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DEVELOPMENT OF A BALANCE RECOVERY CONFIDENCE SCALE FOR COMMUNITY-DWELLING OLDER ADULTS

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Abstract

Falls are concerning issues for older people. There is a lack of instruments that measure balance recovery confidence. Balance recovery confidence refers to the perceived ability to arrest falls. Patient-reported outcome measures (PROMs) are used to obtain information directly from the person being cared for. The overall aim of this thesis is to present the development of a PROM that measures balance recovery confidence in community-dwelling older adults.

Methods: A sequential series of steps was taken to develop the PROM. First, a literature review was done to understand the self-efficacy theory, types of falls-related psychological concerns, PROMs used, the role of balance recovery control and the development of a PROM for the construct of interest. Four studies were then implemented. The first study systematically reviewed existing falls efficacy-related PROMs for their development, content validity and structural validity. The second study assessed the feasibility of studying near-falls and balance recovery among community-dwelling older adults. The third study constructed and validated the content of the balance recovery confidence scale with 22 community-dwelling older adults and 28 healthcare professionals. The final study assessed the psychometric properties of the newly developed PROM with 84 community-dwelling older adults in Singapore.

Results and conclusions: Existing falls efficacy-related PROMs lack high-quality evidence in their development and content validity. The systematic review affirmed an absence of a suitable PROM of balance recovery confidence for community-dwelling older adults. The feasibility study demonstrated that balance recovery was a relatable concept for older adults. A 19-item balance recovery confidence scale was constructed and validated with experts' consensus. Field testing showed that the scale has excellent psychometric properties, having moderate correlations with the Activities-specific Balance Confidence Scale, Falls Efficacy Scale-International, Late Life Function and Disability Instrument-Function and strong correlation with reactive postural control performance.

Keywords: Patient-reported outcome measures, falls efficacy, balance recovery confidence, psychometric properties

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Chapter 1

General introduction

"The beginning is the most important part of the work."

– Plato.

1.1 Introduction

Falls represent a major problem for older people and are recognised as an intrinsic risk of ageing (Montero-Odasso et al., 2021). To understand older adults' perception of their ability to manage this threat, patient-reported outcome measures (PROMs) are used by clinicians to obtain information directly from the individuals (Kyte et al., 2015). Existing PROMs have been used to measure the different falls-related psychological constructs such as falls efficacy, balance confidence and fear of falling (Jørstad et al., 2005; Moore & Ellis, 2008). However, the relationships between these constructs are complex. PROMs developed for specific constructs have been used to measure other constructs (Moore & Ellis, 2008). For example, the Falls Efficacy Scale (FES) – a PROM for falls efficacy has been operationalised to measure fear of falling (Tinetti et al., 1990) or the CONFbal scale – a PROM for balance confidence has been advocated as a falls efficacy scale (Simpson et al., 2009). The interchangeable use of PROMs to evaluate different constructs has generated confusion regarding the constructs within the literature (Hughes et al., 2015). Researchers have been encouraged to set out the falls-related psychological construct of interest and to use appropriate validated PROMs consistently. This approach would promote greater clarity within the evidence base (Moore & Ellis, 2008).

To be appropriately used in research and clinical practice, a PROM needs to target a clearly defined construct that is clinically meaningful and interpretable (McKenna, Heaney & Wilburn, 2019). The proper selection of the most appropriate PROMs for the outcomes of interest is important because improper use of PROMs risks inaccurate conclusions to be drawn (McKenna et al., 2019). For this thesis, the development of a PROM for balance recovery confidence is described. A PROM to measure balance recovery confidence is distinct from other measures in that it responds to the need for a fuller understanding of reactive balance recovery abilities in older people - that is, their perceived ability to recover balance in response to destabilising perturbations, such as a slip or a trip. Balance recovery is an essential capability in older people to arrest a fall (Maki et al., 2011; Tokur et al., 2020), and the understanding of their perception of this ability will be helpful to researchers and clinicians when working with older people. Inquiry into balance recovery confidence has been lacking because there has been no suitable PROM measuring this construct. This thesis aims to present the development and validation of a new PROM that measures balance recovery confidence in community-dwelling older adults.

Chapter 1 aims to present the background to this thesis, providing an outline and detailing the research objectives. The assumptions, limitation, and operational definitions used will also be listed in this chapter.

1.2 Background

On falls

Falls are the leading cause of injuries, hospitalisations and deaths in older adults (WHO, 2018). Approximately 30% of people aged 65 and over have reported experiencing a fall at least once a year (Centre for Clinical Practice, 2013). Among those who have had a fall, half have encountered a second fall within the same year (NIH, 2014). While the causes of falls are multifactorial, impaired control of gait and balance has been identified as the significant reason for falls in older adults (Peel, 2011; Rubenstein, 2006). Stevens et al. (2014) reported that 68.5% of falls were attributable to either internal postural perturbations (i.e., loss of balance caused by volitional movements, being unsteady, being wobbly) or external postural perturbations (e.g., a trip, a slip, caught foot or "tangled feet"). Environmental hazards such as large objects (chair/bed/other furniture), stairs, steps and surface contamination (e.g., water on the bathroom floor) have been shown associated with 61% of fall injuries (Timsina et al., 2017).

Given an increased susceptibility to losing balance arising from the accumulated effects of age, comorbidities and risk-taking behaviours (Rubenstein, 2006; Lord et al., 2007; Peel, 2011), clinicians need to consider targeted rehabilitation assessments and interventions to improve older adults' agency to tackle the threat of falls. One key focus of rehabilitation is addressing perceived and actual balance control abilities (Maki et al., 2003; Horak et al., 2009). To do that, clinicians would need proper measurement instruments to understand individuals' interactions with various environmental hazards and their perceived ability to recover balance in response to the different perturbations, and thereby to arrest a fall.

On falls efficacy

Falls efficacy has been conventionally understood as an individual's confidence in their ability to undertake activities of daily living without falling (Tinetti et al., 1990). However, the construct of falls efficacy has been commonly used to understand a different construct (Kumar et al., 2016). Since the early 1990s, low perceived falls efficacy has been operationalised as fear of falling (Tinetti et al., 1990). Tinetti et al. (1990) developed the Falls Efficacy Scale (FES) and posited that applying a self-efficacy measure would be helpful to mitigate the psychiatric connotations of phobia with fear of falling. The use of a self-efficacy type instrument could also expand a traditional measurement of fear from a dichotomous measure - a person is either afraid of falling or not - to a continuous measure of the degree of confidence (Tinetti et al., 1990).

Falls efficacy has also been interpreted as balance confidence. In the mid-1990s, Powell and Myer constructed another type of falls efficacy scale - the Activities-specific Balance Confidence (ABC) Scale (1995). They applied similar questions to those used by Tinetti et al. (1990). During the development of the ABC Scale, a sample of clinicians were asked to list the different activities of daily living which were essential to independent living, that require position change or walking, but were non-hazardous to most seniors. The ABC Scale was designed to address the limitations of the FES, for example, to include more challenging activities to mitigate the ceiling effect and to have situation-specific questionnaire items to reduce the ambiguity of the task and environment. The items, "Walk outside on icy sidewalks" and "Reach for a small can off a shelf at eye level" are some examples to reflect the improvement. The construct validity of the ABC Scale compared against the FES showed strong congruence (.86) (Hotchkiss et al. 2004).

As the twenty-first century has progressed, the interchangeable use of falls efficacy, balance confidence and fear of falling has resulted in some confusion in the literature (Hughes et al., 2015). About two decades after the genesis of the FES, Hadjistavropoulos et al. (2011) attempted to reconceptualise the constructs of falls efficacy and fear of falling, as balance confidence and fear-avoidance cycle, respectively. Notwithstanding the close association between both constructs, falls efficacy and fear of falling have been posited as distinct and as needing to be studied separately (Li et al., 2002; Hadjistavropoulos et al., 2007; Hughes et al., 2015). Fear of falling relates to both emotional (i.e., anxiety) and behavioural (i.e., avoidance) aspects in its theoretical understanding (Hughes et al., 2015). In contrast, falls efficacy is rooted in Bandura's self-efficacy theory (Bandura, 1982) and can be understood as an individual's perception of their capabilities to act in specific falls-related situations (Simpson et al., 2009). Applying the same self-efficacy concept, Payette et al. (2016) expressed that falls efficacy refers to a person's confidence to manage the threat of a fall. Those authors viewed self-efficacy as a resilience factor that may influence the level of fear experienced in the face of a threat.

Various rehabilitation strategies have been employed to improve *fall resilience*. Cognitive-behavioural interventions include finding ways to reduce fall risks, modifying physical activity behaviours, and teaching strategies to adopt risk-mitigating behaviours (Johnson, 2018). Some falls rehabilitation strategies have aimed to develop capacity in individuals to avoid a fall, such as increasing physical strength and improving balance (WHO, 2012; Sherrington et al., 2019). Other rehabilitation interventions have targeted the abilities of the individual to manage falls. Some contemporary fall management interventions include the use of perturbation-based interventions to train individuals to arrest a fall (Okubo et al., 2019; Lurie et al., 2020), teaching fall management techniques to help older adults land safely on the ground (Moon & Sosnoff, 2017), and ways to properly get up after a fall (Hofmeyer et al., 2002). There is an urgent need for validated PROMs to enable clinicians and researchers to properly evaluate the clinical effectiveness of different interventions specifically targeting perceived self-efficacy to avoid falls or perceived self-efficacy to deal with a fall if the fall was to occur. The accumulated effects of age and comorbidity risk a potential disparity between perceived and actual physiological abilities in older adults (Delbaere et al., 2010), which thereby predispose older adults to falls. Many older persons commonly experience a near-fall in their regular functioning (Ryan et al., 1993; Basler et al., 2017).

On balance control

Balance control has two key components, postural control and equilibrium control (Huxham et al., 2001). Postural control involves the reaction of a stationary body to gravity by the active alignment of the trunk and head, adjustment of the body with the support surfaces and interpreting the environment based on the visual system (Horak, 2006; Huxham et al., 2001). In contrast, equilibrium control relates to the coordination of movement strategies to restore the centre of body mass during self-initiated or externally triggered disturbances of stability (Horak, 2006; Huxham et al., 2001). Clinicians may assess, identify and address the impairments of postural control and equilibrium control differently.

For postural control, clinicians focus their clinical reasoning process on protective balance mechanisms (Huxham et al., 2001). More than 50 different performance-based tests are available for the assessment of static steady-state balance, dynamic steady-state balance and proactive balance to measure postural control performance (Bergquist, 2019). To determine self-efficacy in postural control, many clinicians have focused on measuring balance confidence (i.e., balance self-efficacy). Balance confidence, which relates to performing activities without losing balance, is an essential psychological construct that clinicians consider for rehabilitation success (Simpson et al., 2009). To obtain a measure of balance confidence, Mancini and Horak (2010) reported that the ABC Scale is commonly used by clinicians, despite the availability of another measurement instrument, the CONFbal scale of balance confidence.

