. 12 studies reported only on women, seven only on men and five on women and men. 16 risk factors were identified that were significant in both women and men (e.g. comorbidity, impaired physical function). Of these, 14 were biological factors. 12 biological factors were significant only for women (e.g. diabetes) and two only in men (e.g. urinary urgency). No significant risk factors were found regarding environmental factors in women and men. While education was the only significant socioeconomic factor in women, no socioeconomic risk factor was found to be significant for men.

Conclusion: This is the first systematic review on the influence of gender regarding the risk factors of falls. Results of this review can be seen as an incentive for future studies on this topic, as more research is still necessary to verify data on the influence of gender on falls.

Keywords: systematic review, risk factors, falls, gender

1 Introduction

1.1 Ageing population

It is estimated that by the year 2050, the world's population of adults over the age of 60 will have doubled to 2.1 billion since the year 2020 (WHO, 2022). Furthermore, the global population over the age of 80 is expected to triple (426 million) by 2050 (WHO, 2022). A drastic increase of the ageing population can also be expected in Austria. The percentage of adults over the age of 80 was 4,9% in 2020 and is expected double to 9,7% by the year 2040 (BMSGPK, 2022). This is caused due to rising life expectancy in combination with a growing population (WHO, 2022). Gender plays an influential role not only on the life expectancy but also on the process of ageing. In 2020 the life expectancy in Europe was higher for women than for men (Eurostat, 2022). In Austria in particular, the life expectancy regarding the year 2021, was 83,8 years for women while it was 78,8 years for men. (STATISTIK AUSTRIA, 2023c). Moreover, data has shown that women in Austria also have more healthy life years than men, with 64,7 years for women and 63.1 years for men (STATISTIK AUSTRIA, 2023b).

However, in order to go into further depth on this topic, it is essential to be aware of the definitions of gender and sex and their differentiation from one another, as these are often used synonymously in literature (Gogovor et al., 2021).

The term "sex" refers to characteristics regarding reproductive and sexual anatomy, chromosome, genetics and hormones. While sex is divided into male and female (Heidari et al., 2016), the definition of gender surpasses the binary categories. Gender is a multidimensional construct closely linked to cultural and social dimensions which influence a person's lifestyle, behaviour and self-expression. Unlike sex there are several different gender identities such as man, woman, non-binary and gender-diverse. A person's gender identity can only be self-identified (NIH) and may change throughout a person's lifetime. (Krieger, 2003, Office of Research on Women's Health, n.d., Heidari et al., 2016)

Data on the life expectancy regarding genders outside of the binary construct are still very scarce, however a recently published study from the United States found that the life expectancy of persons identifying as transgender is seven years lower

than cis-gendered persons (Hughes et al., 2022). Moreover, the risk of mortality was nearly twice as high in persons identifying as transgender than in cis-gendered persons at any stage in life (Hughes et al., 2022).

Concerning all genders, ageing is paired with the decline of physical and mental functions leading to a wide range of health conditions such as the loss of hearing and dementia (WHO, 2022). Despite age-related health conditions affecting all genders, it must be noted that gender influences the ageing process and its effects on physical and mental health (Carmel, 2019, Dhar, 2001, Hägg and Jylhävä, 2021). Examples for this can be seen in several age related health conditions such as frailty (Park and Ko, 2021, Nair et al., 2021), osteoporosis (Alswat, 2017) and depression (Albert, 2015, Nair et al., 2021), which are more common in women than in men. These health conditions have all been shown to be significant risk factors for falls in older adults (Sousa et al., 2017). Falls and the influence that gender has on them will be elaborated throughout the next chapter of this thesis.

1.2 Falls

There are many different definitions of falls in international literature (Masud and Morris, 2001), however a definition which is frequently found in literature is by the Kellogg International Working Group (Noury et al., 2008), which defined “falls as the unintentional coming to ground, or some lower level” (Kellogg International Working Group, 1987).

Each year 37.3 million falls which result in necessary medical attention occur worldwide, thereby putting a strain on the health system (Mikos et al., 2021, WHO, 2021a). Falls can result in physical (Terroso et al., 2014) as well as psychological consequences, such as fear of falling (Jørstad et al., 2005, Tinetti et al., 1994). The main fall-related injuries for older adults are fractures – in particular, hip fractures – brain injuries, organ damage, cuts, haematomas, joint dislocation, soft-tissue damage and nerve damage (WHO, 2021b). The “Nursing Quality Measurement 2.0” report from 2022 showed that 34,2% (n=25) of 73 fallers in Austrian hospitals suffered from an injury as a result of falling (Lohrmann et al., 2022). The risk for fall-related injuries increases with age and is highest for adults over the age of 60 (WHO, 2021b), with women being more at risk of having consequences of falls (WHO, 2007,

Hefny et al., 2016, Nilsson et al., 2016, WHO, 2021b, WHO, 2021a). More specifically, women are at a higher risk of fall-related fractures due to the fact that osteoporosis is four times more common in older women than it is in men (Feldstein et al., 2003, Alswat, 2017)

Despite this, incidences of fall-related fractures are at their highest for both men and women in the age group of 60- to 69-year-olds, with incidences decreasing for both genders above the age of 90 (Court-Brown et al., 2017).

Each year 684 000 humans die from the consequences of falls, with adults over the age of 60 making up for the majority of fatal falls (WHO, 2021a). Moreover it has been shown in literature that gender also influences the mortality rate of falls, with older men having a higher risk of fatal falls than women (Garnett et al., 2022, WHO, 2021a). This can also be seen when looking at data regarding causes of death in Austria.

In 2021 a total 899 deaths occurred due to falls in Austria, of which 85% of deaths affected persons over the age of 60. Moreover, for the past 15 years, the annual rate of fatal falls was higher for men than for women. (STATISTIK AUSTRIA, 2023a) So far this section of the thesis has provided an insight on the influence of gender on the consequences of falls. Following, an overview of the risk factors of falls will be introduced, as well as methods of classifying these.

1.2.1 Risk Factors of Falling

As falls are a multifactorial event, there is a wide range of factors that influence fall risk. Although falls can occur to any person at any stage of life (WHO, 2021b), older adults of 65 years and older are particularly at the risk of falling (Heardman and Kamitsuru, 2015).

The risk factors for falls in older adults have been studied extensively throughout literature covering various settings like hospitals or nursing homes (Deandrea et al., 2013, Deandrea et al., 2010, Sousa et al., 2017). In literature, fall risk factors have been classified into intrinsic and extrinsic factors (Schoberer et al., 2018). Intrinsic risk factors concern characteristics and traits of individuals themselves. Examples for these are muscle weakness, gait problems, poor vision, fear of falling. Concurrently, extrinsic factors refer to the environment of an individual. Examples for extrinsic factors are poor lighting, slippery floors and tripping hazards (Franse et

al., 2017, Bueno-Cavanillas et al., 2000, Phelan et al., 2015). However, a further method of classifying fall risk factors, which is specifically aimed at older adults, is the World Health Organisation's (WHO) risk factor model for falls in older age (WHO, 2007). This model will be explained in the next section of this thesis.

1.2.2 WHO risk factor model for falls in older age

The WHO risk factor model for falls in older age (Figure 1) classifies the fall risk factors of older adults into four different categories: biological risk factors, behavioural risk factors, socioeconomic risk factors and environmental risk factors. The biological risk factors deal with individual characteristics of a human being which cannot be changed such as race and gender. Furthermore, chronic illnesses as well the decline of physical, cognitive and affective abilities are also included in the category of biological risk factors. The WHO states Parkinson's disease, arthritis, and osteoporosis as examples for chronic illnesses (WHO, 2007). Sousa and colleagues mention additional chronic illnesses that are to be considered as fall risk factors: chronic obstructive pulmonary disorder (COPD), arthritis, heart disease, hypertension and diabetes (Sousa et al., 2017). In addition, they define cognitive fall-risk factors as a decline in cognitive functions as well as diminished executive functions, while the affective factors include fear of falling, symptoms of depression and anxiety (Sousa et al., 2017). Further biological factors which increase the risk of falls are the following: fluctuation of blood sugar, arthritis, weakness of the lower extremities, diarrhoea, gait problems, impaired balance and mobility, incontinence, orthostatic hypotension, insomnia, urinary urgency, vascular diseases, impaired eyesight, decline in the execution of daily living activities, comorbidity, chronic pain, arterial hypertension, impaired sensomotoric function, osteoporosis, decreased vitamin D, decline of physical health, obesity, metabolic syndrome, COPD, and low serum albumin (Sousa et al., 2017).

The category of behavioural risk factors concerns modifiable day-to-day life choices which may have a negative impact on a person's health. These factors include excessive alcohol intake, intake of multiple medications, lack of exercise and inappropriate footwear.

Environmental risk factors focus on the hazardous surrounding of older adults which may lead to falls in their private homes or also in public spaces. These include

insufficient lighting, loose carpets, slippery stairs and ground, uneven pathways and poor building design.

Socioeconomic risk factors are comprised of factors which impact the economic status as well as the social conditions. This includes low income, lack of education, bad housing conditions, lack of social interactions and community resources, and limited access to healthcare services.

It must be noted that the biological, environmental, socio-economic and behavioural factors interact with each other. The interactions can be seen in Figure 1. Additionally, the risk factors from more than one category can be present at the same time which furthermore increases the risk of falling.

The WHO risk factor model for falls in older age was first mentioned in 2007 and has recently been published again in the document “Step safely: strategies to prevent and manage falls across the life-course” by the WHO (2021).

In comparison to the classification of fall-risk factors by intrinsic and extrinsic factors (Bueno-Cavanillas et al., 2000), the WHO risk factor model of falls in older age incorporates a more holistic approach to fall-risk factors as it acknowledges the influence of socioeconomic factors. A further differentiation to the classification according to intrinsic and extrinsic factors, is that the WHO risk factor model for falls in older age incorporates multifactorial aspect of falls.

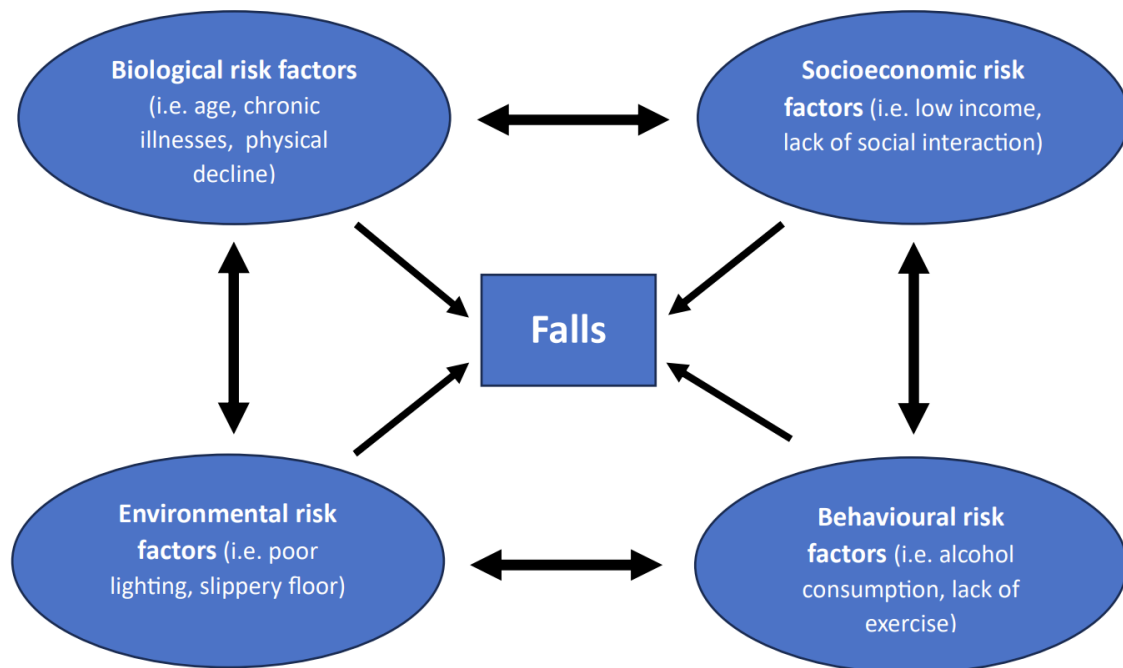


Figure 1: WHO risk factor model of falls in older age (created by the author, adapted version from WHO, 2007)

1.2.3 The relevance of gender regarding fall risk factors in older adults

As previously mentioned, gender has a significant impact on the risk (Rubenstein, 2006), type of injury (Alswat, 2017, Feldstein et al., 2003), as well as on the risk of mortality (Garnett et al., 2022, WHO, 2021a) in regards to falling. Based on this, the assumption can be made that gender also influences the risk factors of falling. Despite gender being analysed as a risk factor by itself in several studies (Deandrea et al., 2013, Deandrea et al., 2010, Sousa et al., 2017), research on the influence of gender regarding the risk factors of falls in older adults is still scarce (Gale et al., 2018). Currently, only few studies have been conducted on this matter, mostly with small sample sizes and limited to a certain population or setting (Chang and Do, 2015). Additionally, there are no reviews available which provide a synthesis of current evidence on gender specific risk factors. Moreover, despite the holistic and multifactorial approach of the WHO risk factors model of falls in older age, only one primary study could be found which applied this model. This study however, was of a cross-sectional design and did not perform a gender specific analysis (Qian et al., 2021).

The identification of such risk factors and the classification according to the WHO risk factor model of falls in older age can not only contribute to the optimization of fall risk assessments, but also to finding optimal and effective measures for the prevention of falls depending on the gender.

1.3 Aim and research question

The aim of this thesis is the identification of gender specific fall risk factors in older adults over the age of 65. In order to do this, a systematic review is performed and significant risk factors are identified and classified according to the WHO's risk factor model for falls in older age.

In this regard, the following research question will be investigated throughout this thesis:

What influence does gender have on fall risk factors regarding older adults over the age of 65?

2 Method

To answer the research question of this thesis, a systematic review was performed. The methodology of this design allows for a systematic approach with the aim of a rigorous synthesis of current evidence (Polit and Beck, 2017). The following section of the thesis elaborates on the inclusion criteria, search strategy, the screening process, the critical appraisal of the included studies as well as the data extraction and data synthesis.

2.1 Inclusion Criteria

Before a search strategy was able to be generated, the inclusion criteria were defined according to the research question (see Table 1). The outcomes of interest were based on the WHO risk factor model for falls in older age as well as the biological factors found in Sousa et al. (2017) (see Table 2).

These criteria were applied during the title- abstract- and full-text screening and served as determinants for whether a study was eligible for data-analysis. The participants of an included study had to be of the age group 65 and older, or the mean age and standard derivation higher than 65 years. Additionally, no limitation was set regarding the setting. The design of included studies was limited to prospective and retrospective cohort studies. This limitation was set, as cohort studies provide a higher quality of evidence than cross-sectional or case-control studies (Duke University, 2023).

Cohort studies can be conducted prospectively as well as retrospectively and allows to show association and the impact of certain factors (Song and Chung, 2010). A further inclusion criterion was that included studies had to contain “fall” or a synonym of “fall” in the title. Studies that focused on recurrent falls were excluded. Additionally, in order to be included, the abstract had to state that the results were split according to gender or specifically focused on one gender (e.g. women). Studies that did not specify in their full text whether they reported on gender but still split results according women/men or female/male were still included.

Table 1: Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Population:	Adults ≥ 65 years old or mean age ≥ 65 years	Age ≤ 64 or mean age < 65 years
Setting:	All settings	-
Results of included studies:	Results split according to gender or only reported on a single gender	Results not split according to gender or focussing specifically on sex
Design:	Retrospective and prospective cohort studies	Other design than cohort
Outcomes:	Risk factors for falls according to WHO risk factor model of falls in older age complimented review by Sousa et al. (2017)	Other risk factors from other sources
Abbreviation: SD = standard deviation		

Table 2: Risk factors of interest and their respective sources

Risk Factors of Interest	Source
Biological Risk Factors	
<ul style="list-style-type: none"> • Affective decline • Age • Arthritis • Chronic illnesses • Cognitive decline • Osteoporosis • Parkinson • Physical decline • Race 	WHO risk factor model for falls in older age
<ul style="list-style-type: none"> • Anxiety • Arterial Hypertension • Arthritis • Chronic obstructive pulmonary disease • Chronic pain • Comorbidity • Decline of sensorimotor function • Depression • Diarrhoea • Difficulty with basic activities of daily living • Difficulty with instrumental activities of daily living • Dizziness • Fear of falling • Fluctuation of blood sugar • Gait problems • Health decline • Imbalance • Incontinence • Increased abdominal circumference • Insomnia • Low level of serum albumin • Low muscle strength of lower extremities • Mobility problems • Obesity • Orthostatic hypotension • Problems with eyesight • Urinary urgency • Vascular Illness • Vitamin D insufficiency 	Sousa et al. (2017)
Behavioural Risk Factors	
<ul style="list-style-type: none"> • Multiple medication use • Excess alcohol consumption • Physical inactivity • Inappropriate footwear 	WHO risk factor model for falls in older age
Socio-Economic Risk Factors	
<ul style="list-style-type: none"> • Low Income • Low Education • Inadequate housing • Lack of social interaction • Access to health and social service • Lack of community resources 	WHO risk factor model for falls in older age
Environmental Risk Factors	
<ul style="list-style-type: none"> • Poor building design • Slippery floor or stairs 	WHO risk factor model for falls in older age

<ul style="list-style-type: none"> • Loose rugs • Insufficient lighting • Uneven sidewalk 	
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2.2 Search strategy and screening

The systematic literature search was performed in PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) in May 2022. The search strategy was based on keywords and their respective synonyms which were preliminarily defined and derived from the components of the research question. A keyword and its respective synonyms as well as applicable medical subject heading (MeSH)-Terms / Major Headings were connected via the Boolean Operator “OR” and “AND”. With a few exceptions, each keyword and its synonyms were entered once in singular form, once in plural and once with truncation. A truncation for woman/women (wom*) was not applicable for PubMed as search-terms need to consist of more than four letters in order for the truncation to be applied. The truncation for man/men (m*) was also left out for the same reason in PubMed and CINAHL.