Choosing PROMs to measure a falls-related psychological construct of interest is not an easy decision (Jorstad et al., 2005). Various factors relating to the key measurements of a PROM are weighted to assess its suitability, including the populations in which it has been tested as well as its validity, reliability, practicality and responsiveness. The absence of a suitable PROM can prompt discussions over the development of a new PROM to address the limitations of existing instruments (De Vet et al., 2011). The addition of a new PROM could provide a solution but risks generating further confusion (Moore and Ellis, 2008). Besides constructing a relevant PROM, numerous validation studies are required to demonstrate empirical evidence of its psychometric properties to justify its use, and this process takes time. If inadequate attention is given to the instrument's validation, the instrument risks being under-utilised.

The PROMs of balance confidence provide a case in point. For example, both ABC and CONFBal scales were constructed conceptually appropriate to measure balance confidence. The ABC Scale was constructed from modifying the FES, whereas the CONFbal scale was developed using the Confidence in Everyday Activities' Scale (Hallam and Hinchcliffe, 1991). The Confidence in Everyday Activities' Scale was designed to determine the confidence in abilities to execute 21 activities without losing their balance. However, there is a preferential use of the ABC Scale in the literature. This could be attributable to a few reasons. First, there is a greater number of psychometric studies conducted for ABC Scale compared against CONFBal scale. Jorstad et al. (2005) reported six validation studies conducted for ABC Scale, whereas CONFBal scale had three. Second, the ABC Scale is widely used in several countries because the original version has been translated and cross culturally-validated in different countries. Some of the recent studies reported the ABC Scale in Arabic version (Elboim-Gabyzon et al., 2019) and in Thai version (Nanthapaiboon et al., 2018).

Having highlighted the importance of selecting suitable PROMs for the construct of interest, it is necessary to consider the prescribed interventions in relation to perceived postural control or balance confidence. Some interventional strategies include teaching older adults to avoid falls hazards or to maintain a higher degree of alertness in potentially hazardous situations (Ang et al., 2020). Rehabilitation aims to train the fixed support balancing strategies, namely the ankle-hip reactions and suspensory manoeuvres (Shumway-Cook & Woollacott, 2017).

Fixed support strategies have been covered at length in the rehabilitation literature. Some widely studied balance rehabilitation training includes static and dynamic balance training using different types of base support, such as a hard surface, a foam surface, or a wobble board (DiStefano et al., 2009). The objective is to improve the individual's ability to remain steady over a given base of support (Nashner, 1979; Winter et al., 1990; Maki et al., 2011).

Reactive balance recovery mechanisms are critical for an individual to achieve equilibrium control (Sibley et al., 2011). Such mechanisms differ from fixed support strategies, given that the movement of limbs is used to alter the base of support to recover balance (Maki & McIlroy, 1997). Change-in-support balance recovery strategies, such as the reach-to-grasp, touching an object for support, rapidly taking or modifying step(s), have been identified as necessary reactive manoeuvres executed by an individual in attempting to recover equilibrium following a loss of balance caused by various perturbations (Maki et al., 2008; Maki & McIlroy, 2006). The change-in-support strategies have been shown to provide much greater stabilisation than fixed support strategies (Maki & McIlroy, 1999). However, the ability to arrest a fall can be more demanding and challenging than the ability to maintain balance, especially for older people (Maki et al., 2003). This is because a complex limb movement is initiated to stop a fall and this execution occurs at rapid speed in response to a perturbation. An ability to execute balance recovery does not guarantee the successful arrest of a fall. The recovery manoeuvres must be appropriate to the characteristics of the balance disturbance and the constraints of the surrounding environment - for example, grasping onto available handholds or stepping on an unobstructed space. In addition, the demands of executing recovery reactions will rise with increasing age-related impairments and comorbidities that affect the neural and musculoskeletal systems.

To assess reactive balance recovery ability, different performance-based assessments, such as the Reactive Balance Test (Gschwind et al., 2013), the Retropulsion Test (Fahn et al., 1987), and the Push and Release Test (Jacobs et al., 2006), can be utilised. Other assessment types, such as perturbation-based assessment, involve exposing the individual to repeated postural perturbations that aim to determine the ability to produce rapid balance reactions (Mansfield et al., 2015). Evidence to support the use of perturbation-based assessment to assess equilibrium is still emerging (Gerards et al., 2017).

Perturbation training has shown promising results in terms of reducing falls incidence among health older adults and other groups, such as post-stroke patients and those living with

Parkinson's (Gerards et al., 2017). However, despite improvements reported in physical balance recovery, studies have reported a lack of significant carryover effect on perceived self-efficacy in balance as measured by the ABC Scale (Lurie et al., 2020) or the FES (Kurz et al., 2016). These studies recommended that more controlled studies with long-term follow-up periods would be needed to better elucidate the effects of perturbation-based training. However, the question remains whether perturbation training improves the perceived ability to recover balance and arrest a fall. The perception of own ability to recover balance from perturbations and avoid a fall is different from the perception of remaining steady during task performance. A measurement instrument that measures perceived reactive balance recovery abilities may give different information to balance confidence measurement instruments.

Balance recovery confidence, unlike balance confidence, relates to the confidence of older people to recover their balance in response to a perturbation such as a slip, a trip or a loss of balance caused by volitional movements. The current knowledge shortfall in this domain may stem from a lack of a suitable self-reported instrument. A PROM with a defined construct of balance recovery confidence has several potential benefits to provide:

1. Greater insight into older adults' perceived balance recovery capacity
2. A more comprehensive understanding of balance control
3. An evaluation of any disparity between perceived and actual balance recovery abilities
4. Encouragement for clinicians to explore more targeted assessments and interventions to address balance recovery-related issues
5. A targeted evaluation of perturbation-based training and its effects on balance recovery confidence

On patient-reported outcome measures for falls

PROMs are self-reporting instruments designed to measure constructs, such as patients' perspectives of their symptoms, functioning or health status, satisfaction, utility, general health or quality of life (McKenna et al., 2019). PROMs can be defined as "any report of the status of a patient's health condition that comes directly from the patient, without the interpretation of the patient's response by a clinician or anyone else" (FDA, 2009, p. 2).

There is growing advocacy of the use of PROMs in rehabilitation practice. In physiotherapy, Kyte et al. (2015) posited that they assist practitioners in their clinical reasoning process. PROMs are used to identify the main problems addressed in rehabilitation care (Greenhalgh, 2009). They also encourage patients' involvement as a way to stimulate self-management (Greenhalgh, 2009). The Chartered Society of Physiotherapy (CSP) has actively encouraged their use by physiotherapists, given that measurable improvements are important ways of demonstrating treatment success (CSP, 2014).

Previous systematic reviews conducted by Jørstad et al. (2005) and Moore and Ellis (2008) on PROMs for falls-related psychological constructs among community-dwelling older adults were not able to identify relevant gold-standard instruments for specific constructs because of the general use of the same PROMs across different constructs used within the literature. Both reviews recommended that clinicians and researchers clarify the terminology of the construct of interest within their study and ensure that the selection of measures are appropriate and consistently chosen.

On the selection and development of patient-reported outcome measures

An international endeavour, the COSMIN (COnsensus-based Standards for the selection of health Measurement INstruments) initiative, was started in 2005 to help researchers select the most suitable outcome measurement instrument for the construct of interest in research and clinical practice based on the instruments' methodological quality. The objective was to discourage the use of poor or unknown quality outcome measurement instruments (Prinsen et al., 2018). COSMIN recommended clear identification of the construct of interest prior to the selection of a suitable PROM. The PROM should have established congruence with the intended outcomes and the target population (Prinsen et al., 2018; Terwee et al., 2018). The choice of PROM should be based on an appraisal of fundamental measurement properties; if no suitable instrument can be identified, a new one should be developed (De Vet et al., 2011).

Before developing a new measure, De Vet et al. (2011) recommended an initial systematic literature review of the measurements properties of all existing PROMs relating to the construct of interest, for three reasons. First, a search for existing instruments can prevent the unnecessary development of new ones, which would only add to the existing confusion. Second, if a new instrument is deemed to be needed, the review would provide important information on what to include or avoid. Finally, if an existing instrument could be adapted to the construct in question, time and effort could be saved.

The development process for a PROM can be lengthy (De Vet et al., 2011). Different stages of content generation, pilot testing, and field testing involve steps going back and forth in a continuous process of evaluation and adaptation (Figure 1.1). These crucial steps ensure good content validity (Terwee et al., 2018). The piloting and field testing of a proposed PROM will help determine its measurement properties, including validity, reliability, responsiveness and interpretability. The definitions of some measurement properties listed in the COSMIN taxonomy are presented in Figure 1.2 and Table 1.1.

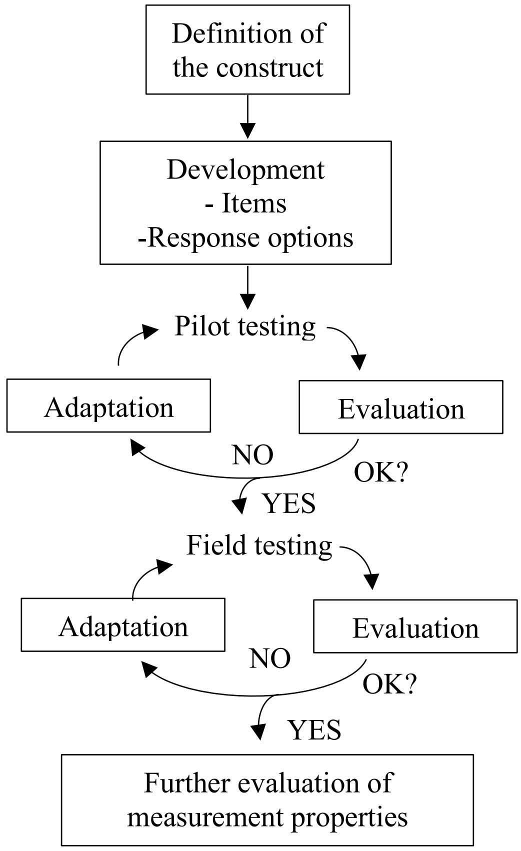

Figure 1.1 Overview of the steps in the development and evaluation of a measurement instrument. Adapted from Figure 3.1 in Chapter 3 Development of a measurement instrument (De Vet et al., 2011).

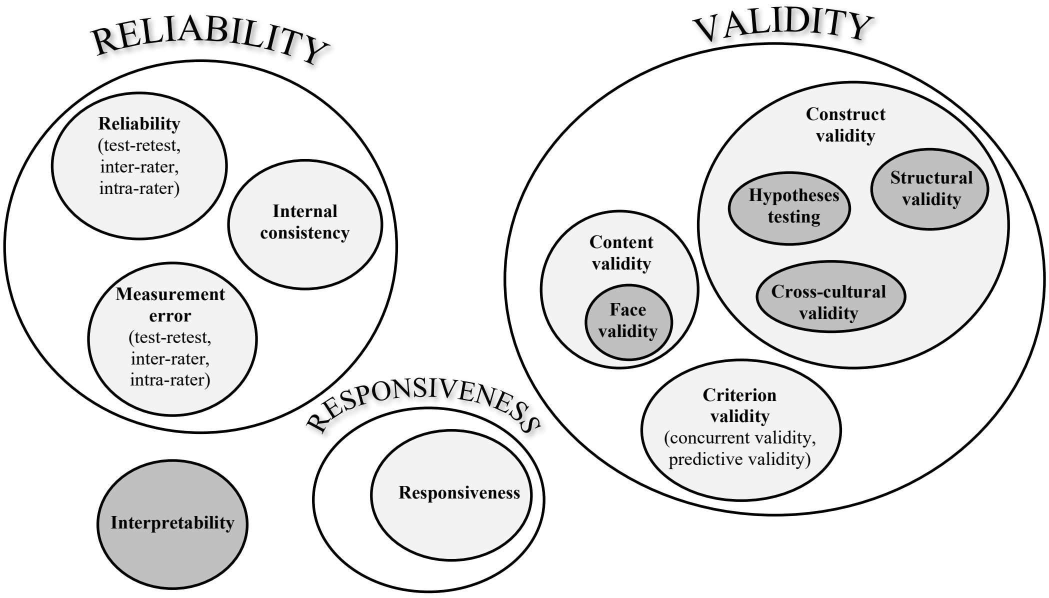

Figure 1.2 Measurement properties of the outcome measurement instruments. Adapted from COSMIN taxonomy of measurement properties (COSMIN, 2021).

Table 1.1 COSMIN definitions of measurement properties (COSMIN, 2021)

Measurement property	Definition
Internal consistency	The degree of the interrelatedness among the items.
Reliability	The degree to which the measurement is free from measurement error.
Content validity	The degree to which the content of a PROM is an adequate reflection of the construct to be measured.
Construct validity	The degree to which the scores of a PROM are consistent with hypotheses based on the assumption that the PROM validly measures the construct to be measured.
Structural validity	The degree to which the scores of a PROM are an adequate reflection of the dimensionality of the construct to be measured.
Responsiveness	The ability of a PROM to detect change over time in the construct to be measured.

Conclusion

Falls are a real threat to the wellbeing of community-dwelling older adults. Despite challenges in the theoretical understanding of falls efficacy, self-efficacy is an important psychological construct needing to be adequately understood to help older adults manage falls. There has been some confusion over the appropriate use of different PROMs to measure various constructs of interest; the selection of a suitable PROM needs to be informed by the quality of its measurement properties.

Against the backdrop presented in **Chapter 1**, the overall aim of the thesis is to report the development of a balance recovery confidence scale for community-dwelling older adults. **Chapter 2** will present a literature review using the theory of self-efficacy (Bandura, 1977) to underpin the balance recovery confidence concept. The chapter will also cover a literature review of different types of existing falls efficacy-related measurement instruments and balance recovery control to lay the groundwork for the thesis. This chapter will also present the methodology of PROM development to elucidate the steps that will be undertaken to develop the scale. **Chapter 3 to Chapter 7** will detail the robust and systematic development. **Chapter 8** will showcase research ouputs arising from the work, with **Chapter 9**, as the last chapter, provide a general discussion to conclude the thesis.

1.3 Research objectives

The objectives of the research were met through the following studies:

Study 1: To conduct a systematic review of the measurement properties of existing PROMs on falls-related self-efficacy used for community-dwelling older adults.

The objectives of Study 1 were to:

- Critically appraise and summarise the evidence on the development, content validity and structural validity of patient-reported outcome measures to assess falls-related self-efficacy in community-dwelling older adults.
- Identify the gaps in knowledge from the evidence obtained from the systematic review.
- Obtain information to justify and inform the development of a new PROM of balance recovery confidence.

Study 2: To assess the feasibility of studying near-falls and the use of balance recovery manoeuvres in community-dwelling older adults.

The objectives of Study 2 were to:

- Establish whether the concepts of near-falls and balance recovery manoeuvres are relatable to community-dwelling older adults
- Gain a preliminary understanding of the incidence of near-falls and the common types of balance recovery manoeuvres used to arrest a fall.

Study 3: To develop and validate the content of a new PROM of balance recovery confidence in community-dwelling older adults.

The objectives of Study 3 were to:

- Construct the content of a PROM measuring balance recovery confidence with community-dwelling older adults.
- Refine the preliminary content of the PROM with healthcare professionals and a new group of community-dwelling older adults.
- Validate the content of the PROM, ensuring its relevance, comprehensiveness and comprehensibility, for community-dwelling older adults.

Study 4: To assess the psychometric properties of a newly developed PROM of balance recovery confidence.

The objectives of Study 4 were to:

- Assess the acceptability of the newly developed PROM among the community-dwelling older adults.
- Examine the factor structure of the newly developed PROM.
- Evaluate the psychometric properties of the newly developed PROM with community-dwelling older adults in Singapore.

1.4 Thesis outline

In the course of my research studies, new knowledge that arose was submitted to and published in peer-reviewed journals. The published articles have been embedded with minimal amendments into this thesis.

A benefit of publishing results in this way is that it demonstrates recognition of the work among the research community; a drawback of including the published work within the thesis is that there will be an element of unavoidable repetition. The thesis consists of nine chapters (Figure 1.3). The development of the scale is presented in the following structure:

Chapter Two

This chapter provides a review of the literature to gather fundamental knowledge for developing a self-efficacy type PROM in the context of balance recovery. Bandura's self-efficacy theory, the different types of falls-related psychological concerns, and the concepts of balance recovery are covered. The chapter details the methodology to develop a PROM for balance recovery confidence. Methods described by De Vet et al. (2011) and Bandura (2006) are referenced to make the scale development process explicit.

Chapter Three

This chapter presents the findings of a systematic review conducted on studies relating to falls efficacy-related PROMs' content development, content validity and structural validity using the COSMIN guidelines. The methodological quality of earlier PROMs' development, the properties of content validity and structural validity are interrogated. The chapter concludes that existing PROMs have been inadequate to measure balance recovery confidence, justifying the development of a new one. This work is published in *BMC Geriatrics*, 2021, 21(21), 1-10.

Chapter Four

This chapter reports a feasibility study that was conducted to establish that the concept of balance recovery is important and relatable to the target population. This chapter describes the involvement of 30 community-dwelling older adults in Singapore. The older adults had to report the incidence of falls or near-falls within a three-week period. If a near-fall occurred, they had to identify the types of balance recovery manoeuvres used to arrest the fall. They were also asked whether they had any difficulty distinguishing between falls or near-falls and the types of balance recovery manoeuvres. This work was published in *Pilot and Feasibility Studies*, 2021, 7(25), 1-10.

Chapter Five

The chapter describes the content development and validation of a new scale for balance recovery confidence. The chapter details how the PROM's content was constructed with 22 Singapore community-dwelling older adults and an international panel of 28 healthcare professionals. This work is under review by an international peer-reviewed journal at the time of writing.

Chapter Six

The chapter presents the study protocol detailing the methods to be applied to assess the psychometric properties of the newly developed PROM. This work was published in *Physical Therapy Reviews*, 2021, 26(6), 457-466.

Chapter Seven

The chapter elucidates the psychometric properties of the newly developed PROM. The chapter details the field test conducted to evaluate its psychometric properties. The assessment of unidimensionality, validity and reliability of the PROM are reported. The distinctive nature of the balance recovery confidence scale for community-dwelling older adults is reflected in the chapter. This work is under review by an international peer-reviewed journal at the time of writing.

Chapter Eight

This chapter reports the research impact of the work based on the author's critical reflections of developing a new PROM of balance recovery confidence from a person-centred practice perspective. This work has been published in the following journals:

1. ***Research impact 1***

   "Falls efficacy: Extending the understanding of self-efficacy in older adults towards managing falls."

   Published in: *Journal of Frailty, Sarcopenia and Falls*, 2021, 6(3), 131-138.

2. ***Research impact 2***

   "Researcher as instrument: a critical reflection using nominal group technique for content development of a new patient-reported outcome measure."

   Published in: *International Practice Development Journal*, 2020, 10(2):10.

3. ***Research impact 3***

   "Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders."

   Published in: *International Practice Development Journal*, 2021, 11(1):9.

Chapter Nine

This chapter provides the general discussion of the thesis. The main findings of the research are reported and the contribution to literature on falls-related self-efficacy PROMs are discussed. Several insights are presented into why certain key steps are needed to develop a PROM. The last chapter shares some recommendations for future work.

Queen Margaret University
EDINBURGH

Development of a Balance Recovery Confidence (BRC) scale for Community-Dwelling Older Adults

Chapter 1 General introduction	• Background and context • Structure of thesis
Chapter 2 Review of the literature	• Self-efficacy theory • Types of falls-related psychological concerns and the patient-reported outcome measures used for the construct of interest • Balance recovery control • Steps to develop a patient-reported outcome measure
Theoretical frameworks	- Self-efficacy theory - Balance recovery concepts - Development of a measurement instrument concepts

Chapter 3 Systematic review Evaluating the methodological quality of studies on content development, content validation and structural validation of falls efficacy-related patient-reported outcome measures.	**Chapter 4 Feasibility study** Assessing the feasibility of studying balance recovery in community-dwelling adults aged 65 years and above.
Chapter 5 Content development and validation of the BRC scale Constructing and validating the content of the BRC scale with community-dwelling older adults and healthcare professionals from different disciplines relating to the care of older persons or falls-related rehabilitation.	**Chapter 6 and 7 Psychometric properties of the BRC scale** Evaluating the acceptability and psychometric properties of the BRC scale among community-dwelling adults aged 65 years and older

Chapter 8 Research dissemination & Chapter 9 General discussion

- The research outputs from different studies
- Discussion and summary

Figure 1.3 Chapter breakdown of the thesis.

1.5 Assumptions in this thesis

- Community-dwelling older adults will be able to read English and understand the instructions given by the PROMs. They will provide answers to the best of their ability that is reflective of their physical abilities and functional performance.

- Community-dwelling older adults will be comfortable providing an honest response when completing the PROMs.

- Community-dwelling older adults are cognitively alert, generally well, and have stable health and functional status.

1.6 Limitations in this thesis

- Community-dwelling older adults involved in the development and validation of the balance recovery confidence scale are represented by a sample of Singapore community-dwelling adults aged 65 years and older. The generalisation of the results across different cultures and societies may be limited until the cross-cultural validity of the PROM has been evaluated with culturally different populations.