As it was an inclusion criterion that the word “fall” or a variation of it had to be included in the title, the filter for the title was applied to the keyword “fall” and its synonyms in PubMed and CINAHL. In PubMed the filter for title and abstract was applied to all other keywords and synonyms in order to increase the ratio of relevant studies compared to irrelevant studies. The appropriate age filters were applied in CINAHL as well as PubMed.

A hand-search was conducted via Google Scholar and GreyLit.org using key words (Appendix 1). The first five pages were screened in Google Scholar. GreyLit.org is a platform which can be used for the search of unpublished “grey” literature.

Backwards referencing was conducted using three relevant reviews (Deandrea et al., 2013, Deandrea et al., 2010, Sousa et al., 2017).

Additionally, an update search was conducted in July 2023, with the aim of finding eligible studies that were published since May 2022. For this, the exact search strategy from May 2022 was applied, with an adjusted time frame from May 2022 to May 2023. Appendix 1 shows the applied search strategy and the respective results

from the search conducted in May 2022 as well as the results from the update search from July 2023.

All studies from PubMed and CINAHL and the hand-search were imported into the referencing program EndNote (Version 20) and duplicates removed. The title-abstract- and full-text screening was conducted according to inclusion/exclusion criteria. Reasons for exclusion were recorded during the full-text screening.

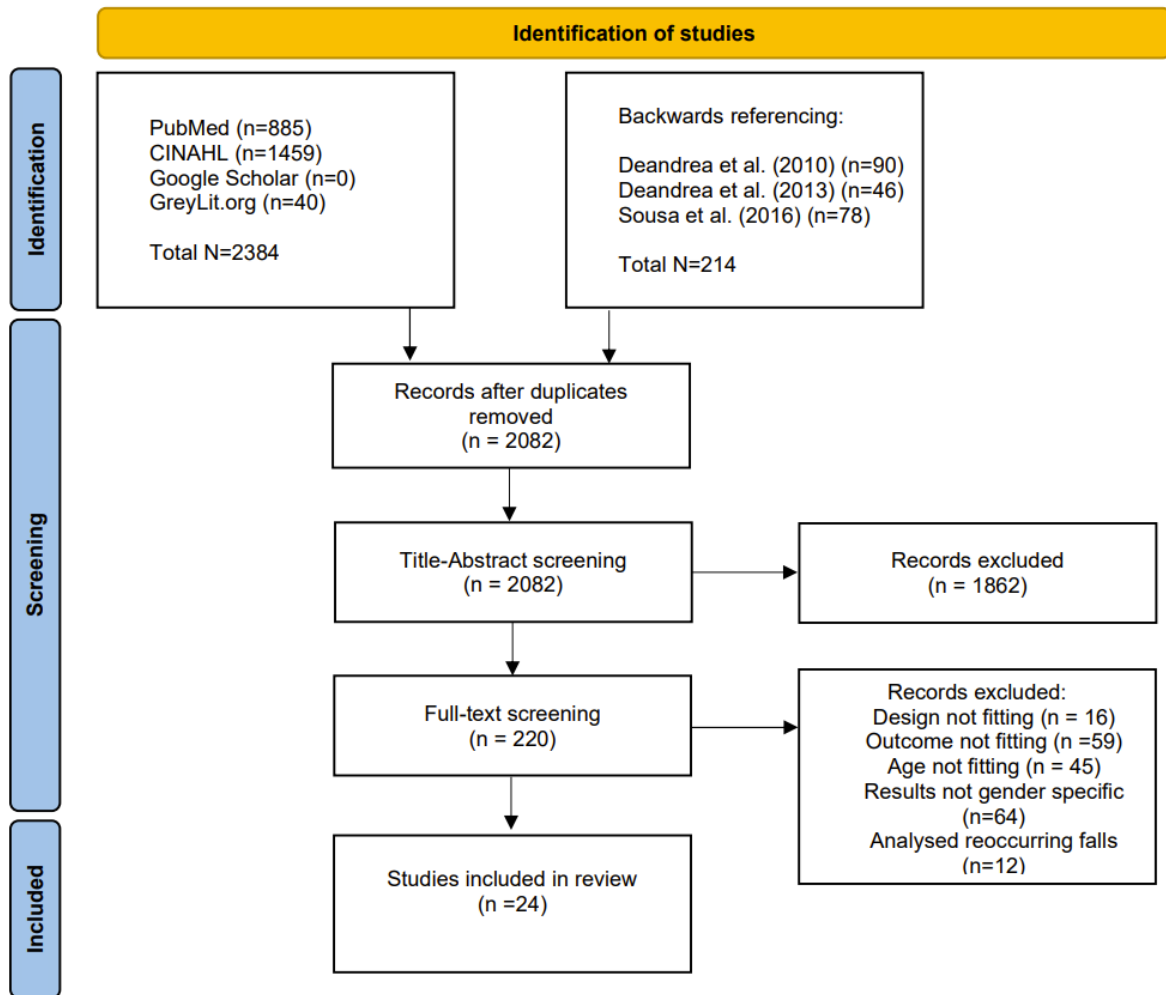


Figure 2: Flowchart of the screening process from the initial search (adapted version from Page et al., 2021)

2.3 Critical appraisal

Throughout the following chapter, the psychometrically tested Newcastle-Ottawa Scale (NOS) (Wells et al., 2000) for cohort studies will be elaborated on, with the NOS being the used appraisal tool for this thesis. Despite this appraisal tool being

developed for case-control as well as cohort studies, the focus will only lie on the tool regarding cohort studies, as this was an inclusion criterion.

The appraisal of the included studies was conducted by the author of this thesis as well as two other individual students. Each student appraised half of the included studies, while the author appraised all studies. The ratings of the NOS from each appraiser were compared with one another and disagreements were resolved through discussion until consensus was met.

The NOS is divided into three domains: selection, comparability and outcome. Each domain is made up of a number of items which are rated following a star-system. The domain "selection" focuses on the recruitment of participants and is comprised of four items: representativeness of the exposed cohort, selection of the non-exposed cohort, ascertainment of exposure, and demonstration that outcome was not present at the start of the study. As each item from the domain "selection" can be rewarded one star, a maximum of four stars can be achieved in this domain. In the case of this thesis, exposures are the potential risk factors that are analysed in a study.

The domain "comparability" is comprised of only one item: comparability of cohorts on the basis of design and analysis. This item, which can be rewarded a maximum of two stars, focuses on significant differences between exposed and non-exposed individuals as well as if a study adjusted their data for covariates.

The third domain "outcome" of the NOS can be rewarded a maximum of one star for each of the following three items: assessment of outcome, was the follow up long enough for outcomes to occur, and adequacy of follow up of cohorts. In the context of this thesis, the relevant outcome is the event of a fall.

Just as recommended according to the NOS coding manual (Wells et al., 2000), certain criteria were predefined and adapted accordingly before the studies were appraised.

To begin with the domain selection, no star was rewarded regarding the representativeness of the exposed cohort if there was an indication that selective sampling was conducted - e.g. the recruitment of participants in a specific area or institution. For the ascertainment of exposure, a whole star was rewarded if all exposures were assorted through secure records and/or structured interviews. However, as studies were able to explore multiple exposures at once it was expected that not all exposures were able to be assorted assertively. For this

reason, only half a star was rewarded if a part of the explored exposures were asserted through secure records or structured interviews, while the other part of exposures was assorted in a different manner (e.g. self-reports). Item number four “demonstration that outcome of interest was not present at start of study” from the domain “selection” was automatically rewarded a star as falls are incidental and not a continuous or progressive event.

For item one from the domain comparability, age was defined as the most important covariate for which a study had to control for and was then rewarded a star. Two stars were rewarded in the case that a study adjusted for any other covariate in addition to age.

For the third domain “outcome”, the item “assessment of outcome” was rewarded a star if a fall was independently recorded or documented in medical records or databases. In this case, a self-reported fall was seen as a setback in quality and no star was awarded. The adequate time for follow-up was set to a minimum of one year or if the mean of the follow-up period surpassed 1 year. As stated in the NOS coding manual, the percentage of participants which were lost to follow up was also predefined for which a cut-off was set to 20%.

2.4 Data extraction

The data extraction was conducted by the author of this thesis using a predefined extraction sheet that was created by the author. The following variables were extracted from the included studies: author, study design, fall incidences, number of study participants that fell, country, mean age and standard deviation (SD), age-range, setting, population, explored risk factors, crude and adjusted effect sizes. Regarding the adjusted risk, only the model including the most covariates was extracted. This step was taken as some studies adjusted the calculated risk to multiple variation of covariates. Any special participant characteristics were extracted if they potentially had an influence in the overall outcome of the study. The extracted data on fall incidences and population were split according to studies that included only women, only men or included men or women. Furthermore, the age-range of participants and the country in which the study was conducted were extracted.

2.5 Data synthesis

The extracted data was grouped into to the four main categories of the WHO risk factor model for falls in older age: behavioural, biological, socio-economic and environmental risk factors. Furthermore, in order to present a better overview, results regarding the biological risk factors were separated into the subcategories “general factors”, “physical performance” and “impaired senses”. The data of the primary studies were presented in a narrative manner.

3 Results

This chapter of the thesis presents the results of the included studies. To begin with, the results of the literature search will be presented, and the overall study characteristics described. This will be followed by the results of the studies. These are sectioned into studies which included only women, only men, and lastly studies which included both women and men. Furthermore, each of these three sections will present the risk factors according to the four main categories of the WHO risk factor model for falls in older age: biological risk factors, behavioural risk factors, socio-economic risk factors and environmental risk factors. Additionally, each section (e.g. studies including only women), includes a subchapter that briefly states any special participant characteristics of the included studies that might have had an influence on the data of the primary studies.

3.1 Results of the Literature Search

The initial literature search conducted in May 2022 yielded a total of 2344 studies from databases and search engines. Additionally, 214 studies were included through backward referencing of relevant reviews. After duplicates were removed, titles and abstracts of 2082 studies were screened according to the pre-defined inclusion criteria (see Table 1 and 2). This resulted in 220 studies being included for full-text screening, after which 24 studies were deemed eligible for inclusion in this review. The update search in July 2023 led to a title- and abstract screening of 101 additional studies, none of which were eligible for inclusion. The screening process, the number of excluded studies as well as the reasons for full-text exclusion from the initial and update search can be seen in the flowcharts from Figure 3.

3.2 Study Characteristics

Of the 24 studies that were included in this review, 12 recruited only women (Bergland et al., 2003, Brown et al., 2000, Davis et al., 1999, Faulkner et al., 2009, Faulkner et al., 2003, Flicker et al., 2003, Heesch et al., 2008, Lim and Sung, 2012, Moon et al., 2020, Shimizu et al., 2015, Volpato et al., 2005, Whooley et al., 1999), seven only men (Cauley et al., 2013, Khalatbari-Soltani et al., 2021, Chan et al.,

2007, Gill et al., 2009, Jefferis et al., 2015, Papachristou et al., 2017, Parsons et al., 2009) and five studies recruited women as well as men (Huang et al., 2019, Kubo et al., 2021, Lim et al., 2016, Lopez et al., 2011, Menant et al., 2012). Five studies were of a retrospective cohort design (Huang et al., 2019, Kubo et al., 2021, Lim et al., 2016, Lopez et al., 2011, Moon et al., 2020) while the remaining 19 studies were of a prospective cohort design (Menant et al., 2012, Lim and Sung, 2012, Khalatbari-Soltani et al., 2021, Bergland et al., 2003, Brown et al., 2000, Davis et al., 1999, Faulkner et al., 2009, Faulkner et al., 2003, Flicker et al., 2003, Heesch et al., 2008, Shimizu et al., 2015, Volpato et al., 2005, Whooley et al., 1999, Cauley et al., 2013, Chan et al., 2007, Gill et al., 2009, Jefferis et al., 2015, Papachristou et al., 2017, Parsons et al., 2009). The majority of the studies included community dwelling adults, with only one study being conducted in residential care facilities, including assisted living facilities and nursing homes (Flicker et al., 2003), and another conducting a nation-wide telephone survey amongst community-dwellers (Heesch et al., 2008). Sample sizes ranged from 270 (Gill et al., 2009) to 8,562 (Heesch et al., 2008). Not all studies mentioned the participants' age range, however the narrowest age range was from 70-75 years of age (Heesch et al., 2008) while the widest age range was from 65 to 106 years (Moon et al., 2020). Mean ages ranged from 70.4 years (Kubo et al., 2021) to 83.7 years (Flicker et al., 2003). The studies were conducted in seven different countries: USA (n=10) (Brown et al., 2000, Chan et al., 2007, Cauley et al., 2013, Davis et al., 1999, Faulkner et al., 2009, Faulkner et al., 2003, Huang et al., 2019, Parsons et al., 2009, Volpato et al., 2005, Whooley et al., 1999), South Korea (n=3) (Lim et al., 2016, Lim and Sung, 2012, Moon et al., 2020), Australia (n=5) (Flicker et al., 2003, Khalatbari-Soltani et al., 2021, Heesch et al., 2008, Lopez et al., 2011, Menant et al., 2012), United Kingdom (n=2) (Jefferis et al., 2015, Papachristou et al., 2017), Japan (n=2) (Kubo et al., 2021, Shimizu et al., 2015), Canada (n=1) (Gill et al., 2009), Sweden (n=1) (Bergland et al., 2003). Regarding the percentage of women that fell, Kubo et al. (2021) showed the lowest percentage of fallers that were women (9.0%) while the highest percentage was in the study by Volpato et al. (2005) with 64.9%. The range in percent of fallers that were men was between 8.3% (Kubo et al. 2021) and 47.0% (Khalatbari-Soltani et al., 2021). Only four studies specified that they included their sample according to gender (Huang et al., 2019, Lim et al., 2016, Lopez et al., 2011, Menant et al., 2012), while one study used the term sex (Kubo et al., 2021). However, despite using the

term sex, Kubo et al. (2021) was still included into the analysis as, according to the definitions of gender and sex by the Office of Research on Women's Health (Office of Research on Women's Health, n.d.), the analysed factors of this cohort study were not strictly referable to sex. The remaining studies did not specify whether they are referring to sex or gender. An overview of the study characteristics as well as the studied risk factors of interest can be found in Table 3 and 4 respectively.