- There may be different administration methods associated with the conduct of PROMs and performance-based measures, such as the explanations given to participants. This risk has been mitigated by using the same administrator to conduct the PROMs and performance-based measures during field testing.

- There is no current gold standard instrument to measure balance recovery confidence. The PROMs and performance measures reviewed provide an initial understanding of the construct validity of the newly developed PROM that measures balance recovery confidence in community-dwelling older adults.

1.7 Operational Definitions

Balance confidence	The perceived ability to undertake activities of daily living without losing balance (Powell & Myers, 1995).
Balance recovery confidence	The perceived ability to recover balance and arrest a fall in response to destabilising perturbations that can occur in everyday activities.
Concept	Global definition and demarcation of the subject of measurement
Conceptual framework	A model representing the relationships between the items and the construct to be measured (e.g., reflective or formative model).
Construct	A well-defined and precisely demarcated subject of measurement.
Falls-related self-efficacy or falls efficacy	Relates to the confidence in an individual's ability to manage the threat of falls (Payette et al., 2016). The conventional interpretation of falls efficacy relates to the confidence of performing common daily activities without falling (Tinetti et al., 1990).
Fear of falling	A lasting concern about falling that leads to individuals avoiding activities that they remains capable of performing (Tinetti & Powell, 1993).
Item	A single statement or question.
Measurement theory	A theory about how the scores generated by items represent the construct to be measured (e.g., classical test theory or item response theory)
Patient	In the literature of PROMs and COSMIN methodology, the term "patient" encompasses different patient groups, healthy individuals and even caregivers. The term "patient" refers to healthy community-dwelling older adults as the target population of interest in the thesis
Patient-reported outcome measure (PROM)	A measurement of any aspect of a patient's health status that comes directly from the patient, without interpretation of the patient's response by a clinician or anyone else (De Vet et al., 2011; FDA, 2009). The term "PROM" will be used interchangeably with the terms, "scale" or "measurement instrument"

1.8 Abbreviations

ABC scale	Activities-specific Balance Confidence Scale
BRC scale	Balance Recovery Confidence scale
CONFbal scale	CONFbal scale of balance confidence
COSMIN	Consensus-based Standards for the Selection of Health Measurement Instruments
CST	30-second chair stand test
CTT	Classical Test Theory
FES	Falls Efficacy Scale
FES-I	Falls Efficacy Scale-International
GES	Gait Efficacy Scale
GFFM	Geriatric Fear of Falling Measure
GPE	Global Perceived Effect
HRQoL	Health-related quality of life
HSD	Handgrip strength dynamometer
Icon-FES	Iconographical Falls Efficacy Scale
IRT	Item Response Theory
LLFDI-F	Late Life Function and Disability Instrument- Function
MBT	Mini-BESTest
MES	Mobility Efficacy Scale
MFES	Modified Falls Efficacy Scale
PAMF scale	Perceived Ability to Manage Risk of Falls or Actual Falls Scale
PAPMFR scale	Perceived Ability to Prevent and Manage Fall Risk Scale
PRISMA	Preferred Reporting Items of Systematic Reviews and Meta-Analyses Protocol
PROM	Patient-reported outcome measure
QMU	Queen Margaret University
RPC	Reactive postural control
RMT	Rasch Measurement Theory
SAFE scale	The Survey of Activities and Fear of Falling in the Elderly Scale
SIT	Singapore Institute of Technology
UICFFM	The University of Illinois at Chicago Fear of Falling Measure

Chapter 2

Review of the literature

“The ability to act is tied to a belief that it is possible to do so.”

“Self-efficacy is the belief in one's capabilities to organize and execute the sources of action required to manage prospective situations.”

– Albert Bandura.

2.1 Introduction

Chapter 2 presents the literature review relating to the research. The review set out to provide key fundamental knowledge to inform the development of a balance recovery confidence scale. The chapter is divided into four parts:

- Part I: An overview of the self-efficacy theory that underpins balance recovery confidence.
- Part II: A description of the common types of falls-related psychological concerns, and the PROMs used to measure these constructs.
- Part III: A reflection on the role of balance recovery control.
- Part IV: A synthesis of the steps to design a PROM, rationalising the methodology for developing a measure of perceived self-efficacy for balance recovery.

2.2 Part I: Overview of the self-efficacy theory

The theory of self-efficacy was first introduced by Bandura (1977) as an explanatory model of human behaviour. Self-efficacy is thought to causally influence behaviour outcomes (Bandura, 1989, 1997). The theory explains how expectations of personal efficacy can determine whether coping behaviours will be initiated, how much effort will be expended, and how long perceived self-efficacy will be sustained in the face of obstacles and adverse experiences.

To fully elucidate the theory, Bandura (1977) posited that expectations of self-efficacy (as efficacy expectations) would be different compared to outcome expectations (Figure 2.1). An efficacy expectation refers to the conviction of being able to enact the behaviours one needs to effectively cope with the situation at hand, whereas an outcome expectation refers to a person's estimate that a given behaviour will lead to an outcome (positive or negative). By distinguishing between the two, clinicians can better appreciate the agency in individuals and deploy appropriate rehabilitation strategies (Rubenstein, 2006; Stevens et al., 2018). For example, an older person who believes that they can regularly partake in physical activities or can participate in strength-training programmes will persevere in the task in order to attain the outcome of sustained physical functioning. This is reflective of efficacy expectations. If the older person has serious doubts about their abilities to participate, then even knowing the importance of exercises to improve the physical functioning does not influence their behaviour.

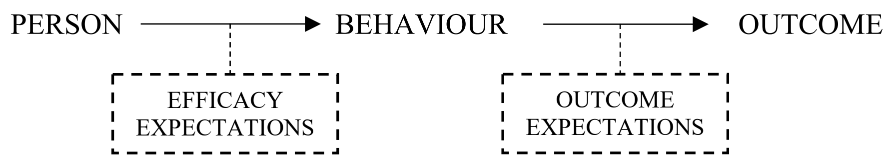

Figure 2.1 Diagrammatic representation of the difference between efficacy expectations and outcome expectations. Adapted from Figure 1 in Self-efficacy: towards a unifying theory of behavioural change (Bandura, 1977).

Self-efficacy has a deterministic influence on individuals' behaviours (Bandura, 1997). Bandura (1994) expressed that individuals with low aspirations and weak commitment tended to dwell on personal deficiencies when encountering obstacles instead of attending to how they could perform the required tasks successfully. When the expectation of efficacy is not restored following failure or setbacks, these individuals may perceive their capabilities have diminished, leaving them vulnerable to stress and depression (Bandura, 1982). It is essential to establish self-efficacy in individuals because when individuals seriously doubt their capabilities, information on efficacy expectation will not influence them to adopt positive behaviours, and the lack of self-efficacy beliefs can debilitate the person (Bandura, 1994).

Self-efficacy, as a self-regulatory mechanism, is considered to be an individual's perception of their capabilities to complete specific tasks or perform in a specific situation successfully (Bandura, 1981). As "agentic operators" in their life, people will contribute to their own motivation and action (Bandura, 2018). The amount of self-efficacy that an individual has can determine the amount of effort and persistence they will expend to complete a given task, overcoming any obstacles encountered (Bandura, 1977, 2000). An individual with low self-efficacy is more likely to give up when facing a challenging task; someone with high self-efficacy is more likely to persevere (Bandura, 2004). From the theoretical perspective of social cognitive theory, human functioning is viewed as the product of a dynamic interplay of (1) personal factors in the form of cognition, affect and biological events, (2) environmental influences, and (3) behavioural patterns based on the causal model of triadic reciprocal causation (Figure 2.2) (Bandura, 1999). The individual's level of self-efficacy can influence how well one can organise cognitive, social, and behavioural skills to complete specific tasks or perform in a specific situation. It is important to understand how a person interprets the results of one's behaviour informs and alters their environments and the personal factors they possess, which, in turn, inform and change subsequent behaviour. Perceived efficacy can directly affect human functioning and behaviour (Bandura, 1990).

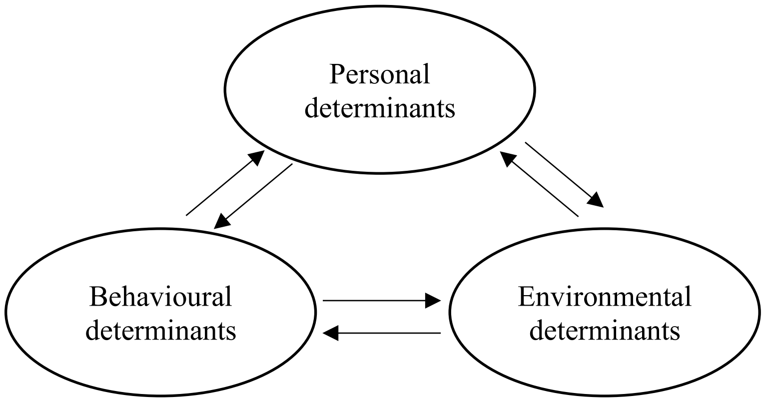

Figure 2.2 Schematization of triadic reciprocal causation in the causal model of social cognitive theory. Adapted from Figure 1 in guest editorial: On the Functional Properties of Perceived Self-Efficacy Revisited (Bandura, 2012).

Bandura (1977) had described four sources of information that can shape personal efficacy:

1. Performance accomplishments or enactive mastery
2. Vicarious experience
3. Social or verbal persuasion
4. Emotional and physiological states

Performance accomplishments are considered particularly influential in developing self-efficacy. If an individual has repeated success and limited failure, perceived self-efficacy will increase, which will drive future efforts to overcome failures or obstacles (Bandura, 1977).

Vicarious experience relates to the opportunity that arises when an individual sees others successfully perform a task. Bandura (1977) suggests that through observing the success of others, one might enhance their self-efficacy. However, this information acquisition source is not as dependable as the knowledge obtained through self-performance, which provides a more significant efficacy source than performance modelling (Bandura, 1977).

Verbal persuasion is an accessible source of influence. This refers to an exhortative source of information given by other agents that aids the individual to increase effort in accomplishing a task (Bandura, 1977). In the context of falls rehabilitation, persuasion is often provided by the clinicians. Social influence refers to the encouragement from social networks surrounding the older person, such as guardians, friends or carers, who can help the person overcome adverse experiences and strengthen their belief in their capacity to accomplish tasks. As each task is successfully performed, efficacy will increase and consequentially, self-doubt can be reduced (Li et al., 2002).

The final source refers to emotional arousal or the physiological states (Bandura, 1977). Experiences of emotional or physiological arousal can impact self-efficacy expectations when the ability to perform a behaviour is affected by positive or negative statements about a person's competence or control.