Table 3: Study characteristics of included studies

Author (Year)	Country	Study Design	Setting	Sample Size	Min. Age / Age-Range	Mean Age (SD)	Follow-up Period	Rate / Nr. of Falls	Rate / Nr. of Fallers (%)
Studies including only women									
Bergland et al. (2003)	Sweden	PrCS	Community	n=307	75-93 yrs.	80.8 yrs. (SD not mentioned)	1 yr.	- / n=308	- / n=155 (50.5%)
Brown et al. (2000)	USA	PrCS	Community	n=6,049	72-99 yrs.	78.5 yrs. (SD 4.6)	3 yrs.	- / n=11,869	- / n=3,326 (55.0%)
Davis et al. (1999)	USA	PrCS	Community	n=705	-	74 yrs. (SD 5)	2 yrs.	- / n=328	- / n=213 (30.2%)
Faulkner et al. (2003)	USA	PrCS	Community	n=6,692	69-101 yrs.	77 yrs. (SD 5)	3 yrs.	- / n=11,863	- / -
Faulkner et al. (2009)	USA	PrCS	Community	n=8,378	-	71 yrs. (SD 3)	4 yrs.	460 falls per 1,000 woman yrs. / n=15,416	- / -
Flicker et al. (2003)	Australia	PrCS	Residential Care	Total: N=1,619 Low-level care*: n=667 High-level care*: n=952	-	Low-level care: 83.7 yrs. (SD 8.7) High-level Care: 83.7 (SD 9.1)	Low-level care: average of 145 days (range 17-881) High- level care: 168 days (range 16-1,033)	1.6 falls per yr. / Total falls: N=1051 Low-level care: n=388 High-level care: n=643	- / Total fallers: N=415 (25.6%) Low-level care: n=177 (27%) High-level care: n=238 (25%)
Heesch et al. (2008)	Australia	PrCS	Telephone survey of community	1999: n=8,562 2001: n=6,747	70-75 yrs.	Not mentioned	3 / 6 yrs.	- / -	1999: - / n=1,529 (17.8%) 2001: - / 1,197 (17.7%)

Lim & Sung (2012)	South Korea	RCS	Community	n=438	65-92 yrs.	72.3 yrs. (SD 6.54)	1 yr.	- / -	- / n=283 (64.6%)
Moon et al. (2020)	South Korea	RCS	Community	n=6,134	65-106 yrs.	74.8 yrs. (SD not mentioned)	1 yr.	- / -	- / n=1,152 (18.7%)
Shimizu et al. (2015)	Japan	PrCS	Community	n=1,285	75-90 yrs.	78.6 yrs. (SD 2.8)	1 yr.	- / -	- / n=299 (23%)
Volpato et al. (2005)	USA	PrCS	Community	n=878	-	Without diabetes (n=742): 79.1 yrs. (SD 8.1) With diabetes (n=136): 75.3 yrs. (SD 6.5)	3 yrs.	- / -	- / n=570 (64.9%)
Whooley et al. (1999)	USA	PrCS	Community	n=7,414	-	With Depression (n=467): 74.5 yrs. (SD 5.3) Without Depression (n=6,947): 73.3 yrs. (SD 5.1)	Mean follow-up: 6 yrs. (SD 2)	- / -	- / n=4,426 (59.7%)
Studies including only men									
Cauley et al. (2013)	USA	PrCS	Community	n=2,731	-	78.9 yrs. (SD 5.1)	1 yr.	- / -	- / n=759 (28.2%)
Chan et al. (2007)	USA	PrCS	Community	n=5,995	-	73.7 yrs. (SD 5.9)	4.5 yrs.	- / -	- / n=10,768 (13.4%)
Gill et al. (2009)	Canada	PrCS	Community	n=270	-	81.1 yrs. (SD 4.0)	Median Follow up 373 days (range, 11–822 days)	- / n=343	- / n=120 (44.0%)
Jefferis et al. (2015)	United Kingdom	PrCS	Community	n=700	71–91 yrs.	78.0 yrs. (SD 4.5)	1 yr.	- / -	- / n=128 (18.2%)

Khalatbari-Soltani et al. (2021)	Australia	PrCS	Community	n=1,624	-	77.3 yrs. (SD 5.4)	Mean follow-up period 42.6 months (range 4-48 months)	- /n=2541	- /n=766 (47.0%)
Papachristou et al. (2017)	United Kingdom	PrCS	Community	n=1,198	71-92 yrs.	77.95 yrs. (SD 4.4)	3 yrs.	- / -	- / n=163 (16.0%)
Parsons et al. (2009)	USA	PrCS	Community	n=5,872	65-100 yrs.	73.6 yrs. (SD 5.8)	1 yr.	- / -	- /n=1,489 (25%)
Studies including women and men									
Huang et al. (2019)	USA	RCS	Community	Total: N=1,097 Women n=437 Men n=660	Total sample: -	Women: 72.5 yrs. (SD 6.3) Men: 71.9 yrs. (SD 5.8)	2 yrs.	- / -	- / Total sample: N= 257 (23.4%) Women n= 113 (25.8%) Men: n=144 (32.9%)
Kubo et al. (2021)	Japan	RCS	Community	Total: N=4,255 Women: n=2,164 (51.1%) Men: n=2,091 (49.1%)	Total sample: 65-77 yrs.	Women: 70.4 yrs. (SD 3.4) Men: 70.4 yrs. (SD 7.5)	1 yr.	- / -	- / Total sample: N= 369 (8.7%) Women n= 195 (9.0%) Men: n=174 (8.3%)
Lim et al. (2016)	South Korea	RCS	Community	Total: N=2,465 Women: n=1378 Men: n=1087	Total sample: -	Women: 74.8 yrs. (SD 3.7) Men: 74.8 (SD 4.1)	1 yr.	- / -	- / Total sample: N= 495 (20.1%) Women n= 304 (22.8%) Men: n=191 (18.3%)

Lopez et al. (2011)	Australia	RCS	Community	Total: N=5,354 Women: n=3,014 Men: n=2,340	Men: 76-81 yrs. Women: 76-81 yrs."	Women: 77.9 yrs. (SD not mentioned) Men: 78.1 (SD not mentioned)	1 yr.	- / -	- / Total sample: N=1,051 (19.6%) Women n=576 (19.1%) Men: n=475 (20.3%)
Menant et al. (2016)	Australia	PrCS	Community	Total: N=463 Women: n=248 Men: n=215	Total sample: 70-90 yrs.	Women: Serum 25OHD ≤50 nmol/L (n=109): 78.7 yrs. (SD 4.8) Serum 25OHD >50 nmol/L (n=139): 77.6 yrs. (SD 4.6) Men: Serum 25OHD ≤50 nmol/L (n=45): 78.6 yrs. (SD 4.7) Serum 25OHD >50 nmol/L (n=170): 77.7 yrs. (SD 4.5)	1 yr.	- / -	- / Total sample: N=209 (45.9%) [†]
<p>Abbreviations: 25OHD = 25-hydroxyvitamin D, min. = minimum, nmol/L = nanomole per liter, nr. = number, PrCS = prospective cohort study, RCS = retrospective cohort study, SD = standard deviation, yr. = year, yrs.= years,</p> <p>* Flicker et al. (2003): Low-level care refers to assisted living facilities, while high-level care refers to nursing homes</p> <p>[†] Menant et al. (2016): Number of falls for men and women is not mentioned separately</p>									

Table 4: Studied risk factors of interest

Author (Year)	Studied Risk Factors of Interest
Studies including only women	
Bergland et al. (2003)	<p>Behavioural Risk Factors: polypharmacy ≥ 3</p> <p>Biological Risk Factors: impaired vision, impaired hearing, less than a full score on PADL, less than a full score on IADL, osteoporosis, symptoms of depression, hypertension</p>
Brown et al. (2000)	<p>Biological Risk Factors: urinary incontinence</p>
Davis et al. (1999)	<p>Behavioural Risk Factors: alcohol use, physical activity, polypharmacy ≥ 3</p> <p>Biological Risk Factors: physical function, visual impairment, cognitive function, illness of the heart, illness of the lung, arthritis</p>
Faulkner et al. (2003)	<p>Socioeconomic Risk Factors: social integration</p>
Faulkner et al. (2009)	<p>Behavioural Risk Factors: physical activity (Harvard alumni questionnaire)</p> <p>Biological Risk Factors: difficulty performing IADLs, dizziness upon standing, fear of falling, visual impairment, self-rated health decline, standing balance, gait speed</p>
Flicker et al. (2003)	<p>Biological Risk Factors: serum vitamin D (25OHD), low cognitive function, age</p>
Heesch et al. (2008)	<p>Behavioural Risk Factors: physical activity</p>
Lim & Sung (2012)	<p>Behavioural Risk Factors: physical activity</p> <p>Biological Risk Factors: non-communicable disease</p> <p>Environmental Risk Factors: slippery floor, poor lighting</p>
Moon et al. (2020)	<p>Biological Risk Factors: urinary incontinence</p>
Shimizu et al. (2015)	<p>Biological Risk Factors: vitamin D Serum, age, serum albumin, 5-m walking time (s), stork standing time with eyes open (s)</p>
Volpato et al. (2005)	<p>Biological Risk Factors: diabetes</p>
Whooley et al. (1999)	<p>Biological Risk Factors: depression</p>
Studies including only men	
Cauley et al. (2013)	<p>Behavioural Risk Factors: physical activity</p>
Chan et al. (2007)	<p>Behavioural Risk Factors: physical activity (PASE)</p> <p>Biological Risk Factors:</p>

	physical performance measures (leg extension power, gait speed, narrow walk pace)
Gill et al. (2009)	Behavioural Risk Factors: relative physical activity (being less active than peers) Biological Risk Factors: age, decline of memory since past 5 years,
Jefferis et al. (2015)	Behavioural Risk Factors: physical activity
Khalatbari-Soltani et al. (2021)	Socioeconomic Risk Factors: education, income
Papachristou et al. (2017)	Biological Risk Factors: gait speed Behavioural Risk Factors: physical activity
Parsons et al. (2009)	Biological Risk Factors: Urinary urgency
Studies including women and men	
Huang et al. (2019)	Biological Risk Factors: balance and walking problems, age, race, comorbidity, ADL dependence, depression, urinary incontinence, PCS (physical summary score), MCS (mental summary score) Socioeconomic Risk Factors: education, income
Kubo et al. (2021)	Biological Risk Factors: physical function, psychological function, cognitive function, health status
Lim et al. (2016)	Biological Risk Factors: physical performance (OLST, TUG)
Lopez et al. (2011)	Biological Risk Factors: hearing impairment, visual impairment
Menant et al. (2016)	Biological Risk Factors: vitamin D insufficiency (serum 25OHD \leq 50 nmol/L)
Abbreviations: 25 OHD = 25-hydroxyvitamin D, ADL = activities of daily living, IADL = instrumental activities of daily living, OLST = one-leg standing test, PADL = personal activities of daily living, PASE = physical activity scale for the elderly, TUGT = time-up and go test	

3.3 Special participant characteristics of included studies

The following section of this thesis presents special participant characteristics of included studies which might have had an influence on the results of the primary studies. An overview of the extracted special participant characteristics can be found in Appendix 2.

3.3.1 Special participant characteristics of studies including only women

Special participant characteristics were found in three studies that included only women (Heesch et al., 2008, Lim and Sung, 2012, Whooley et al., 1999). In the study by Heesch et al. (2008) which analysed physical activity, it is notable that the majority of the participants (54%) had very low to low physical activity levels at baseline. Similar to this, Lim & Sung (2012) which studied the influence of communicable diseases amongst other things, reported that 77% of participants reported being affected by one or more communicable diseases. On the contrary, Whooley et al. (1999) which studied the influence of depression on the risk of falls reported that only 6.3% of participants were considered depressed according to the GDS (Geriatric Depression Scale).

3.3.2 Special participant characteristics of studies including only men

Special characteristics were identified in three studies that included only men (Cauley et al., 2013, Gill et al., 2009, Jefferis et al., 2015). Cauley et al. (2013) which performed age-specific analyses with participants <80 years of age and ≥80 years of age, reported that only 11% of participants were ≥80 years of age. Moreover, each participant from the study by Gill et al. (2009) had at least one modifiable risk factor for falling. Lastly, Jefferis et al. (2015) that studied physical activity, reported that 67.3% of participants had no mobility limitation.

3.3.3 Special participant characteristics of studies including women and men

Special participant characteristics were found in three studies that included men as well as women as participants (Huang et al., 2019, Lopez et al., 2011, Menant et al., 2012). In the study by Huang et al. (2019) women had been diagnosed with breast cancer and men with prostate cancer 2-3 years prior to the study. The second study to have noticeable participant characteristics is by the authors of Lopez et al. (2011) which studied the influence of hearing and vision impairment on the risk of falls. While 30.1% of men that took part in the study had a hearing impairment, the percentage for women with an impairment was at 12.7%. Lastly, Menant et al. (2016) which analysed the influence of vitamin D insufficiency, showed that only 2.8% (n=3) of women which had a 25OHD serum level below ≤ 50 nmol/L, received supplementation of vitamin D. With women that had a serum 25OHD >50 nmol/L, 8.6% (n=12) received vitamin D supplementation. Similar with men, only 4.4% (n=2) of participants with a 25OHD serum level below ≤ 50 nmol/L and 2.4% (n=4) of participants with >50 nmol/L received vitamin D supplementation.

3.4 Quality of Appraised Studies

This chapter elaborates on the critical appraisal of the included studies. The ratings for the individual studies can be seen in Appendix 3. The methodological quality of all included studies ranged from five to eight out of nine stars. The study by Lim & Sung (2012), Heesch et al. (2008), and Flicker et al. (2003) had the worst overall ratings reaching five out of nine possible stars. In total, ratings for the domain selection ranged from three to four stars. As all studies recruited their study participants from a representative or somewhat representative population, the deductions for this domain occurred only for questions on the ascertainment of exposure. Eight of the 24 studies did not provide adequate ascertainment of the studied risk factors as the ascertainment was either based on self-reports from study participants or missing description. One study conducted a structured interview to assess exposure (Lim and Sung, 2012), while others used validated instruments or tests. As previously mentioned, all studies automatically received a star regarding the question of the outcome being present at the start of the study.

The ratings for the domain comparability ranged from zero to two stars. A total of 16 studies (Brown et al., 2000, Khalatbari-Soltani et al., 2021, Cauley et al., 2013, Chan et al., 2007, Davis et al., 1999, Faulkner et al., 2009, Gill et al., 2009, Faulkner et al., 2003, Jefferis et al., 2015, Lim et al., 2016, Lopez et al., 2011, Moon et al., 2020, Parsons et al., 2009, Shimizu et al., 2015, Volpato et al., 2005, Whooley et al., 1999) adjusted their data to age as well as other confounders, and therefore received two out of two stars for the domain comparability. Five studies (Bergland et al., 2003, Flicker et al., 2003, Huang et al., 2019, Kubo et al., 2021, Papachristou et al., 2017) adjusted their data only according to age and were rated with one star. Moreover, two studies did not score any star in regards to comparability (Lim and Sung, 2012, Menant et al., 2012) as there was no indication that they had adjusted their data to age or any other confounder.

Ratings for the domain “outcome” ranged from zero to three stars. Regarding the assessment of outcome ratings, the majority of studies received low ratings, with only two studies achieving a star (Gill et al., 2009, Volpato et al., 2005). These two, were the only studies that conducted interviews with the studies’ participants, with the goal of verifying a fall and ruling out possible slips or close encounters with a fall. The authors of the remaining 22 studies trusted the participants to correctly self-report a fall and therefore did not receive a star. Flicker et al. (2003) which studied the risk factor of falls in the residential care setting, was the only study where the follow-up did not exceed one year. No study had a complete follow-up rate, however 13 studies were able to maintain their percentage of participants which were lost to follow up below 20% (Bergland et al., 2003, Khalatbari-Soltani et al., 2021, Brown et al., 2000, Cauley et al., 2013, Chan et al., 2007, Davis et al., 1999, Faulkner et al., 2003, Huang et al., 2019, Kubo et al., 2021, Menant et al., 2012, Parsons et al., 2009, Shimizu et al., 2015, Whooley et al., 1999).

3.5 Fall risk factors of studies including only women

This section presents the results of the 12 studies that included only women as participants (Bergland et al., 2003, Brown et al., 2000, Davis et al., 1999, Faulkner et al., 2009, Faulkner et al., 2003, Flicker et al., 2003, Heesch et al., 2008, Lim and Sung, 2012, Moon et al., 2020, Shimizu et al., 2015, Volpato et al., 2005, Whooley et al., 1999). Firstly the biological risk factors will be presented which were analysed

in 10 studies (Bergland et al., 2003, Brown et al., 2000, Davis et al., 1999, Faulkner et al., 2009, Flicker et al., 2003, Lim and Sung, 2012, Moon et al., 2020, Shimizu et al., 2015, Volpato et al., 2005, Whooley et al., 1999). The biological risk factors are followed by behavioural risk factors which were studied in five studies (Bergland et al., 2003, Davis et al., 1999, Faulkner et al., 2009, Heesch et al., 2008, Lim and Sung, 2012) as well as environmental risk factors (Lim and Sung, 2012) and socio-economic risk factors (Faulkner et al., 2003) which were analysed in each one study. All data of studies only including women can be seen in Appendix 4.

3.5.1 Biological Risk Factors

The biological risk factors which were analysed in studies that only included women, are presented according to general risk factors, physiological disorder, impaired senses and physical performance.

3.5.1.1 General Risk Factors

The analysed general biological risk factors of falls in women were activities of daily living (ADL), age, chronic conditions, cognitive function, comorbidity, depression, fear of falling, health-status, serum albumin, urinary incontinence, vitamin D insufficiency.

Two of three studies measured that having difficulties with performing ADL / instrumental activities of daily living (IADL) significantly increase the risk of falling (Faulkner et al., 2009, Davis et al., 1999). Bergland et al. (2003) in contrast, did not show a significant increase in the odds of falling for people who did not score all the points on the personal activities of daily living (PADL) (OR 1.6; CI not mentioned; $p=0.22$) and IADLs (OR 1.4; CI not mentioned; $p=0.12$). One of two studies that measured the risk factor increased age (Flicker et al., 2003, Shimizu et al., 2015), showed significant results. Community dwelling women that were ≥ 80 years had a 42% higher chance of falling (OR 1.42; CI 1.09–1.84; $p= 0.009$) compared to community dwelling women between the age of 75-79 (OR 1.00) (Shimizu et al., 2015). Heesch et al. (2008) and Lim & Sung (2012) both showed that being diagnosed with one or more chronic conditions, significantly increases the odds of falling. When looking at the data by Heesch et al. (2008), it is apparent that the odds

of falling increased with the number of diagnosed chronic conditions. The influence of cognitive function on falling was measured by the studies Davis et al. (1999) and Flicker et al. (2003). The results of Davis et al. (1999) did not show a significant increase in the rate ratio of falling with impaired cognitive function. Flicker et al. (2003), which conducted a study in a nursing home, measured cognitive function using the AMTS (Abbreviated Mental Test Score, 0-10 points, higher score – better cognitive function) for which a score ≤ 8 points indicates impaired cognitive function (Flicker et al., 2003). Residents living in a residential care setting which scored between 4-7 points had a significantly higher hazard ratio of falling (HR 1.37; CI 1.03–1.82; p-value not mentioned) compared to residents with scores between 8-10 points (HR 1.00). Bergland et al. (2003), which was the only study to measure the influence of comorbidity on falling, showed that community dwelling women which are diagnosed with more than three illnesses, are twice as likely to fall than community dwelling women diagnosed with less than three illnesses (OR 2.0; CI not mentioned; p=0.002). Both studies that measured the influence of depression on falling regarding community dwelling women, showed significant increases in odds ratios ranging from 1.4 to 2.1 (Whooley et al., 1999, Bergland et al., 2003). Faulkner et al. (2009) was the only study that included only women to measure fear of falling. Results showed a significant increase in the risk of falling (RR 1.20; CI 1.11-1.29; p-value not mentioned). Moreover, this study also showed that the participants that noted a health decline had a significant higher risk of falling compared to those participants that did not state a health decline (RR 1.19; CI 1.04-1.35; p-value not mentioned) (Faulkner et al., 2009). Shimizu et al. (2015) was the only study to measure the influence of serum albumin in the risk of falling. Authors of this study were able to show that a serum albumin lower than 4.3 gram per deciliter (g/dL) significantly increased the odds ratio for falling in women (OR 1.32; CI 1.02-1.70; p=0.037). Urinary incontinence was found to be a significant risk factor in all three studies that measured this factor (Brown et al., 2000, Heesch et al., 2008, Moon et al., 2020). Two studies measured the influence of vitamin D on falling. While Shimizu et al. (2015) showed that a low level of serum 25-hydroxy vitamin D (25OHD) significantly increases the risk of falling by 40%, results from Flicker et al. (2003) showed that higher serum 25OHD significantly reduced the hazard ratio by 23

3.5.1.2 Physiological Disorders

Six physiological disorders (arthritis, diabetes, hypertension, illness of the heart, illness of the lungs and osteoporosis) were explored in three cohort studies that included only women (Bergland et al., 2003, Davis et al., 1999, Volpato et al., 2005). All of the physiological disorders were analysed by each one study. The risk factor arthritis did not significantly increase the rate ratio of falling in community dwelling women (Rate Ratio 1.3; CI 0.9-2.0; p-value not mentioned) (Davis et al., 1999). Regarding diabetes, Volpato et al. (2005) showed that the odds ratio of falling in community dwelling women with diabetes was 38% higher (OR 1.38; CI 1.04–1.81; p-value not mentioned) than for women without diabetes (OR 1.00). The study that explored hypertension, showed significant results with an odds ratio of 1.8 (CI not mentioned; p=0.002) (Bergland et al., 2003). An illness of the heart and an illness of the lungs were also shown to be significant risk factors of falling. The illness of the heart increased the rate of falling by nearly two-fold (Rate Ratio 1.7; CI 1.1-2.5; p-value not mentioned) and the illness of the lungs by nearly three-fold (Rate Ratio 2.8; CI 1.4-5.6; p-value not mentioned) (Davis et al., 1999). Osteoporosis was also shown to be a significant risk factor of falling (Bergland et al., 2003). According to Bergland et al. (2003) osteoporosis significantly increased the odds of falling by more than two-fold (OR 2.1; CI not mentioned; p=0.005).

3.5.1.3 Physical performance

Three studies (Davis et al., 1999, Faulkner et al., 2009, Shimizu et al., 2015) explored nine outcomes regarding physical performance (balance, chair-stand test, dizziness, functional reach, one-leg standing test, time-up and go test, quadriceps strength, reaction time and gait speed).

Balance and gait speed were the only outcomes which were analysed by two studies, while the outcomes chair stand test (≥ 10.2 seconds), dizziness, low functional reach, OLST (one-leg standing test) (< 16 seconds), low scores on the TUGT (time-up and go test), low quadriceps strength and slow reaction time were analysed by one study. Taking longer than 10.2 seconds on the chair stand test (Davis et al., 1999), suffering from dizziness while standing (Faulkner et al., 2009), not being able to perform the OLST longer than 16 seconds (Shimizu et al., 2015)

and having low quadriceps strength (Davis et al., 1999) showed a significant negative impact on falling. Balance was measured in two studies, of which only the study by Faulkner et al. (2009) revealed significant results. This prospective study showed that good balance is a protective factor regarding the risk of falling (RR 0.85; CI 0.76-0.95; p-value not mentioned). Two of the three studies that measured the impact of gait speed on falling showed significant results. While Shimizu et al. (2015) measured significant results regarding a low gait speed (OR 1.37; CI 1.05–1.79; p=0.019), Faulkner et al. (2009) showed that a faster gait speed than the average also increased the risk of falling (RR 1.18; CI 1.08-1.30; p-value not mentioned).

3.5.1.4 Impaired senses

Two studies analysed the influence of impaired hearing and eyesight on the possibility of falling (Bergland et al., 2003, Heesch et al., 2008).

Impaired hearing, which was only studied by Bergland et al. (2003), did not show a significant increase in the odds of falling. However, both studies that studied impaired vision on falling, showed significant odds ratios ranging from 1.49 to 1.83 (Bergland et al., 2003, Heesch et al., 2008).

3.5.2 Behavioural Risk Factors

The analysed behavioural risk factors in regards to studies including only women, were the consumption of alcohol, physical inactivity and polypharmacy.

Alcohol consumption was only measured by Davis et al. (1999). This prospective study showed that alcohol consumption did not significantly increase the risk of falling in community dwelling women (RR 0.9; CI 0.5-1.5; p-value not mentioned). The influence of levels of physical activity were analysed by four studies (Faulkner et al., 2009, Davis et al., 1999, Heesch et al., 2008, Lim and Sung, 2012). Only Heesch et al. (2008) found that participants that stated that they partook in very high levels of physical activity had a significant decrease in the odds of falling. Faulkner et al. (2009) assessed physical activity using a modified version of the Harvard alumni questionnaire (Paffenbarger et al., 1986) which assesses the duration and the frequency of physical exercise as well as the length of walks and climbed stairs. In contrast to Heesch et al. (2008), they found that women from the two most active quartiles had significant increases of 12-26% in the risk of falling. The remaining two

studies that measured physical activity, did not show significant results (Davis et al., 1999, Lim and Sung, 2012). Two studies measured the influence of polypharmacy on the risk of falling in community dwelling women. Both Bergland et al. (2003) and Davis et al. (1999) defined polypharmacy as taking more than three types of medication a day. In the prospective study by Bergland et al. (2003), which only presented crude data, polypharmacy was not significantly associated with an increased risk of falling compared to women that did not have polypharmacy (OR 1.3; CI not mentioned; $p=0.33$). Although Davis et al. (1999) adjusted the data to several covariates, polypharmacy did not show a significant increase in the rate of falls compared to women that took less than 3 types of medication a day (Rate Ratio 1.3; CI 0.9-1.9; p -value not mentioned).

3.5.3 Socioeconomic Risk Factors

Education and social integration were socioeconomic fall risk factors which were measured in studies that included only women.

Heesch et al. (2008) conducted a prospective survey from 1996 to 1999 and once from 1996 to 2002. Education was sorted to different levels and the education level “no secondary school” was used as a reference point of measurement. The survey responses from 1996 to 1999 did not show a significant increase in odds of falling for any higher level of education. On the contrary, in the responses from 1996 to 2001, all higher levels of educations showed a significant increase in odds of falling in women. Social integration was measured using the Lubben Social Network Scale (LSNS), for which the composite score (higher score, better social integration) is made up of the scores in regards to family network, friendship network and interdependence. The composite score showed that higher scores than the lowest quartile equates for no significant reduction in the relative risk of falling.

3.5.4 Environmental Risk Factors

Lim & Sung (2012) was the only study including only women that explored environmental risk factors for falls.

This retrospective study showed that community dwelling women with poor lighting during the night were nearly twice as likely to fall as compared to community dwellers with suitable / appropriate night lighting (OR 1.98; CI not mentioned;

p=0.032). Furthermore, Lim et al. (2012) analysed the risk factor slippery floor in the bathroom however, this result was not significant (OR 1.04; CI not mentioned; p=0.086). It must be noted that Lim & Sung (2012) did not adjust the data to possible covariates.

3.6 Fall risk factors of studies including only men

This section of the thesis describes the results of studies on fall risk factors which included only men. Of the seven studies, biological risk factors were explored in four studies (Chan et al., 2007, Gill et al., 2009, Papachristou et al., 2017, Parsons et al., 2009) and behavioural risk factors in five studies (Papachristou et al., 2017, Jefferis et al., 2015, Cauley et al., 2013, Chan et al., 2007, Gill et al., 2009). Environmental risk factors were not analysed in any of the studies including only men, while one study analysed socio-economic risk factors (Khalatbari-Soltani et al., 2021) All data on the fall risk factors in men can be seen in Appendix 5.

3.6.1 Biological Risk Factors

The biological risk factors which were analysed in studies including only men, were categorised according to general risk factors and physical performance. No studies were found regarding physiological disorders and impaired senses.

3.6.1.1 General Risk Factors

General risk factors that were studied were age, cognitive function and urinary urgency. The risk factor age, which was analysed in one study, did not have a significant influence on the odds of falling in regards to men (OR 1.03; CI 0.97–1.10; p=0.34) (Gill et al., 2009). Furthermore, Gill et al. (2009) was the only study which included only men that explored cognitive function. This prospective study showed that a decrease in memory since the last five years significantly increased the odds of falling in community dwelling men (OR 1.90; CI 1.13–3.20; p=0.02). Parsons et al. (2009) showed that urinary urgency significantly increases the risk of falling in men, indicating that the risk increases with the frequency of urinary urgency.

3.6.1.2 Physical Performance

Two studies that included only men studied the following factors of physical performance regarding the risk of falling: performance on the chair stand test, leg extension power, narrow walking pace, walking speed. Low performance on the chair stand test, low leg extension power and a narrow walking pace did not significantly increase the risk of falling in men (Chan et al., 2007). The effect of gait speed on the risk falling was assessed by two studies (Chan et al., 2007, Papachristou et al., 2017), however significant results were only seen in the study by Papachristou et al. (2017).

3.6.2 Behavioural Risk Factors

The only behavioural risk factor that was analysed in studies with only men was physical inactivity. This factor was studied in five of six studies that included only men (Papachristou et al., 2017, Jefferis et al., 2015, Cauley et al., 2013, Chan et al., 2007, Gill et al., 2009). Cauley et al. (2013) assessed physical activity according to active energy expenditure (EE), as well as the daily minutes of moderate activity in which a participant partook. According to Cauley et al. (2013), moderate activity was defined as activity that uses 3-6 metabolic equivalents (METs) while active EE was defined as calories that were burnt as a result of physical movement of moderate intensity or higher. Cauley et al. (2013) categorised their data according to the age groups <80 years of age and ≥80 years of age. The results showed that performing less than 125 minutes of moderate activity per day and burning less than 775 active calories per day did not significantly impact the risk of falling in men, over the age of 80 (11%; n=not specified). For participants that were below the age of 80 (89%; n=not specified), burning between 190.6 -775 kcal/day through movement of at least moderate intensity showed to be a significant protective factor against falling. Furthermore, performing between 32.6-84.6 minutes of moderate activity was also a significant protective factor against falling for persons under the age of 80. (Cauley et al., 2013) Gill et al. (2009) showed that participants that rated themselves as less active than their peers did not have a significant increase in the odds of falling (OR 1.43; CI 0.65–3.13; p=0.38). Jefferis et al. (2015) studied the following factors of physical activity on the incidence rate ratio of falling regarding

persons with and without mobility problems: steps per day, ≥ 30 minutes of moderate to vigorous physical activity per day in bouts of either > 1 minute or ≥ 10 minutes, ≥ 30 minutes of light activity per day, ≥ 30 minutes of sedentary time per day, walking < 9000 steps per day and ≥ 9000 steps per day. Sedentary behaviour was classified as activity that uses < 1.5 METs, light activity as using 1.5-3 METs and moderate to vigorous activity as using > 2 METs. For persons with no mobility problems ($n=471$) having a higher step count (IRR 1.20; CI 1.06–1.35; p-value not mentioned), performing ≥ 30 minutes of moderate to vigorous physical activity per day in bouts of either > 1 minute (IRR 1.50; CI 1.10–2.04; p-value not mentioned) and ≥ 10 minutes (IRR 1.99; CI 1.20–3.29; p-value not mentioned); walking ≥ 9000 per day (IRR 1.60; CI 1.17–2.20; p-value not mentioned) significantly increased the incident rate of falling. On the contrary, having a higher step count (IRR 0.84; CI 0.72–0.97; p-value not mentioned) and performing ≥ 30 minutes of moderate to vigorous physical activity per day in bouts of ≥ 10 minutes (IRR 0.21; CI 0.07–0.68; p-value not mentioned) significantly decreased the incident rate of falls in persons with mobility problems ($n=229$). Furthermore, ≥ 30 minutes of sedentary time a day significantly increased the incident rate ratio (IRR) of falling in persons with mobility problems ($n=229$) (IRR 1.11; CI 1.00–1.23; p-value not mentioned) (Jefferis et al., 2015). Papachristou et al. (2017) measured physical activity once based on the Fried assessment for Frailty, and once through self-reports. Both assessments showed that physical inactivity leads to a significant increase in the risk of falling with odds ratio from 1.80 (according to the Fried assessment) to 1.83 (according to self-reports). Chan et al. (2007) used the Physical Activity Scale for the Elderly (PASE) to assess physical activity based on occupational, household and leisure activities and for which a lower score indicates less physical activity (Washburn et al., 1993). The participants that were among the third and the fourth most active quartile, had significantly increased risks of falling compared to the quartile that was the least active (Chan et al., 2007).

3.6.3 Socioeconomic Risk Factors

Khalatbari-Soltani et al. (2021) was the only study including only men that studied socio-economic risk factors. The analysed factors were income and education.

However, both education and income, did not lead to a significantly increased incident rate of falls in men.

3.6.4 Environmental Risk Factors

No study which included only men investigated environmental risk factors.

3.7 Fall risk factors of studies including women and men

The following chapter illustrates the fall risk factors of the five studies that included men as well as women. Results for the genders were shown separately. Biological factors were explored in all five studies (Huang et al., 2019, Kubo et al., 2021, Lim et al., 2016, Lopez et al., 2011, Menant et al., 2012) and socio-economic risk factors were analysed in one study (Huang et al., 2019). No study explored behavioural or environmental risk factors. All data on studies that analysed fall risk factors regarding women and men is to be seen in Appendix 6.

3.7.1 Biological Risk Factors

The results of studies that included women as well as men are presented as general risk factors, impaired senses and physical performance. No study was found that analysed risk factors regarding physiological disorders.

3.7.1.1 General Risk Factors

The studied biological risk factor with regard to studies including men and women were ADL dependence, age, impaired cognitive function, comorbidity, depression, race, health-status, psychological function, urinary incontinence, vitamin D insufficiency, impaired hearing and vision, impaired physiological function and performance. These factors were studied by a total of three cohort studies (Huang et al., 2019, Kubo et al., 2021, Menant et al., 2012). Huang et al. (2019) showed that a dependence in at least one of the six activities of daily living was a significant risk factor for men (OR 1.55; CI 1.38–1.75; $p < 0.001$) as well as women (OR 1.31; CI 1.14–1.52; $p < 0.001$), however the odds of falling were slightly higher in men. Age was only a significant risk factor for men in this study (OR 1.06; CI 1.03–1.10; $p < 0.001$). Kubo et al. (2021) was the only study with women as well as men to study

the risk factor of impaired cognitive function. This retrospective study measured cognitive function by asking the participants if they see themselves as forgetful and if others have told them that they are forgetful. Men with self-reported forgetfulness had a slightly higher significant odd of falling than women. On the contrary, if the participants had been told that they were forgetful, women (OR 1.54; CI 1.07-2.21; $p=0.02$) had a slightly higher odd of falling than men (OR 1.60; CI 1.04-2.46; $p=0.03$) (Kubo et al., 2021). The prevalence of a comorbidity similarly increases the odds of falling significantly in community dwelling women (OR 1.26; CI 1.10–1.45; $p=0.001$) as well as men (OR 1.25; CI 1.12–1.40; $p<0.001$) (Huang et al., 2019). Depression significantly increased the odds of falling in men by nearly three-fold (OR 2.88; CI 1.51–5.46; $p=0.001$), while women did not have a significant increase (OR 1.41; CI 0.72–2.76; $p=0.319$) (Huang et al., 2019). Similar results were seen regarding the race, where Caucasian men had a significantly higher risk of falling than men of other race (OR 1.79; CI 1.12–2.78; $p=0.013$). The risk of falling in Caucasian women however, did not significantly increase compared to women of another race. Kubo et al. (2021) showed that both women and men had significantly increased odds of falling if they stated that their current state of health is not good. However, the odds ratio for falling regarding women was at 2.50 (CI 1.68-3.71; $p<0.001$) while the odds of men was 1.57 (CI 1.01-2.45; $p=0.04$). Psychological function was measured by two studies. Huang et al. (2019) used the Mental Component Score (MCS) from the Veterans RAND 12-Item Health Survey (VR-12) for which lower scores indicate worse psychological function. Women and men of this study had very similar scores which showed that higher scores on the MCS (better psychological function) significantly reduced the odds of falling. The second study to measure the influence of psychological function on the odds of falling was Kubo et al. (2021). This retrospective study asked their participants four questions regarding if they had felt gloomy in the last month, if they experienced joy in daily activities, if they were able to concentrate and if they found it difficult to do things that they could do easily before. The odds of falling significantly increased for both, women and men, if they had felt gloomy or had difficulty to do things that were once easier. Interestingly, not experiencing joy in daily activities only significantly increased the odds of falling in women. Contrastingly, not being able to concentrate only significantly increased the odds of falling in men. Urinary incontinence, which was studied by Huang et al. (2019), significantly increases the odds ratio of falling only in men (OR 1.69; CI 1.08–

2.65; $p=0.021$). Similarly, a vitamin D insufficiency below 50 nanomol per liter (nmol/l) also only significantly increased the incident rate ratio in men by nearly two-fold (IRR 1.93; CI 1.19-3.15; $p=0.008$), while there was no significant increase for women (Menant et al., 2012).