The concept of self-efficacy has been enduring. Emerging from Bandura's (1971) social cognitive theory, it has been applied to research in diverse fields of medicine, athletics, media, business, social and political change, psychology, psychiatry, and education, generating insights into the role of self-belief in individuals' perceived capability in many areas of life (Pajares, 2002). Conceptual understanding of the nature of self-efficacy beliefs has been useful to explain how they are acquired and how they influence the motivational and self-regulatory processes. However, self-efficacy has attracted criticism related to two aspects of its practical application: (1) inappropriate assessment of self-efficacy beliefs, and (2) difficulty in distinguishing between expectancy constructs, both empirically and theoretically (Pajares, 1997). In essence, inappropriate assessment of self-efficacy beliefs can be related to poorly constructed PROMs limiting the explanatory and predictive nature of self-efficacy. It is hard to determine the quality and accuracy of a PROM to assess self-efficacy when there are no criteria against which to judge it (Pajares, 1997). For the difficulties in distinguishing between efficacy expectancy and other expectancy constructs, for example, self-concept or perceptions of competence, the issue surrounds different authors perceiving tautological relationships between different constructs despite their distinctive natures (Pajares, 1997). Taking the examples of efficacy expectancy and self-concept, the former refers to a context-specific assessment of competence to perform a specific task (Bandura, 1997); by contrast, self-concept is more general, including, for example, determination of self-worth based on internal and external comparisons (Marsh, 1991). Yet, some authors have defined that self-concept as a generalised form of self-efficacy (Harter, 1990).

A similar conundrum is witnessed among falls-related psychological constructs (Hadjistavropoulos et al., 2011). To mitigate these problems, Bandura (2006) presented a guide for constructing self-efficacy scales. Conceptual issues, for example, distinguishing self-efficacy from self-concept, self-worth and outcome expectancy, are highlighted in the guide to encourage PROM developers to remain aware of the need to distinguish between commonly conflated constructs. Key conceptual and methodological recommendations regarding the nature and structure of self-efficacy scales should be adopted to improve the content quality. For example, proper instruction wording using "I can…", the inclusion of items reflecting gradations of challenges, and explicit description of the construct of interest need to be synthesised into the PROM. The use of "I will…" is unsuitable for a self-efficacy instrument. Willingness is a statement of intention and is conceptually and empirically separable from self-efficacy (Bandura, 2006). "Can do" denotes assurance to execute given levels of performance, which is in keeping with the operative conception of perceived self-efficacy (Bandura, 2007).

The approach of critically distinguishing different latent constructs is crucial for the development of a balance recovery confidence scale, especially when low falls efficacy or balance confidence has been conventionally interpreted as fear of falling (Hill et al., 1996). PROMs for these self-efficacy constructs have been commonly used to quantify the emotive construct of fear (Hughes et al., 2015). Instead of conflating emotive and cognitive constructs measured by a self-efficacy scale, a falls-related self-efficacy scale should be used to influence common falls-related issues, such as fearful and defensive behaviours (Lavedan et al., 2018; Pauelsen et al., 2018). Identifying the level of perceived self-efficacy will allow clinicians to have a better insight of older adults taking some degree of control to enhance their quality of life. Highly efficacious older adults who accept that potential falls are part of life would focus on doing things they want to preserve their autonomy and independence (Gustavsson et al., 2018).

The rich content of Bandura's self-efficacy theory (1977) facilitates understanding of the importance of empowerment in older people to effect change in themselves and their situations through their efforts. Self-efficacy in older people to manage falls, and the effects of various rehabilitation interventions on falls efficacy, are still poorly understood. Balance recovery confidence relates to the perceived ability to execute balance recovery manoeuvres in response to perturbations and arrest a fall. A PROM to provide a quantifiable measure of balance recovery confidence can be useful in a number of respects. First, it can be used as an outcome measure determining the clinical efficacy of interventions targeting reactive balance abilities.

Current literature has demonstrated that perturbation-based training lacks a carryover effect in balance confidence even where there have been significant improvements in balance recovery performance (Lurie et al., 2020). A purposefully constructed PROM of balance recovery confidence would provide a more accurate representation of changes in perceived self-efficacy to counter perturbations. Second, the information of balance recovery confidence complements the individual's falls prevention-related self-efficacy, for example, perceived ability of functioning without losing balance. These perceived capabilities could improve functioning of individuals. Bandura (1989) argued that successful functioning is best served by accurate efficacy appraisals. A more comprehensive understanding of individuals' perceived falls prevention abilities will help improve the agency of individuals to counter falls. Third, the PROM can help make the understanding of perceived performance to successfully recover balance clearer (Figure 2.3). Perceived self-efficacy could be reflected by choice, performance and persistence. Different perceived efficacy expectations influence the coping behaviour to produce the outcome ultimately (Bandura, 2007).

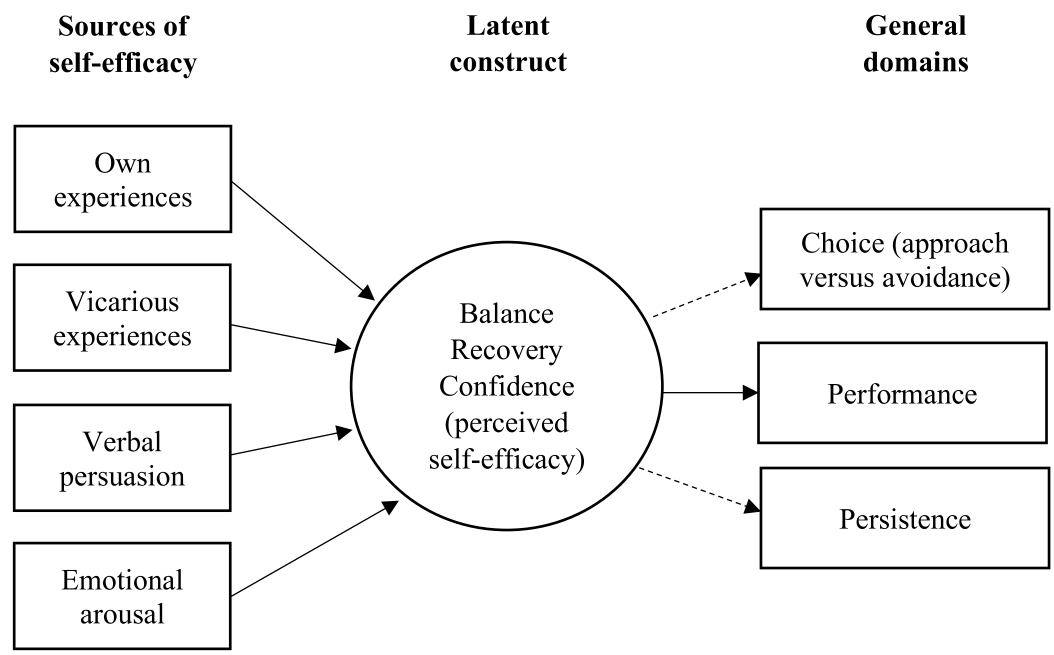

Figure 2.3 A unidimensional model reflective of the perceived performance to recover balance. Adapted from Figure 9.3 in Chapter 9 Personal Control Beliefs (Reeve, 2009)

2.3 Part II: Types of falls-related psychological concerns and patient-reported outcome measures used

Falls-related psychological concerns is an umbrella term (Hughes et al., 2015) encompassing falls efficacy (Payette et al., 2016; Tinetti et al., 1990), fear of falling (Tinetti & Powell, 1993), balance confidence (Powell & Myers, 1995), and outcome expectancies (Yardley & Smith, 2002). There are other falls-related psychological factors such as anxiety and depression. However, research on these constructs through fall rehabilitation is limited. Outcome expectancy, which stems from the self-efficacy theory (Bandura, 1977), is also the subject of limited research (Hughes et al., 2015). Falls-related literature has primarily focused on fear of falling, falls efficacy and balance confidence. These three concepts are reviewed in this section, alongside their associated PROMs.

Fear of falling

Fear of falling was first introduced by Marks and Bebbington (1976) as “space phobia”. This phobia “might be a hitherto unrecognised syndrome or an unusual variant of agoraphobia.” (Marks & Bebbington, 1976, p. 345). Murphy and Issacs (1982) and Bhala et al. (1982) then gave further attention to this fear by reporting their observations of patients expressing psychophysiological signs following a fall. Bhala et al. (1982) said that ptophobia described fear of walking or standing as a result of earlier falls, to differentiate it from agoraphobia (i.e., feeling that something dreadful might happen) or acrophobia (i.e., fear of falling from heights).

On the other hand, Murphy and Issacs (1982) described the fear of falling as a post-fall syndrome exhibited by people having walking disorders with a severe tendency to clutch and grab for support, leading to an inability to walk unsupported or to a caution gait after a fall. However, characterising fear of falling as a phobia with psychiatric connotations was viewed as inappropriate by Tinetti et al. (1990). Tinetti (1988) found that 48% of persons over the age of 75 years who had fallen in the previous year acknowledged being afraid of falling, as did 27% of those who had not fallen. This finding implied that a previous fall is not essential to the development of fear of falling. Instead, fear of falling might be better understood as “a lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing” (Tinetti & Powell, 1993, p. 36).

The understanding of fear of falling has evolved over the years but this has resulted in some ambiguity over selecting an appropriate measure (Abyad & Hammami, 2017). Tinetti et al. (1990) proposed that fear should be operationally defined as “low perceived self-efficacy or confidence at avoiding falls”. However, some authors have adopted a single-item question to singularly focus on the fear by asking, “At the present time, are you very fearful, somewhat fearful or not fearful that you may fall (again)?" (Arfken et al., 1994). Others have identified the need to consider individuals avoiding activities as a consequence of fear (Howland et al., 1998). Some authors eschewed the term “fear” and have instead focused loss of confidence in activities performance through concerns about falling (Yardley et al., 2005; Delbaere et al., 2011).

Table 2.1 Instruments to measure fear of falling

PROMs for fear of falling	Abbreviation	Developer	Number of items	Scoring
Survey of Activities and Fear of Falling in the Elderly	SAFE	Lachman et al., 1998	22	0-3 for each 6-subcategory question. A higher score indicates a greater fear of falling
University of Illinois at Chicago Fear of Falling measure	UIC-FFM	Velozo & Peterson, 2001	16	0–4 for each item with the descriptions: very worried, moderately worried, a little worried and not at all worried
Geriatric Fear of Falling measure	GFFM	Huang, 2006	15	1-5 for each item with 1 (never) and 5 (always)
Falls Efficacy Scale – International	FES-I	Yardley et al., 2005	16	1-4-point scale with 1 (not at all concerned) and 4 (very concerned)
Iconographical Falls Efficacy Scale	Icon-FES	Delbaere et al., 2011	30	1-4-point scale with 1 (not at all concerned) and 4 (very concerned)
Fear of Falling Avoidance Behaviour Questionnaire	FFABQ	Landers et al., 2011	14	0-5-point scale with 0 (completely disagree) to 4 (completely agree)

Among many interpretations of fear of falling, a new clinical entity, "Psychomotor Disadaptation Syndrome" was proposed, to identify fear of falling as a geriatric syndrome (Mourey et al., 2004). The syndrome, characterised by backward disequilibrium and gait abnormalities, recognises postural and motor disabilities and links fear of falling with physiological ageing. However, Bloch (2017) opined that introducing this syndrome has further complicated the understanding of the fear of falling and "has no real practical relevance to clinical work by rehabilitation and physical therapists" (p. 666). Although a consistent operational definition of fear of falling has proved elusive, different measures have been set out. Several multi-item measures proposed in the literature are listed in Table 2.1.