3.7.1.2 Impaired senses

The influence of impaired hearing and impaired vision were each measured by Lopez et al. (2011). This retrospective study showed that hearing and vision impairments significantly increase the odds of falling for women as well as men. However, the odds of falling when suffering from a hearing or a vision impairment, was slightly higher in women than in men.

3.7.1.3 Physical Performance

Three studies with men as well as women (Huang et al., 2019, Kubo et al., 2021, Lim et al., 2016) measured the following five outcomes of physical performance regarding the risk of falling: balance or walking problems, impaired physical function, performance of the OLST, TUGT and OLST+TUGT. Self-reported balance or walking problems were noted as a significant risk factor for falling regarding women as well as men. However, while the odds ratio for women was at 1.81 (CI 1.16-2.83; $p=0.009$), the odds ratio for men increased more than four-fold (OR 4.22; CI 2.83-6.30; $p<0.001$) (Huang et al., 2019). Physical function as an outcome itself was measured in two studies. Huang et al. (2019) used the physical component score (PCS) of the VR-12 for which higher scores indicate better physical function. The results of this retrospective study showed that a higher score (better physical function) significantly decreased the odds of falling in women (OR 0.97; CI 0.96–0.99; $p=0.003$) and men (OR 0.96; CI 0.94–0.98; $p<0.001$) (Huang et al., 2019). The second study to measure physical function was Kubo et al. (2021), which assessed physical function according to the following three criteria: having pain in the knees or lower back, the inability to walk for 15 minutes, and the need to use the handrails or wall when climbing stairs. When looking at the unadjusted data, all three of these criteria were significant risk factors for women as well as men. However, this retrospective study only presented adjusted data on the inability to climb stairs without using the handrails or the wall for men and women, and having pain in the

knees or lower back while walking or standing up. Like with the unadjusted data, all outcomes were shown to significantly increase the odds of falling. Interestingly, having to use the handrails or wall to climb the stairs increased the odds in women by nearly three-fold (OR 2.88; CI 2.01-4.13; $p < 0.01$), while the increase in men was close to two-fold (OR 1.98; CI 1.25-3.13; $p < 0.01$). The performance on the TUGT, OLST and the combined scores of the OLST and the TUGT did not significantly change the odds of falling in women as well as men (Lim et al., 2016).

3.7.2 Behavioural Risk Factors

None of the studies that included women as well as men analysed behavioural risk factors.

3.7.3 Socioeconomic Risk Factors

The only socio-economic risk factors that were analysed in studies including women as well as men were education and income. These factors were measured in the study by Huang et al. (2019) which showed that both higher education (\geq high school diploma) and higher income (\geq 20,000 dollars) did not significantly increase the odds of falling in women as well as men.

3.7.4 Environmental Risk Factors

No study that included women as well as men analysed environmental risk factors.

4 Discussion

This systematic review aimed to analyse fall risk factors in older adults according to gender. Only a very limited number of studies analysed fall risk factors of men as well as women which made a direct comparison of results difficult. In addition, the very heterogenous outcome assessment of the primary studies, did not make it possible to perform a meta-analysis. Nevertheless, with regard to the research question, it was possible to identify significant gender-specific risk factors (Figure 3 and Figure 4).

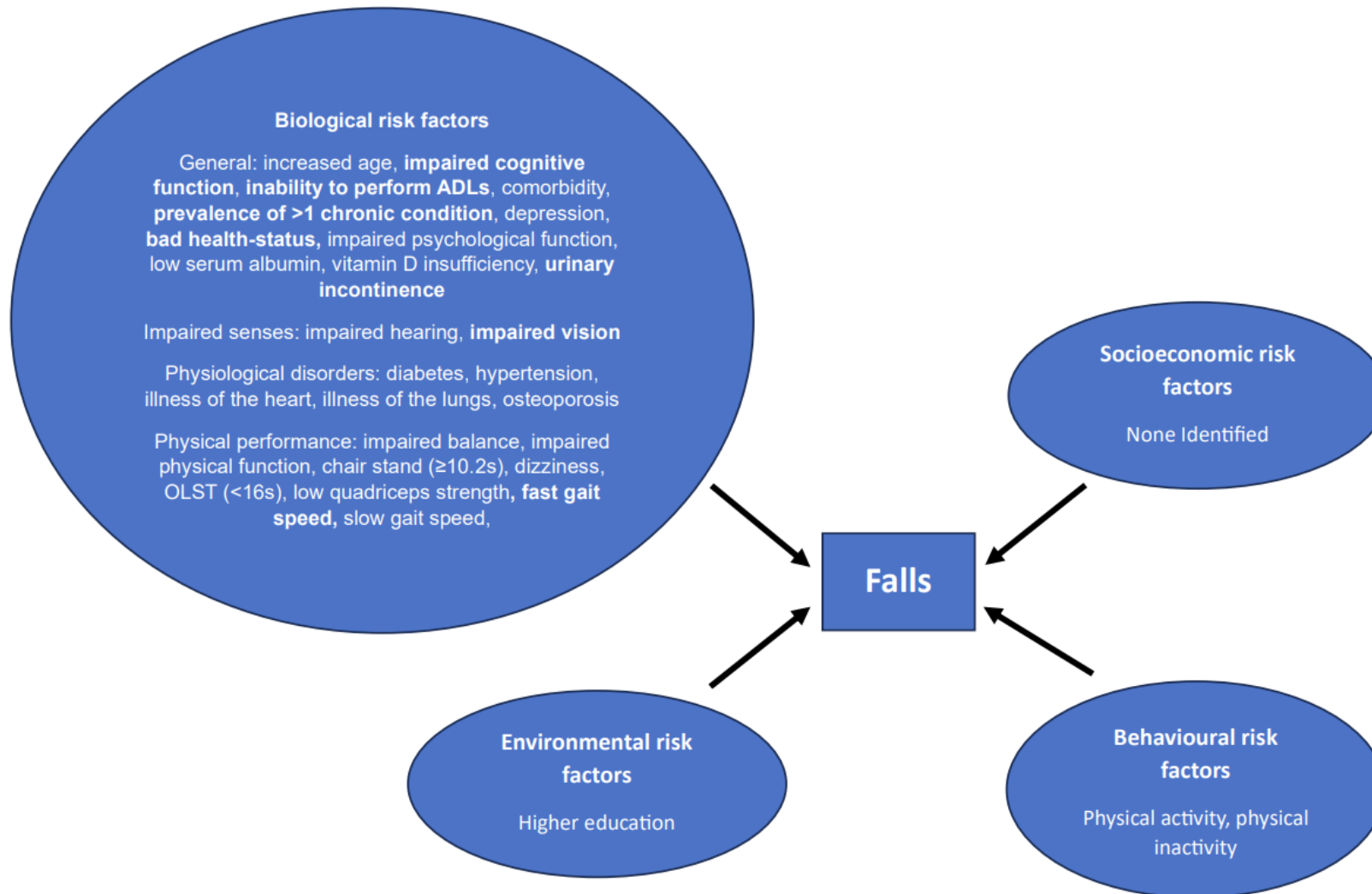


Figure 3: Identified significant risk factors for women categorized according to the WHO risk factor model of falls in older age. Bold font represents significant risk increase in more than one study. Figure does not include protective factors.

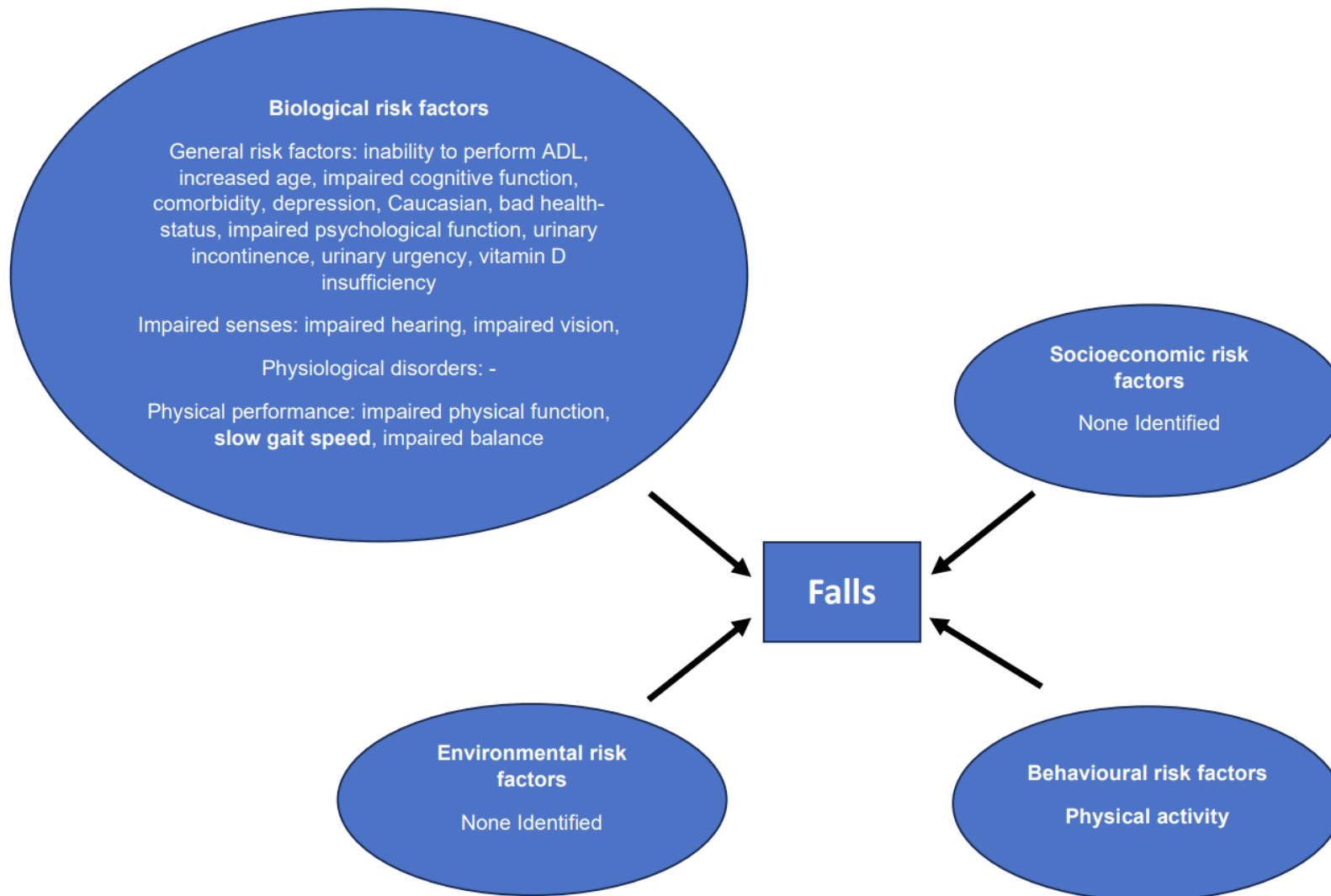


Figure 4: Identified significant risk factors for men categorized according to the WHO risk factor model of falls in older age. Bold font represents significant risk increase in more than one study. Figure does not include protective factors.

The majority of analysed risk factors across all included primary studies were from the category biological factors, followed by behavioural risk factors. There was an overlap of 14 biological risk factors that were significant for both women and men. Of the biological risk factors, illness of the lungs had the strongest influence on falls in women with an almost 3-fold increased chance of falling (Davis et al., 1999), while impaired balance had the highest influence on falls in men with an over 4-fold increase in the chance of falling (Huang et al., 2019).

When looking at the behavioural risk factors, it was seen that performing physical activity in general, was measured as a significant risk factor of falling in both men (Chan et al., 2007, Jefferis et al., 2015) and women (Faulkner et al., 2009). Interestingly, Chan et al. (2007) and Faulkner (2009), which were two of three studies that measured physical activity as a significant risk factor, were the only studies that use an instrument or assessment tool to measure physical activity. Remaining studies on physical activity surveyed these risk factors through an electronic device (Cauley et al., 2013, Jefferis et al., 2015) or solely through dichotomous questioning (Davis et al., 1999, Lim and Sung, 2012, Gill et al., 2009, Papachristou et al., 2017). The study by Chan et al. (2007) which only included men, assessed the physical activity using the PASE which was specifically developed to assess physical activity for older adults over the age of 65 and has shown strong validity (Washburn et al., 1999, Dinger et al., 2004) and reliability (Washburn et al., 1993). When interpreting the results of Chan et al. (2007), it must be noted that the authors also analysed the scores of the individual categories of physical activity that the PASE assesses (occupational, household and leisure activities), which showed that the majority of falls were attributed to household activities. Furthermore, leisure activities such as walking, weight training and sport, were the least performed type of physical activity and were not associated to falls (Chan et al., 2007). Faulkner et al. (2009) used the Harvard Alumni Questionnaire to assess physical activity in men. Unfortunately, no further information can be found on this questionnaire. This therefore makes Chan et al. (2007) the only study included in this review that used a validated and reliable assessment scale to measure physical activity levels in older adults.

Furthermore, the results of both Faulkner et al. (2009) and Jefferis et al. (2015) indicate that specifically performing high amounts and intensity of physical activity, such as more than 30 minutes of moderate to vigorous physical activity per day,

significantly increase the risk of falling. An explanation for this may be that in comparison to persons with high sedentary behaviour, high amounts and higher intensities of physical activity potentially increase the exposure of a situation or environment in which a fall and a consequential injury may occur (Ramsey et al., 2022). Similar to physical activity, individual criteria of good physical performance (fast gait speed, ability to perform chair stand ≥ 10.2 seconds) in women also showed significant increases in the risk of falling (Davis et al., 1999). However, multiple public-health guidelines and recommendations have presented the benefits of physical activity for older adults (Fiona et al., 2020, Izquierdo et al., 2021, Titze et al., 2020). In particular, the WHO guideline on physical activity from 2020 (Fiona et al., 2020) gives a strong recommendation with moderate certainty in evidence in favour of adults of 65 years and older to perform at least 150 to 300 minutes of moderate to vigorous aerobic training per day to decrease the risk of falls. Furthermore, the guideline states that the additional strengthening of balance through multicomponent exercise on at least three days of the week is strongly recommended to prevent falls (Fiona et al., 2020).

More specifically, a Cochrane review published in 2020, which assessed the influence of physical activity programs on falling regarding adults over the age of 65 (Sherrington et al., 2020), underlines the importance of active movement in older age in order to prevent falls. The measurements of Sherrington et al. (2020), which are based on 116 included randomized-controlled trials (RCTs) and over 25,000 participants, showed that there is a high certainty of evidence that physical activity, in particular balance and functional exercise in older adults significantly decreases the rate of falls by 24%. Moreover, it was seen that high amounts of physical exercise (>3h/week) combined with balance and functional activity, decreased the incident rate ratio by 42%. Contrary thereto, a systematic review from 2020 showed that there is a moderate confidence in evidence that physical activity interventions significantly increases the risk of falls in residents of long-term care homes by 17% (Schoberer and Breimaier, 2020). Although the Cochrane review as well as the review by Schoberer and Breimaier (2020) included men as well as women, no gender-specific subgroup analyses were performed. This suggests that the effect of physical activity programs on falls in older age regarding gender remains inconclusive and needs further high-quality research.

When looking at the gender aspect of the research included in this systematic review, several flaws can be seen. Firstly, the number of cohort studies which performed gender specific analyses on the risk factors of falls is very low in relation to the entire research on falls so far. Secondly, despite this thesis's focus on gender rather than sex, research on gender specific risk factors focuses solely on men and women, therefore not taking genders outside of the binary construct into consideration. More specifically, studies that reported specifically on gender, only stated the percentage of assumably cisgendered women and men in their sample, therefore not acknowledging agendered or non-binary participants. Additionally, the majority of included studies generally did not specify whether they included their sample based on sex or gender, while only four primary studies referred to the term gender and one study used the term sex. This lack of specification on the basis of gender and sex can be explained by looking at reporting guidelines. A systematic review from 2021 aimed at exploring the correct use of gender and sex in reporting guidelines that were published from inception until 2018 (Gogovor et al., 2021). Gogovor et al. (2021) based the correct use of gender and sex on three criteria: the integration of sex and gender outside of the binary, such as intersex and non-binary; the appropriate use of wording to describe sex and gender; the non-interchangeable use of sex and gender throughout the guideline. Only one reporting guideline (Sex and Gender Equity in Research guideline) (Heidari et al., 2016) of the 407 that were studied met all three of these criteria (Gogovor et al., 2021). The Sex and Gender Equity in Research guideline (SAGER), does not state that when reporting on gender, authors should indicate the percentage of gender-diverse populations such as persons identifying as transgender or non-binary (Heidari et al., 2016). However, the authors of the SAGER guideline also discuss that unfortunately not all areas of the world are acquainted with such extent of gender diversity. This may be a further explanation for the lack of specification between gender and sex regarding the primary studies of this review and calls further education on this topic. Nevertheless, the SAGER guideline emphasizes the correct and appropriate use of gender and sex and urges to conduct gender and sex specific analyses in research regardless of their outcome. Therefore, it is encouraged to refer to the SAGER guidelines when reporting study results, with the hope of increasing gender-specific analyses in research.