Falls efficacy

Falls efficacy relates to the degree of confidence to perform common activities of daily living without falling (Tinetti et al., 1990). Those authors introduced the term as a construct used as a proxy measure to determine fear of falling. Based on Bandura's self-efficacy theory, the authors posited that fear of falling should be operationally defined as "low perceived self-efficacy or confidence at avoiding falls". The measurement instrument of falls efficacy could be used to quantifiably measure the fear of falling (Tinetti et al., 1990).

The seminal article, "Falls efficacy as a measure of fear of falling" (Tinetti et al., 1990), led to a proliferation of studies on falls efficacy and fear of falling (Hadjistavropoulos et al., 2011). Numerous PROMs were developed and modified to measure different falls-related psychological constructs (e.g., falls efficacy, balance confidence and fear of falling; Jørstad et al., 2005). Further inquiry into falls efficacy and fear of falling has led to calls to transform understanding of these constructs (Moore & Ellis, 2008). However, researchers have continued to report indistinguishable interpretation of the two constructs in the literature (Hughes et al., 2015). There is a need to revisit the interpretation of falls efficacy because the interchangeable use of measures for falls efficacy and fear of falling is not theoretically sound (Li et al., 2002; Moore & Ellis, 2008; Hadjistavropoulos et al., 2011).

Whilst falls efficacy and fear of falling are related, both constructs are distinct (Hadjistavropoulos et al., 2011) and each should be measured by specific instruments. Fear of falling involves three components that may not necessarily overlap with each other (Rachman, 1978). These are (a) the physiological component (e.g., increased autonomic reactivity), (b) the behavioural component (e.g., walking slowly and deliberately to prevent a fall), and (c) the cognitive component (e.g., the subjective estimation of the level of danger and ability to avoid a fall). In contrast, falls efficacy, rooted in Bandura's social cognitive theory (1977), relates to an individual's confidence in their ability to manage a threat of a fall (Payette et al., 2016).

To improve the conceptualisation of falls efficacy, Hadjistavropoulos et al. (2011) proposed that it should be interpreted as "equivalent and interchangeable" with the term "balance confidence". Li et al. (2002) asserted that falls efficacy has a mediating role in the relationship between fear of falling and functional ability in older adults. Hughes et al. (2015) attempted to clarify the theoretical understanding between falls efficacy and balance confidence. The authors reiterated Tinetti's (1990) definition of falls efficacy as confidence in the ability to undertake the activities of daily living without falling, and Powell and Myer's (1998) definition of balance confidence as a belief in the ability to maintain balance whilst performing activities of daily living. Hughes et al. (2015) echoed the confusion of researchers, such as, Jørstad et al., 2005; Moore & Ellis, 2008 and Hadjistavropoulos et al., 2011, regarding the interpretations in the literature. This shared uncertainty prompts consideration of the roots of the conundrum.

The major challenge surrounding the complexity to understanding falls efficacy relates to the congruence between measurement instruments. As mentioned earlier, it is a challenge to measure unobservable constructs. One way to assess whether an instrument validly measures the construct of interest is by evaluating the construct validity. Construct validity refers to the degree to which the scores of a measurement instrument are consistent with hypotheses, such as, the relationships with scores of other instruments (De Vet et al., 2011). The higher magnitude of correlations or differences between two instruments, the instruments are measuring more similar or different constructs. For example, Hotchkiss et al. (2004) identified the FES is highly correlated (.86) to the ABC Scale (for balance confidence) and is moderately correlated (.67) to the Survey of Activities and Fear of Falling in the Elderly scale (for fear of falling). In contrast, Fadavi-Ghaffari et al. (2019) showed that the FES is highly correlated (.92) to the Falls Efficacy Scale-International (FES-I) (for fear of falling) but has a moderately-high correlation (.72) to a single fear of falling question. This indicated the complexity of the relationships measured by the different instruments for the construct of interest. Nevertheless, it is important to note that congruency between instruments does not imply the equivalence of the constructs being measured. The need to provide detailed description, conceptual models or theories about the construct, and the continued testing of specific and challenging hypotheses remains to validate the PROM measuring the construct that it purports to measure (De Vet et al., 2011).

Table 2.2 Instruments to measure falls efficacy

PROMs for falls efficacy	Abbreviation	Developer	Number of items	Scoring
Falls Efficacy Scale	FES	Tinetti et al., 1990	10	10-point continuum with 1 (very confident) to 10 (not confident at all). A higher score is equivalent to lower confidence or efficacy
Modified Falls Efficacy Scale	mFES	Hill et al., 1996	14	11-point visual analogue scale, marked from 0 to 10 with a higher score depicting higher confidence
Perceived Ability to Prevent and Manage Fall Risks	PAPMFR	Yoshikawa & Smith, 2019	6	1-5 for each item with 1 (excellent) and 5 (poor). Items scores are reversed coded so that higher scores represented higher perceived ability to prevent and manage fall risks
Perceived Ability to Manage Risk of Falls or Actual Falls	PAMF	Tennstedt et al., 1998	5	1-4-point scale with a higher score depicting a greater sense of ability to manage risk of falls
Perceived Control over Falling	PCOF	Tennstedt et al., 1998	4	1-4-point scale with a higher score depicting a greater sense of control

The different PROMS used to measure falls efficacy are listed in Table 2.2. While some measurement instruments were developed to measure falls efficacy, some studies have used these PROMs to measure fear of falling or balance confidence, given the ubiquitous conflation of terms. This is concerning because instruments may not be appropriate for constructs other than those they were designed to measure, and there is a risk of improper use of instruments (Prinsen et al., 2018). To address the confusion, some researchers have called for new instruments to be developed, while others called for a more explicit description of the construct of interest and consistent use of instruments for their intended construct (Hughes et al., 2015; Moore & Ellis, 2008). The notion of self-efficacy in older people to manage falls remains poorly understood. Further work is needed to improve the conceptual understanding of falls efficacy, including the application of appropriate measurement instruments.

Balance confidence

Balance confidence was conceptualised by Powell and Myers (1995) following the introduction of the falls efficacy concept. Those authors suggested that assessing balance confidence would provide a better understanding of an individual's self-efficacy in maintaining one's balance during task performing or the decision to engage in a particular activity, whether the cognitive appraisal is accurate or not. For example, a person who has a high degree of balance confidence may engage in potentially more hazardous activities, such as standing on a chair; one with lower confidence might avoid such actions (Powell & Myers, 1995).

The ABC Scale was then developed by Powell and Myers (1995), aiming to provide a better assessment of balance confidence. The interpretation of balance confidence was based on performing different activities without losing balance or becoming unsteady. However, to make the conceptual understanding of balance confidence clearer, Filiatrault et al. (2007) amended the ABC Scale's cue question from, "How confident are you that you will not lose your balance or become unsteady when you . . ." to "Up to what point are you confident that you will maintain your balance when you do the following activities?" Filiatrault et al. (2007) posited that a newly presented question should be framed from an action rather than an avoidance perspective.

Falls efficacy and balance confidence in older people have generally been understood as synonymous - that is an individual's confidence to perform daily activities without falling or while maintaining balance (Hotchkiss et al., 2004; Hadjistavropoulos et al., 2011; Hughes et al., 2015). As mentioned in the earlier section on falls efficacy, Hadjistavropoulos et al. (2011) posited that balance confidence is "equivalent and interchangeable" with falls efficacy. Balance confidence, which draws on the self-efficacy theory, is generally understood as the perceived ability to engage in everyday functional tasks without losing their balance (Simpson et al., 2009; Hughes et al., 2015).

Given this premise of understanding balance confidence, balance recovery confidence - which relates to the perceived ability to recover balance in response to a perturbation, such as a slip, a trip or a loss of balance caused by volitional movement - appeared to be understudied presently. There is nascent literature on rehabilitation interventions to improve balance recovery abilities, such as, perturbation-based balance training to prevent falls (Mansfield et al., 2015). The efficacy expectation that an older adult has to arrest a fall after a loss of equilibrium builds on the perceived capability of equilibrium control (Maki et al., 2008). The construct of balance recovery confidence is distinct from balance confidence. Balance recovery confidence is related to reactive ability to recover balance and restore equilibrium, whereas balance confidence is focused on perceived performance of activities without losing balance. A greater understanding of balance recovery confidence is needed in fall rehabilitation practice.

Table 2.3 Instruments to measure balance confidence

PROMs for balance confidence	Abbreviation	Developer	Number of items	Scoring
Activities-specific Balance Confidence Scale	ABC	Powell & Myers, 1995	16	0-100% response continuum with 0% (no confidence) and 100% (complete confidence)
Activities-specific Balance Confidence Scale-Simplified	ABC-S	Filiatrault et al., 2007	15	4-category response format with 0 (not at all confident) to 3 (very confident)
Activities-specific Balance Confidence Scale- Short version	ABC-6	Peretz et al., 2006	6	0-100% response continuum with 0% (no confidence) and 100% (complete confidence)
CONFbal scale of balance confidence	CONFbal	Simpson et al., 2009	10	1-3-point scale with 1 (confident), 2 (slightly confident) and 3 (not confident)

Different PROMs used to measure balance confidence are listed in Table 2.3. Some measures on balance confidence were developed by referencing scales for other constructs, such as the FES (Tinetti et al., 1990) and the Confidence in Everyday Activities Scale (Hallam & Hinchcliffe, 1991). Other PROMs presented are improved versions of the original 16-item

ABC scale (Powell & Myers, 1995) to address the efficiency of use or contextual relevance. For example, the shortened six-item ABC Scale (Peretz et al., 2006) or the 15-item ABC, excluding “walk outside on icy sidewalks” from the original (Filiatrault et al., 2007).

In summary, the constructs, fear of falling, falls efficacy and balance confidence have been commonly studied in the literature. These three falls-related psychological constructs have been perceived to have close congruence. PROMs originally constructed for one psychological construct have been conveniently used to measure others.

2.4 Part III: Balance recovery control

The three constructs, fear of falling, falls efficacy and balance confidence, have remained dominant falls-related psychological concerns across the years. There has been little attention given to the role of balance recovery confidence. Rooted in the concept of self-efficacy, balance recovery confidence relates to the perceived capability of arresting a fall upon a loss of balance due to internal or external perturbations resulting in disequilibrium. This section will present the unique nature of balance recovery control.

Balance recovery is a critical ability for older adults to avoid falls, given the numerous potential disturbances of postural equilibrium experienced in everyday life (Okubo et al., 2018). This imperative ability to restore balance in a state of disequilibrium is the ultimate determinant of whether a fall can be transformed to a near-fall (Maki et al., 2011). Balance recovery is a complex and multifactorial skill applied across a wide range of potential fall scenarios in indoor, outdoor and workplace environments (Winter et al., 1990; Komisar et al., 2019). A successful recovery of balance turns a potential fall into a near-fall, which is a stumble event or loss of balance that would result in a fall if sufficient recovery mechanisms were not activated (Maidan et al., 2014). An individual may experience different forms of near-fall-related situations in everyday activities, including but not limited to a trip over an obstacle, a loss of footing on a slippery or uneven surface, losing balance when a bus or elevator suddenly starts or stops, or when standing up from a chair. Near-falls have been as occurring more frequently than actual falls (Nagai et al., 2017). More than half of community-dwelling older adults report experiencing occasional or frequent near-falls (Arnold and Faulkner, 2007; Basler et al., 2017), with one-third reporting a near-fall at least once a month (Nagai et al., 2017).

From an early inquiry into balance control (Babinski, 1899), there has been a proliferation of knowledge surrounding the inextricably intertwined dynamics of posture, movement, function and falls over the past century. Often, the terms balance and balance recovery are used interchangeably. The control of postural dynamics (the orientation of various body segments relative to the gravitational vector) focuses on the ability of a person to stay upright by maintaining and restoring balance during normal activities. Balance, *stricto sensu*, is preserved when the centre of mass remains within the base of support, or more generally, within the limits of stability (Massion and Woollacott, 2004). When attending to balance recovery control, the maintenance of balance exploits a change in the base of support to restore equilibrium (Maki and McIlroy, 1997). The recovery mechanisms for an individual to restore balance following unexpected perturbations, such as, from slips or trips experienced in regular functioning, would be different to those that maintain postural equilibrium (Winter, 1995; Maki et al., 2011; Komisar et al., 2019; Tokur et al., 2020). For example, a person standing still may sufficiently maintain equilibrium through the regulation of muscle activities at the ankles (fixed-support strategy) while a person activating several prime movers at the hip and ankle joints to take several steps (change-in-support strategy) to restore equilibrium following a trip.

A common way to differentiate balance control and balance recovery control is to consider balance as a broad approach towards the maintenance of postural stability across task performance and balance recovery as the postural recovery reactions to various balance perturbations (Winter et al., 1990; Massion, 1992; Maki and McIlroy, 1997; Patti et al., 2018). Central to understanding the balance control mechanisms, multiple strategies may be adopted to maintain balance through proactive and reactive balance mechanisms (Huxham et al., 2001). The use of proactive balance mechanisms can explain anticipatory postural adjustments, including avoidance strategies, i.e., walking around an impending obstacle and adaptational strategies, i.e., stride shortening, reducing gait speed, raising of arms or bending forward (Huxham et al., 2001). These strategies may be opted by a person when faced with perceived disequilibrium stimuli (Woollacott and Tang, 1997; Huxham et al., 2001). In the context of balance recovery control, some of these postural movements can be viewed as antecedent adjustments. However, there is mixed evidence that these adjustments restore postural equilibrium. Graham et al. (2015) reported that the change in step length and trunk angle would provide maximal balance recovery performance, whereas Pater et al. (2015) posited that there was no evidence that anticipatory postural adjustments would affect the recovery stepping response.

Commonly applied balance control strategies are ankle-hip strategy (Winter et al., 1990), suspensory strategy (Winter et al., 1990), and straight-knee posture strategy (Di Guilio et al., 2013). In contrast, balance recovery control relates to change-in-support strategies that focus on the use of limb movements, that is, initiating a step, modifying a step, touching an object for support or grabbing a stable handhold to alter the base of support and restore postural equilibrium. These recovery strategies occur rapidly after the onset of postural disturbances and have been found to be common (Maki and McIlroy, 1997). Compensatory limb movements are common reactions to externally applied postural perturbation, even for small disturbances in which stability could have been maintained without moving the arms or legs (McIlroy and Maki, 1995; Maki and McIlroy, 1999). Change-in-support strategies attempt to gain a biomechanical advantage by achieving a greater degree of stabilisation through an effective change in the base of support. These strategies are better reactions in responding to large perturbations than fixed-support reactions (Maki et al., 2011). Fixed-support reactions can be inadequate or elicited too late to maintain balance, even in seemingly innocuous situations (Winter et al., 1990). These balance recovery reactions have identified as meriting greater attention in falls prevention work (Maki et al., 2011), especially for individuals who frequently encounter unexpected events of destabilisation in day-to-day activities.

Another balance recovery control strategy, the hop, has been proposed by Marinsek and Cuk (2010). The hop differentiates itself from a stepping strategy with a temporarily elevated centre of mass. To achieve this hop strategy, the movement needs considerable ankle plantarflexion and knee flexion to accompany a significant trunk flexion to generate the momentum for the change in the centre of mass (Cheng and Yeh, 2015). However, this strategy has been mainly studied among gymnasts and not older adults. Nevertheless, there are practical scenarios in which this strategy might be useful for community-dwelling older adults - for example, a sideways hop to avoid collision with a small child or a pet, or two or three hops to maintain their equilibrium while putting on trousers. In studying perceived balance recovery control, clinicians and researchers can better understand the different falls-related psychological constructs and their influence on an individual's behaviour and function in real-world scenarios.

There is growing evidence of the need to assess the balance recovery ability in older adults; it has been found to be compromised compared with younger adults (Hilliard et al., 2008; Carty et al., 2011). Older adults' reduced ability to recover balance following a loss of stability puts them at higher risk of falls. Ellmers et al. (2018) reported that the disparity in perceived and actual balance recovery abilities in older adults could be successfully recalibrated using exergaming interventions. In a way, older adults who perceived themselves being less efficacious could gain higher level of confidence and others who viewed themselves being highly efficacious were able to be more aware about their limitations, then reduced their risk-taking behaviours. Exergaming - portmanteau of "exercise" and "videogaming" - is a means to deliver an intervention with augmented feedback relating to task performance provided to the participant (Ellmers et al., 2018). With a potential significant age-related decline in their ability to maintain or restore balance, it is crucial for older adults to identify existing or remnant balance recovery capability (Komisar et al., 2019). An older person might not be aware of declining reactive recovery abilities even though they had been capable of independent functioning until they experience a fall.

The suitability of existing instruments to measure perceived balance recovery confidence is uncertain. Present studies employing balance recovery training have commonly applied falls efficacy-related measures, such as the FES or the ABC Scale. However, the nuances in the cue question and specific items of these PROMs, which attempt to determine confidence in the ability to perform activities of daily living, rather than confidence in the ability to arrest a fall, would not provide an accurate measure of perceived balance recovery abilities. A distinct construct of balance recovery confidence for community-dwelling older adults requires a PROM that focuses on a range of perturbation-type scenarios in which the respondent evaluates their personal ability to recover balance, arresting a fall. The lack of a suitable instrument to measure balance recovery confidence highlighted the need for one to be developed specifically for this purpose, using proper methodology. A PROM of balance recovery confidence would allow a more significant inquiry of the perceived balance recovery ability in older adults by clinicians and researchers to tackle the issues surrounding balance recovery control in older adults and improve the agency in older individuals on developing necessary skills in fall prevention practice.

2.5 Part IV: Development of a patient-reported outcome measure

There are different approaches to developing a PROM. Some PROM developers have applied the guidelines described by the US Food and Drug Administration (FDA, 2009; Klingels et al., 2016; Strickland et al., 2020). However, the use of the FDA guidance for purposes beyond its intended aim may be inappropriate (FDA, 2009). The FDA guidance aimed to ensure that an appropriate outcome measure is developed to measure treatment benefits or risks in a medical product clinical trial and "support claims in approved medical product labelling" (FDA, 2009, p. 1).

Further guidance for developing a measurement instrument for use in the field of medicine and health sciences has been provided by De Vet et al. (2011; see Table 2.4). This guidance was conceptualised to provide "practical advice, underpinned by theoretical principles, on developing and evaluating measurement instruments in all fields of medicine" (De Vet et al., 2011). De Vet et al. (2011) highlighted that the PROM development's methodological details must be suitably adopted as a measurement instrument used in various disciplines, such as imaging techniques, psychology, microbiology, genetics, and others differ significantly from each other (De Vet et al., 2011).

Table 2.4 Six steps in the development of a measurement instrument (De Vet et al., 2011).

Step 1	Definition and elaboration of the construct intended to be measured
Step 2	Choice of the measurement method
Step 3	Selecting and formulating items
Step 4	Scoring issues
Step 5	Pilot testing
Step 6	Field testing

Step 1 Definition and elaboration of the construct to be measured

The construct's definition is a statement of the understanding of the construct to be measured (De Vet et al., 2011). The construct should be defined in as much detail as possible based on various sources, such as theoretical and research-based literature and the involvement of the target population. This elaboration addresses the common issue of misinterpretation when PROM developers fail to define, conceptualise or operationalise the construct that the PROM is intended to measure (McKenna, Heaney, & Wilburn, 2019).

Balance recovery confidence is operationally defined as the perceived ability to recover balance and arrest a fall in response to a perturbation that can occur in everyday activities. The PROM for balance confidence is conceptualised to be unidimensional, focusing on the perceived balance recovery performance across different scenarios (Figure 2.3, above). The construct of balance recovery confidence should be understandable and relevant to the target population according to the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guidelines (Prinsen et al., 2018). The literature of balance recovery control abilities has been presented through the works of several authors, including Winter et al. (1990), Maki and McIlroy (1997). Essentially, balance recovery strategies such as change-in-support reactive manoeuvres must be executed in an effective and timely manner in response to different perturbations to avoid falling on the ground.

Step 2 Choice of a measurement method

The choice of a measurement instrument should correspond closely to the construct to be measured (De Vet et al., 2011). To determine the perceived ability of the individuals in their care, clinicians would either conduct an interview or use a PROM to obtain information from the individual because perception always requires direct information from the person (De Vet et al., 2011). PROMs are commonly adopted, as the questionnaire-based approach is cost-effective and is administered easily (Weldring & Smith, 2013). When designing an appropriate PROM, developers need to be mindful that the content structure, such as the directive (i.e., the cue question), should be phrased so that it is understood by clinicians and patients. For example, the cue question should be phrased to assess what individuals think they can do. A PROM sets out to gauge an individual's view of their own ability to perform in terms of achieving certain objectives (Bandura, 2006).