When comparing the results of this thesis to international literature, it can be said that several of the identified gender-specific risk factors of this thesis have been found significant in previous reviews (Deandrea et al., 2013, Deandrea et al., 2010, Sousa et al., 2017). Examples for these are cognitive impairment, dizziness, and increased age. These factors have been shown to significantly increase the risk of falls not only in community-dwelling older adults (Deandrea et al., 2010, Sousa et al., 2017) but also in hospital inpatients and nursing home residents (Deandrea et al., 2013). Interestingly, dizziness was amongst the strongest risk factors in the review by Deandrea et al. (2010) that investigated over 30 fall risk factors in community dwellers. While Deandrea showed an increased risk by nearly two-fold, the results of this thesis presented a notably lower increased risk of 16% (Faulkner et al., 2009). However, it must be mentioned that Deandrea et al. (2010) based this effect on pooled data from six studies, while the effect in this thesis is from a single study (Faulkner et al., 2009).

The methodological appraisal of the included studies yielded overall ratings ranging from five to eight out of nine possible stars. The majority of deductions were attributed to the ascertainment of exposure, ascertainment of outcome and the adequacy of follow-up. Nearly all studies based their ascertainment of falls on self-reports which led to reductions in ratings, on the basis of a possible recall bias. Especially as studies had long follow-up times, participants may have forgotten that they had fallen or falsely reported a trip or a slip as a fall. Only two studies performed structural interviews with study participants to verify the occurrence of a fall. Flicker et al. (2003) which was the only study conducted in the residential care setting, did not consult to medical records such as fall reports, despite possibly having access to this. Moreover, on the ascertainment of falls, it was noted that different definitions of falls were applied throughout the included studies which may be a contributing factor to the heterogeneity of study results. Similarly, the ascertainment of outcomes was also more than often based on self-reports. In addition, the assessment of the outcome was in some cases not suitable. As an example, Gill et al. (2019) defined being physically active as being more active than peers, despite there being an array of suitable physical activity assessment tools aimed at older adults (Strath et al., 2013).

This review has made several research gaps regarding gender-specific risk factors of falls visible. As previously mentioned, gender specific research on the risk factors of falls so far, has focused only on men and women. This shows that research regarding fall risk factors in terms of genders outside of the binary construct is missing and is to be strongly encouraged for future researchers as this furthermore enables to gain a better understanding on fall risk factors. Although a broad range of outcomes were analysed, only few primary studies conducted research on the same outcome. Furthermore, the outcome assessment was very heterogenous throughout the studies that studied the same risk factors. This was especially apparent in studies measuring the influence of physical activity on falls (Cauley et al., 2013, Davis et al., 1999, Faulkner et al., 2009, Gill et al., 2009, Jefferis et al., 2015).

Despite the broad range of included risk factors in this review, is apparent that an elaborate gender specific analysis of socio-economic, environmental and behavioural risk factors is still missing. Although the majority of studied outcomes were from the category of biological risk factors, depression was the only psychological risk factor which was studied. This shows a clear research gap regarding important psychological risk factors such as fear of falling and anxiety.

Surprisingly, only one of the included studies was conducted in a residential care setting (Flicker et al., 2003) while the remaining studies were focused on community-dwellers. This shows that there is a gap regarding research on gender-specific fall risk factors for older adults in health-care institutions. It can be said that the previously mentioned research gaps indicate that the overall number of cohort studies on gender specific risk factors for falls still remains low and calls for further high-quality research in order to better understand the influence of gender on the risk factors for falls. More specifically, research situated in different settings is of high importance as risk factors of falls vary according to the setting (Deandrea et al., 2013, Deandrea et al., 2010). This systematic review can be seen as an incentive for researchers to conduct more primary studies on this topic while referring rigorous and standardized methods of outcome assessment in order to increase comparability amongst primary studies. Additionally, once more research is available and the certainty of evidence has been assessed, results can be integrated into current fall guidelines, with the aim of supporting health professionals, such as nurses, in taking measures of fall prevention. Moreover, it

should be considered to develop an updated gender-specific WHO risk factor model of falls in older age. Moreover, it is apparent that when referring to the current WHO model, the biological risk factors are very vaguely described and a specification of the biological risk factors should be taken into account in updated models. Furthermore, frailty and history of falls were not specifically mentioned to be a risk factor in the WHO model despite it being recognized as a major significant risk factor of falls in previous literature (Xu et al., 2022). Based on this criticism, updated versions of the WHO model should clearly specify biological risk factors as well include frailty and history of falls into the current model as well as updated models.

It is to be acknowledged that this review has limitations as well as strengths. Despite the comprehensive literature search which also included a search for grey literature, it is possible that some articles relevant to the topic of this thesis were overlooked during the screening process, as this was only done so by one person (Waffenschmidt et al., 2019). Regardless, the critical appraisal of the included studies was conducted by two additional persons.

With this being the first known systematic review on gender-specific fall risk factors of older adults so far, no limitations were set during the literature search regarding the setting. This enabled to provide a comprehensive overview and as well as the identification of significant research gaps. However, a limitation was set regarding the design. By including only cohort studies, research of higher methodological quality was able to be included, as cohort studies are less prone to biases and more rigorous than case-control studies or cross-sectional studies. An additional strength of this thesis is the analysis of a wide variety of risk factors. This is attributed to the vague description of biological risk factors and resulted in having to resort to Sousa et al. (2017) for further specification of the risk factors. It must be mentioned that even with the addition of risk factors from Sousa et al. (2017), further significant risk factors of falls such as frailty (Cheng and Chang, 2017) and history of falling (Asai et al., 2022, Wapp et al., 2022) were not analysed in this thesis despite them being noted as significant risk factors in previous literature. Although originally intended, no meta-analysis of results was conducted within thesis. This was due to the low number of comparable studies.

5 Conclusion

This is the first known systematic review aiming to identify gender specific fall risk factors in older adults. Results indicate that there are several biological risk factors such as impaired senses, impaired physical performance, impaired cognitive function as well as the lack of physical activity that are significant fall risk factors for men as well as for women. 14 factors were significant only for women (e.g. diabetes, dizziness) and two only in men (urinary urgency and Caucasian). Despite the comprehensiveness of this thesis, additional comparable gender specific research is still needed to further explore the impact of gender on fall risk factors. More specifically, this review shows that gender-specific research on behavioural, socioeconomic, environmental risk factors as well as studies conducted in health-care institutions are largely lacking. Nevertheless, this review can be seen as an incentive for researchers to conduct primary studies on fall risk factors including gender-specific analyses. Moreover, it can be assumed that increased research on this field can contribute to an optimization of fall risk assessments and ultimately to the prevention of falls.

6 References

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Appendix

Appendix 1: Applied search strategies in databases and search-engines of initial and update search

Database/ Search- Engine	Search Strategy	Date	Results
PubMed	((((("fall"[Title] OR "falls"[Title] OR "fall"[Title] OR "accidental falls"[MeSH Terms]) AND ("female"[Title/Abstract] OR "females"[Title/Abstract] OR "female*" [Title/Abstract] OR "male"[Title/Abstract] OR "males"[Title/Abstract] OR "male*" [Title/Abstract] OR "women"[Title/Abstract] OR "woman"[Title/Abstract] OR "men"[Title/Abstract] OR "man"[Title/Abstract] OR "gender"[Title/Abstract] OR "sex"[Title/Abstract] OR "sex differences"[Title/Abstract] OR "sex difference"[Title/Abstract] OR "sex differenc*" [Title/Abstract] OR "sex"[MeSH Terms] OR "sex factors"[MeSH Terms] OR "sex characteristics"[MeSH Terms])) AND ("risk factors"[MeSH Terms] OR "risk factors"[Title/Abstract] OR "risk factor"[Title/Abstract] OR "risk factor*" [Title/Abstract] OR "contributing factor"[Title/Abstract] OR "contributing factors"[Title/Abstract] OR "contributing factor*" [Title/Abstract] OR "predisposing factor"[Title/Abstract] OR "predisposing factors"[Title/Abstract] OR "predisposing factor*" [Title/Abstract] OR "predictor"[Title/Abstract] OR "predictors"[Title/Abstract] OR "predictor*" [Title/Abstract] OR "cause"[Title/Abstract] OR "causes"[Title/Abstract] OR "caus*" [Title/Abstract])) AND ("prospective"[Title/Abstract] OR "restrospective"[Title/Abstract] OR "cohort"[Title/Abstract] OR "longitudinal"[Title/Abstract] OR "prospective cohort"[Title/Abstract] OR "restrospective cohort"[Title/Abstract])) NOT ("meta-analysis"[Title/Abstract] OR "review"[Title/Abstract] OR "meta-analysis"[Publication Type] OR "review"[Publication Type] OR "meta analysis as topic"[MeSH Terms] OR ("review"[Publication Type] OR "review literature as topic"[MeSH Terms] OR "review"[All Fields]) AND "classification"[MeSH Terms]) OR "survey study"[Title/Abstract] OR "cross sectional studies"[MeSH Terms]) Filters: Aged: 65+ years, 80 and over: 80+ years	27.05.2022	885
		09.07.2023*	55
CINAHL	(((MH "Accidental Falls") OR TI "fall" OR TI "falls" OR TI "fall*") AND ((MH "Sex Factors") OR "gender" OR "female" OR "females" OR "female*" OR "males" OR "male" OR "male*" OR	27.05.2022	1459

	"women" OR "woman" OR "wom*" OR "men" OR "man" OR "gender" OR "sex" OR "sex difference" OR "sex differences" OR "sex differenc*") AND ((MH "Risk Factors") OR "risk factor" OR "risk factors" OR "risk factor*" OR "contributing factor" OR "contributing factors" OR "contributing factor*" OR "predisposing factor" OR "predisposing factors" OR "predisposing factor*" OR "predictor" OR "predictors" OR "predictor*" OR "cause" OR "causes" OR "caus*") AND ("prospective" OR "retrospective" OR "cohort" OR "longitudinal" OR "prospective cohort" OR "retrospective cohort")) NOT ((MH "Cross Sectional Studies") OR (MH "Systematic Review") OR (MH "Meta Analysis") OR (PT "review") OR "review" OR "meta-analysis" OR "review" OR "survey study") Limiters - Age Groups: Aged: 65+ years, Aged, 80 and over	09.07.2023*	46
Google Scholar	Fall risk factors AND older adults	27.05.2022	3 250 000
		09.07.2023*	17 300
	Fall risk factors AND elders	27.05.2022	335 000
		09.07.2023*	16 800
GreyLit.org	Fall	27.05.2022	40
	Falls	27.05.2022	40
	Falling	27.05.2022	40
*time frame was set from 27.05.2022 to 27.05.2023			

Appendix 2: Special participant characteristics of included studies

Author (Year)	Special participant characteristic
Studies including only women	
Heesch et al. (2008)	54.0% (n = 4,649) of participants engaged in very low to low physical activity levels
Lim & Sung (2012)	76.9% (n=337) participants ≥ one non-communicable disease
Whooley et al. (1999)	6.3% (n=467) participants were depressed according to GDS (Geriatric Depression Scale) ≥ 6
Studies including only men	
Cauley et al. (2013)	Participants ≥ 80 years: 11% (n=not indicated) Participants <80 years: 89% (n=not indicated)
Gill et al. (2009)	All participants had at least one modifiable risk factor for falling. Elaborate description not available.
Jefferis et al. (2015)	67.3% (n=471) of participants had no mobility limitations
Studies including women and men	
Huang et al. (2019)	All participants had been diagnosed with either prostate or breast cancer 2-3 years prior to study participation.
Lopez et al. (2011)	Hearing impairment Women: 12.7% (n=383) Men: 30.1% (n=704)
Menant et al. (2016)	Women with serum 25OHD ≤50 nmol/L (n=109) Vitamin D supplementation: 2.8% (n=3) Women with serum 25OHD >50 nmol/L (n=139) Vitamin D supplementation: 8.6% (n=12) Men with serum 25OHD ≤50 nmol/L (n=45) Vitamin D supplementation: 4.4% (n=2) Men with serum 25OHD >50 nmol/L (n=170) Vitamin D supplementation: 2.4% (n=4)
Abbreviations: 25OHD = 25-hydroxyvitamin D	

Appendix 3: Appraisal of the included studies according to the Newcastle-Ottawa Scale

Author (Year)	Selection						Comparability		Outcome					Total
	Representativeness of exposed cohort		Selection of nonexposed cohort	Ascertainment of exposure		Outcome not present at start of study	Comparability of cohorts		Assessment of outcome		Follow-up long enough	Adequacy of follow up		
	1a	1b	2a	3a	3b	4a	1a	1b	1a	1b	2a	3a	3b	
Bergland et al. (2003)	-	*	*	-	-	*	*	-	-	-	*	-	*	***** *
Brown et al. (2000)	*	-	*	-	-	*	*	*	-	-	*	-	*	***** **
Cauley et al. (2013)	*	-	*	*	-	*	*	*	-	-	*	-	*	***** ***
Chan et al. (2007)	*	-	*	⊙	-	*	*	*	-	-	*	-	*	***** ***⊙
Davis et al. (1999)	*	-	*	⊙	-	*	*	*	-	-	*	-	*	***** ***
Faulkner et al. (2003)	-	*	*	*	-	*	*	*	-	-	*	-	*	***** ***
Faulkner et al. (2009)	-	*	*	⊙	-	*	*	*	-	-	*	-	-	***** **
Flicker et al. (2003)	-	*	*	*	-	*	*	-	-	-	-	-	-	*****
Gill et al. (2009)	-	*	*	-	-	*	*	*	*	-	*	-	-	***** **
Heesch et al. (2008)	*	-	*	-	-	*	-	*	-	-	*	-	-	*****
Huang et al. (2019)	*	-	*	⊙	-	*	*	-	-	-	*	-	*	***** *⊙
Jefferis et al. (2015)	-	*	*	⊙	-	*	*	*	-	-	*	-	-	***** *⊙

Khalatbari - Soltani et al. (2021)	-	*	*	-	-	*	*	*	-	-	*		*	***** **
Kubo et al. (2021)	-	*	*	-	-	*	*	-	-	-	*	-	*	***** *
Lim et al. (2016)	*	-	*	*	-	*	*	*	-	-	*	-	-	***** **
Lim & Sung (2012)	*	-	*	-	*	*	-	-	-	-	*	-	-	*****
Lopez et al. (2011)	-	*	*	-	-	*	*	*	-	-	*	-	-	***** *
Menant et al. (2012)	-	*	*	*	-	*	-	-	-	-	*	-	*	***** *
Moon et al. (2020)	*	-	*	*	-	*	*	*	-	-	*	-	-	***** *
Papachristou et al. (2017)	*	-	*	⊙	-	*	*	-	-	-	*	-	-	***** ⊙
Parsons et al. (2009)	*	-	*	⊙	-	*	*	*	-	-	*	-	*	***** ***⊙
Shimizu et al. (2015)	*	-	*	*	-	*	*	*	-	-	*	-	*	***** **
Volpato et al. (2005)	-	*	*	*	-	*	*	*	*	-	*	-	-	***** ***
Whooley et al. (1999)	*	-	*	*	-	*	*	*	-	-	*	-	*	***** *

Appendix 4: Extracted data from studies which only included women

Risk Factors	Women only: Crude / Adjusted Data	Factors adjusted by	Author (Year)
Biological Risk Factors			
General Risk Factors			
ADL (IADL, PADL)	Crude Data Less than full score on PADL OR 1.6 (CI not mentioned), p=0.22 Less than full score on IADL OR 1.4 (CI not mentioned), p=0.12	-	Bergland et al. (2003)
	Adjusted Data Difficulty performing IADLs: RR 1.12 (CI 1.07-1.17), p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
	Adjusted Data Difficulties with ≥5 ADLs: Rate Ratio 1.8 (CI 1.3-2.4), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Age	Crude Data Increased Age: HR 1.00 (CI 0.99-1.01), p-value not mentioned	-	Flicker et al. (2003)
	Adjusted Data Age 75-79: OR 1.00 ≥80: OR 1.42 (CI 1.09–1.84), p= 0.009	Age, serum albumin, 5-m normal walking time, fall history	Shimizu et al. (2015)

Chronic conditions	<p>Adjusted Data 1996-1999 Number of chronic conditions 0-1: OR 1.00 2: OR 1.36 (CI 1.16-1.58), p-value not mentioned 3: OR 1.46 (CI 1.24-1.72), p-value not mentioned ≥4 : OR 1.55 (CI 1.32-1.83), p-value not mentioned</p> <p>1996-2002 Number of chronic conditions 0-1: OR 1.00 2: OR 1.34 (CI 1.13-1.58), p-value not mentioned 3: OR 1.32 (CI 1.09-1.59), p-value not mentioned ≥4 : OR 1.52 (CI 1.27-1.83), p-value not mentioned</p>	Fall history, alcohol intake, education, number of chronic conditions, country of birth	Heesch et al. (2008)
	<p>Crude Data Chronic disease: OR 2.02 (CI not mentioned), p= 0.007</p>	-	Lim & Sung (2012)
Cognitive Function	<p>Adjusted Data Impaired Cognitive function: Rate Ratio 1.0 (CI 0.8-1.4), p-value not mentioned</p>	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
	<p>Crude Data AMTS 8–10 points (higher scores indicate better cognitive function): HR 1 AMTS 4–7 points: HR 1.58 (CI 1.20–2.07), p-value not mentioned AMTS 0–3 points: HR 1.34 (CI 1.02–1.75), p-value not mentioned</p> <p>Adjusted Data AMTS 8–10 points (higher scores indicate better cognitive function): HR 1 AMTS 4–7 points: HR 1.37 (CI 1.03–1.82), p-value not mentioned AMTS 0–3 points: HR 0.95 (CI 0.69–1.31), p-value not mentioned</p>	-	Flicker et al. (2003)
Comorbidity	<p>Crude Data Being diagnosed with > 3 illnesses OR 2.0 (CI not mentioned), p=0.002</p>	-	Bergland et al. (2003)
Depression	<p>Crude Data Symptoms of depression OR 1.9 (CI not mentioned), p=0.006</p> <p>Adjusted Data</p>	-	Bergland et al. (2003)

	Symptoms of depression OR 2.1 (CI not mentioned), p=0.002		
	Adjusted Data Depression (GDS ≥ 6 points): OR 1.4 (CI 1.1-1.8), p=0.004	Age, fall history, smoking, education, health-status	Whooley et al. (1999)
Fear of falling	Adjusted Data Fear of falling: RR 1.20 (CI 1.11-1.29), p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
Health-Status	Adjusted Data Self-rated health decline: RR 1.19 (CI 1.04-1.35), p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
Serum albumin	Adjusted Data Serum albumin (g/dL) ≥4.3: OR 1.00 ≤4.3: OR 1.32 (CI 1.02–1.70), p= 0.037	Age, serum albumin, 5-m normal walking time, fall history	Shimizu et al. (2015)
Urinary Incontinence	Adjusted Data Daily urge incontinence: OR 1.35 (CI 1.16-1.57) , p-value not mentioned Weekly urge incontinence (not daily): OR 1.21 (CI 1.16- 1.57) , p-value not mentioned Weekly urge incontinence: OR 1.26 (CI 1.14-1.40), p<0.0001 Weekly stress Incontinence: OR 1.06 (CI 0.95-1.19), p=0.3	Age, fall history, alcohol use, medical history, grip strength	Brown et al. (2000)
	Crude Data OR 1.859 (CI 1.426–2.422), p-value not mentioned Adjusted Data OR 1.329 (CI 1.003–1.762), p-value not mentioned	Age, alcohol intake, hypertension, diabetes, smoking	Moon et al. (2020)

	<p>Adjusted Data 1996-1999 Leaking urine Never/rarely: OR 1.00 Sometimes: OR 1.31 (CI 1.13-1.53), p-value not mentioned Often: OR 1.33 (CI 1.07-1.66), p-value not mentioned Missing: OR 1.11 (CI 0.70-1.76), p-value not mentioned</p> <p>Adjusted Data 1996-2002 Leaking urine Never/rarely: OR 1.00 Sometimes: OR 1.38 (CI 1.17-1.63), p-value not mentioned Often: OR 1.27 (CI 0.98-1.65), p-value not mentioned Missing: OR 0.89 (CI 0.51-1.56), p-value not mentioned</p>	Fall history, alcohol intake, education, number of chronic conditions, country of birth	Heesch et al. (2008)
Vitamin D insufficiency	<p>Adjusted Data Serum 25OHD level <20 ng/mL (lowest tertile): OR 1.40 (1.01–1.94), p-value not mentioned 20 to 25 ng/mL (middle tertile): OR 1.18 (0.84–1.66), p-value not mentioned ≥25 ng/mL (highest tertile): OR 1.00</p>	Age, serum albumin, 5-m normal walking time, fall history	Shimizu et al. (2015)
	<p>Crude Data Log 25D (higher serum 25OHD levels in nmol/L): HR 0.77 (CI 0.62–0.94), p-value not mentioned</p> <p>Adjusted Data Log 25D (higher serum 25OHD levels in nmol/L): HR 0.74 (CI 0.59–0.94), p-value not mentioned</p>	-	Flicker et al. (2003)
Impaired Senses			
Impaired hearing	<p>Crude Data OR 0.9 (CI not mentioned), p=0.53</p>	-	Bergland et al. (2003)
Impaired vision	<p>Crude Data OR 2.0 (CI not mentioned), p=0.007</p> <p>Adjusted</p>	-	Bergland et al. (2003)

	OR 1.8 (CI not mentioned), p= 0.04		
	<p>Adjusted Data 1996-1999 Eyesight problems Never: OR 1.00 Rarely: OR 1.18 (CI 1.00-1.39), p-value not mentioned Sometimes: OR 1.13 (CI 0.97-1.31), p-value not mentioned Often: OR 1.49 (CI 1.25-1.78), p-value not mentioned</p> <p>1996-2002 Eyesight problems Never: OR 1.00 Rarely: OR 1.09 (CI 0.90-1.32), p-value not mentioned Sometimes: OR 1.20 (CI 1.01-1.41), p-value not mentioned Often: OR 1.83 (CI 1.50-2.24), p-value not mentioned</p>	Fall history, alcohol intake, education, number of chronic conditions, country of birth	Heesch et al. (2008)
Physiological Disorders			
Arthritis	<p>Adjusted Data Rate Ratio 1.3 (CI 0.9-2.0), p-value not mentioned</p>	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Diabetes	<p>Adjusted Data OR 1.38 (CI 1.04–1.81), p-value not mentioned</p>	Age, history of falls, hypertension, vision impairment, education	Volpato et al. (2005)
Hypertension	<p>Adjusted Data OR 1.8 (CI not mentioned), p=0.02</p>	-	Bergland et al. (2003)
Illness of the heart	<p>Adjusted Data Rate Ratio 1.7 (CI 1.1-2.5), p-value not mentioned</p>	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Illness of the lungs	<p>Adjusted Data Rate Ratio 2.8 (CI 1.4-5.6), p-value not mentioned</p>	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)

Osteoporosis	Crude Data OR 2.2 (CI not mentioned), p=0.003 Adjusted Data OR 2.1 (CI not mentioned), p=0.005	-	Bergland et al. (2003)
Physical performance			
Balance	Adjusted Data Standing balance, eyes closed (vs. poor) Fair balance: RR 0.95 (CI 0.88-1.04), p-value not mentioned Good balance: RR 0.85 (CI 0.76-0.95), p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
	Adjusted Data Full tandem, eyes closed (10 sec): Rate Ratio 0.7 (CI 0.5-1.0), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Chair Stand Tests	Adjusted Data Chair stands (≥ 10.2 sec): Rate Ratio 1.4 (CI 1.0-1.9) , p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Dizziness	Adjusted Data Dizziness upon standing: RR 1.16 (CI 1.06-1.27) , p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
Functional Reach	Adjusted Data Functional reach (≥ 35 cm): Rate Ratio 0.7 (CI 0.5-1.0), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Gait speed	Adjusted Data Quartile with slowest usual gait speed: Rate Ratio 0.8 (CI 0.6-1.2), p-value not mentioned Quartile with slowest rapid gait speed: Rate Ratio 1.1 (CI 0.8-1.5), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
	Adjusted Data Fast usual walking pace (unit=2 SD): RR 1.18 (CI 1.08-1.30) , p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)
	Adjusted Data 5-m normal walking time (s) <3.9: OR 1.00 ≥ 3.9: OR 1.37 (CI 1.05-1.79), p=0.019	Age, serum albumin, 5-m normal walking time, fall history	Shimizu et al. (2015)

OLST	Adjusted Data Stork standing time with eyes open (s) ≥16s: OR 1.00 <16s: OR 1.61 (1.24–2.10), p<0.001	Age, serum albumin, 5-m normal walking time, fall history	Shimizu et al. (2015)
TUGT	Adjusted Data Quartile that scored worst on TUGT: Rate Ratio 1.1 (CI 0.8-1.5), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Quadriceps strength	Adjusted Data Quartile with the lowest quadriceps strength: Rate Ratio 1.5 (CI 1.1-2.1), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Reaction Time	Adjusted Data Quartile with slowest hand reaction time: Rate Ratio 0.9 (CI 0.6-1.2), p-value not mentioned Quartile with slowest foot reaction time: Rate Ratio 0.9 (CI 0.7-1.3), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Behavioural Risk Factors			
Alcohol Use	Adjusted Data Alcohol use: Rate Ratio 0.9 (CI 0.5-1.5), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Physical inactivity	Adjusted Data Physical activity (No): Rate Ratio 1.1 (CI 0.8-1.5), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
	Adjusted Data Physical activity (Harvard Alumni questionnaire) Quartile 1 (lowest amount of physical activity): RR 1.0 Quartile 2: RR 1.03 (CI 0.92-1.14), p-value not mentioned Quartile 3: RR 1.12 (CI 1.01-1.25), p-value not mentioned Quartile 4 (highest amount of physical activity): RR 1.26 (CI 1.10-1.44), p-value not mentioned	Age, fall history, dizziness, physical activity, walking speed	Faulkner et al. (2009)

	<p>Crude Data 1996-1999 Physical activity None/Very low: OR 1.00 Low: OR 0.85 (CI 0.73-0.98), p=0.03 Moderate: OR 0.82 (CI 0.71-0.95), p=0.01 High: OR 0.78 (CI 0.62-0.96), p=0.02 Very High: OR 0.62 (CI 0.45-0.86), p<0.01</p> <p>1996-2002 Physical activity None/Very low: OR 1.0 Low: OR 0.88 (CI 0.74-1.05), p-value not mentioned Moderate: 0.91 (CI 0.77-1.08), p-value not mentioned High: OR 0.78 (CI 0.61-1.00), p=0.05 Very High: OR 0.61 (CI 0.41-0.89), p=0.01</p> <p>Adjusted Data 1996-1999 Physical activity None/Very low: OR 1.00 Low: OR 0.91 (CI 0.78-1.06), p-value not mentioned Moderate: OR 0.90 (CI 0.77-1.05), p-value not mentioned High: OR 0.87 (CI 0.70-1.09), p-value not mentioned Very High: OR 0.68 (CI 0.49-0.95), p=0.02</p> <p>1996-2002 Physical activity None/Very low: OR 1.00 Low: OR 0.91 (CI 0.76-1.09), p-value not mentioned Moderate: OR 0.95 (CI 0.80-1.13), p-value not mentioned High: OR 0.83 (CI 0.64-1.07), p-value not mentioned Very High: OR 0.63 (CI 0.43-0.93), p=0.02</p>	Fall history, alcohol intake, education, number of chronic conditions, country of birth	Heesch et al. (2008)
	<p>Crude Data Physical inactivity: OR 0.78 (CI not mentioned), p=0.293</p>	-	Lim & Sung (2012)
Polypharmacy	<p>Crude Data ≥3 Medications: OR 1.3 (CI not mentioned), p=0.33</p>	-	Bergland et al. (2003)

	Adjusted Data ≥ 3 Medications: Rate Ratio 1.3 (CI 0.9-1.9), p-value not mentioned	Age, fall history, functional reach, quadriceps strength, chair stand	Davis et al. (1999)
Socioeconomic Risk Factors			
Education	Adjusted Data 1996-1999 Education No secondary: OR 1.00 Some secondary: OR 0.97 (CI 0.85-1.12), p-value not mentioned Completed secondary: OR 0.82 (CI 0.67-1.01), p-value not mentioned Trade certificate/university degree: OR 1.13 (CI 0.95-1.34), p-value not mentioned Missing: OR 0.92 (0.68-1.24), p-value not mentioned 1996-2002 Education No secondary: OR 1.00 Some secondary: OR 1.23 (CI 1.05-1.45) , p-value not mentioned Completed secondary: OR 1.26 (CI 1.01-1.57) , p-value not mentioned Trade certificate/university degree: OR 1.32 (CI 1.08-1.61) , p-value not mentioned Missing: OR 1.05 (CI 0.74-1.50), p-value not mentioned	Fall history, alcohol intake, education, number of chronic conditions, country of birth	Heesch et al. (2008)
Social Integration	Adjusted Data Lubben Social Network Scale (LSNS) (higher score, better social integration) Quartile 1 (0–28 points): RR 1.0 Quartile 2 (29–33 points): RR 0.88 (CI 0.77–1.01), p-value not mentioned Quartile 3 (34–38 points): RR 0.93 (CI 0.80–1.08), p-value not mentioned Quartile 4 (39–50 points): RR 0.96 (CI 0.81–1.14), p-value not mentioned	Age, arthritis, incontinence, polypharmacy(<4), Parkinson's	Faulkner et al. (2003)
Environmental Risk Factors			
Poor lighting	Crude Data Poor night light: OR 1.98 (CI not mentioned), p= 0.032	-	Lim & Sung (2012)
Slippery Floor	Crude Data Slippery floor in the bathroom: OR 1.04 (CI not mentioned), p= 0.862	-	Lim & Sung (2012)

Abbreviations: 25OHD = 25-hydroxy vitamin D, ADL = activities of daily living, CI = confidence interval, HR = hazard ratio, IADL = instrumental activities of daily living, LSNS = Lubben Social Network Scale, OLST = one-leg standing test, OR = odds ratio, PADL = personal activities of daily living, RR = risk ratio, SD = standard deviation, TUGT = time-up and go test

Appendix 5: Extracted data from studies which included only men

Risk Factors	Men only: Crude / Adjusted Data	Factors Adjusted by	Author (Year)
Biological Risk Factors			
General risk factors			
Age	Adjusted Data Increased age: OR 1.03 (CI 0.97–1.10), p=0.34	Age, fall history, self-rated health, alcohol intake, medication	Gill et al. (2009)
Cognitive Function	Adjusted Data Memory compared to the last 5 years: OR 1.90 (CI 1.13–3.20), p=0.02	Age, fall history, self-rated health, alcohol intake, medication	Gill et al. (2009)
Urinary Urgency	Adjusted Data Urinary urgency <1/2 the time: RR 1.18 (1.07–1.31), p-value not mentioned ≥1/2 the time: RR 1.31 (1.17–1.47), p-value not mentioned	Age, fall history, dizziness, impaired mobility, number of narrow walk trials	Parsons et al. (2009)
Impaired Senses			
-	-	-	-
Physiological Disorders			
-	-	-	-
Physical Performance			
Chair Stand	Adjusted Data Chair stands time Quartile 1 (slowest to complete 5x chair stand): Reference Quartile 2: RR 0.94 (CI 0.85-1.04), p-value not mentioned Quartile 3: RR 0.99 (CI 0.90-1.10), p-value not mentioned Quartile 4: RR 1.09 (CI 0.98-1.21), p-value not mentioned	Age, falls in past 12 months, dizziness, education, BMI	Chan et al. (2007)
Gait speed	Adjusted Data Gait Speed Fried component: Lowest quantile of walking speed OR 1.99 (1.30-3.04), p-value not mentioned Self-reported: Slow walking speed OR 2.27 (CI 1.56-3.32), p-value not mentioned	Age	Papachristou et al. (2017)
	Adjusted Data Gait speed Quartile 1 (slowest): Reference	Age, falls in past 12 months, dizziness, education, BMI	Chan et al. (2007)

	<p>Quartile 2: RR 1.03 (CI 0.94-1.13), p-value not mentioned</p> <p>Quartile 3: RR 0.96 (CI 0.86-1.07), p-value not mentioned</p> <p>Quartile 4 (fastest): RR 1.06 (CI 0.94-1.19), p-value not mentioned</p>		
Leg extension power	<p>Adjusted Data</p> <p>Leg extension power</p> <p>Quartile 1(weakest): Reference</p> <p>Quartile 2: RR 0.88 (CI 0.81-0.97), p-value not mentioned</p> <p>Quartile 3: RR 0.86 (CI 0.77-0.95), p-value not mentioned</p> <p>Quartile 4 (strongest): RR 0.82 (CI 0.73-0.92), p-value not mentioned</p>	Age, falls in past 12 months, dizziness, education, BMI	Chan et al. (2007)
Narrow gait pace	<p>Adjusted Data</p> <p>Narrow gait pace</p> <p>Quartile 1 (slowest): Reference</p> <p>Quartile 2: RR 0.94 (CI 0.85-1.03), p-value not mentioned</p> <p>Quartile 3: RR 0.86 (CI 0.77-0.95), p-value not mentioned</p> <p>Quartile 4 (fastest): RR 0.89 (CI 0.79-1.00), p-value not mentioned</p>	Age, falls in past 12 months, dizziness, education, BMI	Chan et al. (2007)
Behavioural Risk Factors			
Physical activity	<p>Adjusted Data</p> <p>Age <80</p> <p>Active EE (kcal/d)</p> <p>Quartile 1 (<190.6): RR 0.75 (CI 0.48-1.19), p-value not mentioned</p> <p>Quartile 2 (190.6 - <323.8): RR 0.53 (CI 0.36-0.79), p-value not mentioned</p> <p>Quartile 3 (323.8 - <507.8): RR 0.63 (CI 0.44-0.90), p-value not mentioned</p> <p>Quartile 4 (507.8 - <775.0): RR 0.66 (CI 0.48-0.92), p-value not mentioned</p> <p>Q5 (>775.0): Reference point</p> <p>Moderate activity (minutes/day)</p> <p>Quartile 1 (<32.6): RR 0.76 (CI 0.48-1.20), p-value not mentioned</p> <p>Quartile 2 (32.6 - <55.8): RR 0.59 (CI 0.40-0.87), p-value not mentioned</p> <p>Quartile 3 (55.8 - <84.6): RR 0.68 (CI 0.48-0.98), p-value not mentioned</p> <p>Quartile 4 (84.6 - <125.0): RR 0.79 (CI 0.56-1.10), p-value not mentioned</p> <p>Q5 (>125.0): Reference point</p> <p>Age ≥80</p> <p>Active EE (kcal/d)</p>	Age, race, health-status, smoking, diabetes	Cauley et al. (2013)

	<p>Quartile 1 (<190.6): RR 1.43 (CI 0.90-2.26), p-value not mentioned Quartile 2 (190.6 - <323.8): RR 1.11 (CI 0.68-1.79), p-value not mentioned Quartile 3 (323.8 - <507.8): RR 1.12 (CI 0.69-1.82), p-value not mentioned Quartile 4 (507.8 - <775.0): RR 1.00 (CI 0.58-1.70), p-value not mentioned Q5 (>775.0): Reference point</p> <p>Moderate activity (minutes/day) Quartile 1 (<32.6): RR 1.54 (CI 0.99-2.39), p-value not mentioned Quartile 2 (32.6 - <55.8): RR 1.18 (CI 0.77-1.83), p-value not mentioned Quartile 3 (55.8 - <84.6): RR 1.15 (CI 0.73 1.82), p-value not mentioned Quartile 4 (84.6 - <125.0): RR 1.13 (CI 0.69-1.86), p-value not mentioned Q5 (>125.0): Reference point</p>		
	<p>Adjusted Data Relative physical activity (being less active than peers): OR 1.43 (CI 0.65–3.13), p=0.38</p>	<p>Age, fall history, self-rated health, alcohol intake, medication</p>	<p>Gill et al. (2009)</p>
	<p>Adjusted Data</p> <p>No mobility problems (n=471) Steps per day (thousands): IRR 1.20 (1.06–1.35), p-value not mentioned ≥ 30 minutes of moderate to vigorous physical activity per day in bouts > 1 minutes: IRR 1.50 (CI 1.10–2.04), p-value not mentioned ≥ 30 minutes of moderate to vigorous physical activity per day in bouts ≥10 minutes: IRR 1.99 (CI 1.20–3.29), p-value not mentioned ≥ 30 minutes of light activity per day: IRR 1.04 (CI 0.87–1.25), p-value not mentioned ≥ 30 minutes of sedentary time per day: IRR 0.89 (CI 0.77–1.03), p-value not mentioned <9000 steps per day: IRR 1.02 (CI 0.85–1.24), p-value not mentioned ≥9000 steps per day: IRR 1.60 (CI 1.17–2.20), p-value not mentioned</p> <p>Any mobility problems (n=229) Steps per day (thousands): IRR 0.84 (CI 0.72–0.97), p-value not mentioned ≥ 30 minutes of moderate to vigorous physical activity per day in bouts > 1 minutes: IRR 0.70 (CI 0.48–1.04), p-value not mentioned ≥ 30 minutes of moderate to vigorous physical activity per day in bouts ≥10 minutes: IRR 0.21 (CI 0.07–0.68), p-value not mentioned Light activity per day (≥30 min): IRR 0.90 (CI 0.79–1.01), p-value not mentioned Sedentary time per day (30 min): IRR 1.11 (CI 1.00–1.23), p-value not mentioned</p>	<p>Age, fall history, number of chronic diseases, vision, number of medication</p>	<p>Jefferis et al. (2015)</p>

	<p>Adjusted Data Physical Activity Fried component: Physical inactivity OR 1.80 (CI 1.26-2.58), p-value not mentioned Self-reported: less active than other men OR 1.83 (CI 1.26-2.64), p-value not mentioned</p>	Age	Papachristou et al. (2017)
	<p>Adjusted Data Physical Activity Scale for the elderly (total score) Quartile 1 (least active): Reference Quartile 2: RR 1.03 (CI 0.95-1.12), p-value not mentioned Quartile 3: RR 1.10 (CI 1.01-1.20), p-value not mentioned Quartile 4 (most active): RR 1.18 (CI 1.07-1.29), p-value not mentioned</p>	Age, falls in past 12 months, dizziness, education, BMI	Chan et al. (2007)
Socioeconomic Risk Factors			
Education	<p>Unadjusted Data Education High: 1.00 Intermediate: RR 0.92 (CI 0.78-1.07), p-value not mentioned Low: RR 0.89 (CI 0.76-1.04), p-value not mentioned</p> <p>Adjusted Data Low education: IRR 0.90 (CI 0.68-1.120), p-value not mentioned</p>	Age, country of birth, living arrangement	Khalatbari-Soltani et al. (2021)
Income	<p>Unadjusted Data Income High: 1.00 Intermediate: RR 1.19 (CI 1.04-1.37), p-value not mentioned Low: RR 0.98 (CI 0.86-1.10), p-value not mentioned</p> <p>Adjusted Data Low income: IRR 1.06 (CI 0.86-1.30), p-value not mentioned</p>	Age, country of birth, living arrangement	Khalatbari-Soltani et al. (2021)
Environmental Risk Factors			
-	-	-	-
Abbreviations: 25OHD = 25-hydroxy vitamin D, ADL = activities of daily living, BMI =body mass index, CI = confidence interval, EE = energy expenditure, HR = hazard ratio, IRR = incident rate ratio, OR = odds ratio, RR = risk ratio			

Appendix 6: Extracted data from studies which included women and men

Risk Factors	Women and Men: Crude / Adjusted Data	Factors adjusted by	Author (Year)
Biological Risk Factors			
General Risk Factors			
ADL (IADL, PADL)	<p>Crude Data <u>Women</u> Number of ADL dependence: OR 1.31 (CI 1.14–1.52), p<0.001</p> <p><u>Men</u> Number of ADL dependence: OR 1.55 (CI 1.38–1.75), p<0.001</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Age	<p>Crude Data <u>Women</u> Higher age at baseline: OR 1.02 (CI 0.99–1.06), p=0.231</p> <p><u>Men</u> Higher age at baseline: OR 1.06 (CI 1.03–1.10), p<0.001</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Cognitive Function	<p>Crude Data <u>Women</u> “Do you feel that you forget things a lot?” (Yes): OR 1.70 (CI 1.26-2.28), p<0.01 “Do people tell you that you are forgetful?” (Yes): OR 1.60 (CI 1.04-2.46), p=0.03</p> <p><u>Men</u> “Do you feel that you forget things a lot?” (Yes): OR 1.75 (1.28-2.39), p<0.01 “Do people tell you that you are forgetful?” (Yes): OR 1.54 (CI 1.07-2.21), p=0.02</p> <p>Adjusted Data <u>Women</u> -</p> <p><u>Men</u> Do you feel that you forget things a lot? OR 1.44 (CI 1.03-2.01), p=0.03</p>	Age	Kubo et al. (2021)
Comorbidity	<p>Crude Data <u>Women</u> OR 1.26 (CI 1.10–1.45), p=0.001</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)

	<p><u>Men</u> OR 1.25 (CI 1.12–1.40), p<0.001</p>		
Depression	<p>Crude Data <u>Women</u> OR 1.41 (CI 0.72–2.76), p=0.319</p> <p><u>Men</u> OR 2.88 (CI 1.51–5.46), p=0.001</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Race	<p>Crude Data <u>Women</u> Caucasian: OR 1.30 (CI 0.78–2.13), p=0.322</p> <p><u>Men</u> Caucasian: OR 1.79 (CI 1.12–2.78), p=0.013</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Health-Status	<p>Crude Data <u>Women</u> “What is your current state of health?” (Not good): OR 2.50 (CI 1.68-3.71), p<0.01</p> <p><u>Men</u> “What is your current state of health?” (Not good): OR 1.57 (CI 1.01-2.45), p=0.04</p>	Age	Kubo et al. (2021)
Psychological Function	<p>Crude Data <u>Women</u> Higher scores (higher psychological function) on MCS: OR 0.97 (CI 0.95–0.99), p=0.002</p> <p><u>Men</u> Higher scores (higher psychological function) on MCS: OR 0.97 (CI 0.95–0.98), p<0.001</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
	<p>Crude Data <u>Women</u> Psychological function “Have you felt gloomy in the last month?” (Yes): OR 1.80 (CI 1.31-2.46), p<0.01 “Do you experience joy in your daily activities?” (No): OR 2.26 (CI 1.37-3.71), p<0.01 “Are you able to concentrate on things?” (No): OR 1.72 (CI 0.94-3.16), p=0.08 “Do you find it difficult to do things you could easily do before?” (Yes): OR 1.85 (CI 1.38-2.49), p<0.01</p> <p><u>Men</u></p>	Age	Kubo et al. (2021)

	<p>Psychological function</p> <p>“Have you felt gloomy in the last month?” (Yes): OR 1.68 (1.19-2.36), p<0.01</p> <p>“Do you experience joy in your daily activities?” (No): OR 0.93 (0.52-1.68), p=0.82</p> <p>“Are you able to concentrate on things?” (No): OR 1.85 (1.08-3.17), p=0.02</p> <p>“Do you find it difficult to do things you could easily do before?” (Yes): OR 2.02 (CI 1.48-2.76), p<0.01</p>		
Urinary Incontinence	<p>Crude Data</p> <p><u>Women</u></p> <p>OR 2.27 (CI 0.89–5.80), p=0.086</p> <p><u>Men</u></p> <p>OR 1.89 (CI 1.00–3.58), p=0.050</p> <p>Adjusted Data</p> <p><u>Women</u></p> <p><u>Men</u></p> <p>OR 1.69 (CI 1.08–2.65), p=0.021</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Vitamin D insufficiency	<p>Crude Data</p> <p><u>Women</u></p> <p>Vit D insufficiency (≤50 nmol/L): IRR 0.83 (CI 0.56–1.23), p=0.362</p> <p><u>Men</u></p> <p>Vit D insufficiency (≤50 nmol/L): IRR 1.93 (CI 1.19–3.15), p=0.008</p>	-	Menant et al. (2016)
Impaired Senses			
Impaired Hearing	<p>Crude Data</p> <p><u>Women</u></p> <p>OR 1.51 (CI 1.15–1.97), p-value not mentioned</p> <p><u>Men</u></p> <p>OR 1.44 (CI 1.16–1.78), p-value not mentioned</p> <p>Adjusted Data</p> <p><u>Women</u></p> <p>OR 1.45 (CI 1.08–1.93), p-value not mentioned</p>	BMI	Lopez et al. (2011)

	Men OR 1.38 (CI 1.08–1.78), p-value not mentioned		
Impaired Vision	Crude Data Women OR 1.82 (CI 1.44–2.30), p-value not mentioned Men OR 1.77 (CI 1.35–2.32), p-value not mentioned	-	Lopez et al. (2011)
Physiological Disorder			
-	-	-	-
Physical Performance			
Balance	Crude Data Women Self-reported balance or walking problems: OR 1.81 (CI 1.16–2.83), p=0.009 Men Self-reported balance or walking problems: OR 4.22 (CI 2.83–6.30), p<0.001	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Physical Function	Crude Data Women PCS: OR 0.97 (CI 0.96–0.99), p=0.003 Men PCS: OR 0.95 (CI 0.93–0.96), p<0.001 Adjusted Data Women - Men PCS: OR 0.96 (CI 0.94–0.98), p<0.001	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
	Crude Data Women Physical function “Do you have pain in the knees or lower back when walking or standing up?” (Yes): OR 2.33 (CI 1.73-3.13), p<0.01 “Can you walk for 15 minutes?” (No): OR 2.94 (CI 1.93-4.48), p<0.01	Age	Kubo et al. (2021)

	<p>"Can you climb stairs without using handrails or the wall for support?" (No): OR 4.00 (CI 2.89-5.52), p<0.01</p> <p><u>Men</u> Physical function "Do you have pain in the knees or lower back when walking or standing up?" (Yes): OR 1.67 (CI 1.21-2.31), p<0.01 "Can you walk for 15 minutes?" (No): OR 1.95 (CI 1.15-3.30), p=0.01 "Can you climb stairs without using handrails or the wall for support?" (No): OR 2.39 (CI 1.53-3.73), p<0.01</p> <p><u>Adjusted Data</u> <u>Women</u> "Do you have pain in the knees or lower back when walking or standing up?": OR 1.53 (CI 1.11-2.12), p=0.01</p> <p>"Can you climb stairs without using handrails or the wall for support?": OR 2.88 (CI 2.01-4.13), p<0.01</p> <p><u>Men</u> "Can you climb stairs without using handrails or the wall for support?" OR 1.98 (CI 1.25-3.13), p<0.01</p>		
OLST+TUGT	<p><u>Adjusted Data</u> <u>Women</u> Combined Quartile 1 (lowest score): OR 1 Quartile 2: OR 1.499 (CI 0.956–2.350), p= 0.078 Quartile 3: OR 1.289 (CI 0.823–2.017), p= 0.267 Quartile 4 (highest score): OR 1.481 (CI 0.931–2.355), p= 0.097</p> <p><u>Men</u> Combined Quartile 1 (lowest score): OR 1 Quartile 2: OR 1.135 (CI 0.593–2.173), p= 0.702 Quartile 3: 1.190 (CI 0.780–1.816), p= 0.419 Quartile 4 (highest score): 1.255 (CI 0.717–2.196), p= 0.426</p>	Age, BMI, diabetes, smoking, postmenopausal duration (women only)	Lim et al. (2016)
OLST	<p><u>Adjusted Data</u> <u>Women</u></p>	Age, BMI, diabetes, smoking,	Lim et al. (2016)

	<p>OLST</p> <p>Quartile 1 (lowest score): OR 1</p> <p>Quartile 2: OR 1.414 (CI 0.914–2.189), p=0.120</p> <p>Quartile 3: OR 1.284 (CI 0.809–2.038), p= 0.289</p> <p>Quartile 4 (highest score): OR 1.536 (CI 0.983–2.400), p= 0.060</p> <p><u>Men</u></p> <p>OLST</p> <p>Quartile 1 (lowest score): OR 1</p> <p>Quartile 2: OR 1.571 (CI 0.974–2.536), p=0.064</p> <p>Quartile 3: OR 1.569 (CI 0.992–2.481), p=0.054</p> <p>Quartile 4 (highest score): OR 1.651 (CI 0.961–2.836), p= 0.069</p>	postmenopausal duration (women only)	
TUGT	<p><u>Adjusted Data</u></p> <p><u>Women</u></p> <p>TUGT</p> <p>Quartile 1 (lowest score): OR 1</p> <p>Quartile 2: OR 1.034 (CI 0.678–1.579), p= 0.876</p> <p>Quartile 3: OR 0.926 (CI 0.574–1.493), p= 0.752</p> <p>Quartile 4 (highest score): OR 1.379 (CI 0.912–2.085), p= 0.127</p> <p><u>Men</u></p> <p>TUGT</p> <p>Quartile 1 (lowest score): OR 1</p> <p>Quartile 2: OR 1.571 (CI 0.974–2.536), p=0.064</p> <p>Quartile 3: OR 1.569 (CI 0.992–2.481), p=0.054</p> <p>Quartile 4 (highest score): OR 1.651 (CI 0.961–2.836), p= 0.069</p>	Age, BMI, diabetes, smoking, postmenopausal duration (women only)	Lim et al. (2016)
Behavioural Risk Factors			
-	-	-	-
Socioeconomic Risk Factors			
Education	<p><u>Crude Data</u></p> <p><u>Women</u></p> <p>Education</p> <p>< High school: OR 1.00</p> <p>High school or some college: OR 1.19 (CI 0.68–2.05), p=0.545</p> <p>≥ College: OR 1.29 (CI 0.63–2.62), p=0.488</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)

	<p><u>Men</u> Education: < High school: OR 1.00 High school or some college: OR 1.40 (CI 0.83–2.38), p=0.210 ≥ College: OR 1.69 (CI 0.96–2.96), p=0.070</p>		
Income	<p><u>Crude Data</u> <u>Women</u> Income p-value not mentioned ≤19,999 Dollars: OR 1.00 20,000-39,999 Dollars: OR 1.02 (CI 0.60–1.72), p-value not mentioned ≥40,000 Dollars: OR 1.41 (CI 0.73–2.72), p-value not mentioned</p> <p><u>Men</u> Income ≤19,999 Dollars: OR 1.00 20,000-39,999 Dollars: OR 1.03 (CI 0.63–1.69), p=0.910 ≥40,000 Dollars: OR 1.23 (CI 0.71–2.13), p=0.460</p>	Age at diagnosis of prostate/breast cancer, history of falls, incontinence, unmarried	Huang et al. (2019)
Environmental Risk Factors			
-	-	-	-
Abbreviations: 25OHD = 25-hydroxy vitamin D, ADL = activities of daily living, BMI = body mass index, CI = confidence interval, IADL = instrumental activities of daily living, MCS = mental component score, OLST = one-leg standing test, OR = odds ratio, PADL = personal activities of daily living, PCS = physical component score, TUGT = time-up and go test			