Table 2.5 Suggested situations for using single-item and multi-item Quality of Life Index (Sloan et al., 2002)

Single-item questionnaire	Multi-item questionnaire
Phase 2 study assessing whether a treatment has any impact on quality of life	Phase 3 study needing a delineation of which quality of life components are affected
Stratification factor for the presence of absence of depressive issues	Screen to identify the presence or absence of clinical depression
Assessing fatigue or pain as a correlate of toxicity (brief fatigue or pain inventory)	Assessing the impact of fatigue or pain on the activities of daily living
Identification of patients who need further quality of life assessment	Details of the quality of life related issues once a cutoff score on a single item has been obtained
Clinical setting wherein a basic idea of which domains of quality of life (mental, physical social) may be affected by a particular treatment of situation	Clinical setting wherein precise indications of the way in which the different domains of quality of life may be affected by a particular treatment or situation

The number of items for the PROM should be carefully deliberated. A single-item instrument may not provide a full understanding of the construct (Sloan et al., 2002). Instead, a multi-item PROM will be more appropriate to understand perceived performance across different situations. According to McIver and Carmines (1981), a single item is unlikely able to fully represent a complex theoretical concept - or any specific attribute for that matter. Further, a PROM with multiple items will be more reliable than a single-item instrument (De Vet et al., 2011). From a classical test theory perspective, the replications of the observed scores will have errors that tend to average zero (Cappelleri et al., 2014). However, administering multi-item PROM can have practical problems. Sloan et al. (2002) highlighted issues, such as possible low response rates or questions that are not answered. Sloan et al. (2002) suggested situations in which a single-item or multi-item PROM may be more appropriate, using the Quality of Life Index measurement instrument as an example (Table 2.5).

Other factors that need to be considered when designing a measurement instrument include whether the patient will consider the same aspects of balance recovery confidence as the developers had in mind or whether the construct of balance recovery confidence has the same meaning for all patients. The PROM should be clearly understood by the target population as intended and it should be clear that the same construct is being measured for all patients (Terwee et al., 2018). The content of the items needs to be specific in a multi-item measurement instrument of a unidimensional construct to address the reliability issue (De Vet et al., 2011). For example, the multiple items listed in the measure of balance recovery confidence should be phrased in a way that enables respondents to identify their confidence to recover balance in the given situation. Once constructed, the list needs to be validated from various sources, including literature review, community-dwelling older adults and healthcare experts to ensure that the items are relevant, comprehensive and comprehensible to the target population.

Step 3 Selecting and formulating items

Inputs from literature

According to De Vet et al. (2011), a systematic review of existing PROMs for the construct of interest is imperative. A systematic review helps not only to clarify the construct to be measured but also to provide a set of potentially relevant items.

In the context of falls-related psychological concerns, two systematic reviews, conducted by Jorstad et al. (2005) and Moore and Ellis (2008), have provided some relevant insights. Neither review was able to identify 'gold standard' instruments for respective psychological constructs after analysing amalgamated studies. Their conclusions suggested a need for further work to determine appropriate measures to characterise the falls-related psychological issues faced by older adults. The reviews further expressed that constructs of falls efficacy and balance confidence were similar as both relate to confidence in performing activities without falling or losing balance. Further evidence of a high construct validity (.86) was identified between FES and ABC scale (Hotchkiss et al., 2004), which led to some researchers positing that falls efficacy and balance confidence are "equivalent and interchangeable" (Hadjistavropoulos et al., 2011, p. 9).

A critical appraisal of the development and content validity of existing PROMs would allow a comparison of different key aspects, namely, relevance, comprehensiveness, and comprehensibility of the PROMs' content evaluated by various stakeholders including the target population and healthcare professionals (Terwee et al. 2018). Content validity is the degree to which the content of an instrument is an adequate reflection of the construct to be measured (Mokkink et al. 2010). A properly conducted study of this measurement property will provide a greater clarity of the constructs and the PROMs as understood by different stakeholders. Another point to note is that the similarity of constructs does not imply equivalence. A high congruence between two measurement instruments is no guarantee that the construct of interest can be accurately measured by the choice of PROM (Terwee et al. 2018). There is still a lack of empirical evidence for clinicians to justify selecting available PROMs that were initially developed for another construct. This fundamental gap in the literature could be addressed by a systematic review of existing PROMs for falls-related psychological concerns, using the COSMIN guide (Terwee et al., 2018). In terms of a PROM for balance recovery confidence, this would clarify whether existing PROMs could be applied or adapted to this construct.

The reviews by Jorstad et al. (2005) and Moore and Ellis (2008) have led to a supposition that there may be no suitable PROM for balance recovery confidence. These reviews had existing PROMs categorised into fear of falling, falls efficacy, and balance confidence. Balance recovery confidence differs from those three constructs. Balance recovery confidence relates to the perceived self-efficacy in older people to recover their balance in different perturbations scenarios, such as a slip, a trip, or a loss of balance caused by volitional movement. In contrast, fear of falling is a construct involving emotions and behaviours, while falls efficacy and balance confidence refer to the perceived ability to perform activities of daily living without falling and losing balance. Nevertheless, the literature could still be useful in suggesting various potential scenarios when developing a new PROM of balance recovery confidence for a similar target population. These scenarios allow older adults to give a realistic judgement of their perceived balance recovery abilities to arrest falls in response to perturbation.

PROM developers need to consider several issues relating to content (Bandura, 2006). These can be split into three categories:

1. Levels of task demands that represent gradations of challenges
2. Situational specificity
3. Contextual relevance

(1) Levels of task demands that represent gradations of challenges

Items that offer differing levels of challenge are required in the PROM to allow perceived efficacy to be measured against different levels of task demands which may impede successful performance (Bandura, 2006). Items easily achieved can lead to a gap between perceived and true efficacy. This issue was raised by Powell and Myers (1995) when the original FES (Tinetti et al., 1990), developed for frail older people was found to have a ceiling effect for high-functioning older people living independently in the community.

(2) Situational specificity

Situational specificity relates to how the items are read and understood by older people. The item descriptors should be consistently comprehended and have little variability in the understanding. In an example of a PROM for balance confidence, Powell and Myers (1995) asserted that individuals' confidence in their ability to perform activities without losing balance depends greatly on the circumstances, such as the ease of reaching for something at eye level compared with reaching upwards while standing on a chair. Items written in a situation-specific context can better correspond with performance measures (Myers et al., 1993). Another example is a PROM to measure fear of falling. Delbaere et al. (2011) illustrated the items with pictures to ensure unambiguous reading of the task and environment.

(3) Contextual relevance

Another consideration for PROM developers is that items should be relevant to the context, to maximise the clinical utility of the PROM (Bandura, 2006). Taking the example of an item in the ABC Scale describing a walk outside on icy sidewalks, it would be difficult for older people who live in temperate climates to self-rate their ability (Powell & Myers, 1995; Hill et al., 1996). To mitigate this issue, a PROM needs to be contextual adapted and validated to ensure an adequate reflection of the performance of the items of the original version of the measure (Prinsen et al., 2018). For clinicians to have a thorough understanding of the latent construct, such as falls efficacy in community-dwelling older people, the list of items in a PROM should encompass a range of situations that the older people in question could expect to encounter, which would include a variety of activities inside or outside the home (Hill et al., 1996).

Inputs from experts

De Vet et al. (2011) recommended that PROMs should be developed in close cooperation with experts such as clinicians and the target population. Clinicians in their relevant fields have extensive expertise on the different risk factors of falls, based on their professional disciplines – for example, medicine, nursing, physiotherapy, occupational therapy, podiatry and their clinical reasoning strategies in tackling falls-related issues (Higgs et al., 2008). At the level of understanding symptoms, physical functioning and perceived health, the older people themselves are the key experts and so should be involved in developing the PROM (Prinsen et al., 2018).

To develop a list of suitable items for the PROM, clinicians and community-dwelling older people can offer their invaluable insights (Krueger & Casey, 2014). When constructing items to assess perceived self-efficacy, these participants should express and identify the challenges and impediments involved (Bandura, 2006). Items with varying levels of difficulties should be built in to avoid floor and ceiling effects. Ultimately, PROM developers need to have an exact picture in mind of the construct to be measured, guide the participants as required, and be able to identify the relevant information from the data collected.

Formulation of the preliminary list of items

De Vet et al. (2011) recognised that, when constructing a PROM, new formulations or reformulations should always occur because the information obtained from the different sources, i.e., literature and experts, must be translated into adequate items. The preliminary draft of the PROM should contain as many items as possible. The other methods for evaluation, item reduction and reconsideration can be applied at later phases. The basic rules are guided by Bradburn et al. (2004; see Table 2.5).

Table 2.5 Rules applied in the formulation of items (Bradburn et al., 2004).

Rule 1	Items should be comprehensible to the total target population, independent of their level of education. Difficult words and complex sentences should be avoided.
Rule 2	Terms that have multiple meanings should be avoided.
Rule 3	Items should be specific.
Rule 4	Each item should contain only one question instead of two or more.
Rule 5	Negative wording in question should be avoided.

Step 4 Scoring issues

The scoring options can be expressed at nominal, ordinal, interval or ratio levels (De Vet et al., 2011). PROMs that measure a falls-related psychological construct have used either categorical or continuous variables (Jørstad et al., 2005). For example, the FES (Tinetti et al., 1990) uses 1 to 10, with 10 denoting "not confident at all" and 1 as being "very confident" (categorical variables). The ABC Scale (Powell & Myers, 1995) uses 0% to depict "no confidence" to 100% to represent "completely confident" (continuous variables). According to Bandura (2006), a simpler response format using single unit intervals ranging from 0 to 10 would be suitable, given that the range can retain the same scale structure as 0 to 100. A scoring scale with few options, such as one with a 5-interval scale, should be avoided because of the concerns about the sensitivity and reliability of the instrument to predict performance (Pajares et al., 2001). A well-developed PROM can display responses across a good part of the range of alternatives (De Vet et al., 2011).

A scale on self-efficacy should have a unipolar range of scoring options, ranging from 0 to a maximum strength (Bandura, 2006). A judgement of complete incapability will be reflected as a zero score and not a negative score as there can be no lower gradation. Bandura (2006) opined that bipolar scales with negative gradations below the zero point do not make sense to judge the inability to perform the task or activity. As efficacy beliefs can differ in generality, strength and level, an adequate breadth of scoring options allows people to judge their efficacy level across a wide range of activity domains.

The total score with a reflective conceptual model will have the items scores summed up (De Vet et al., 2011). This sum scoring method is identified for all the PROMs for falls efficacy or balance confidence (Jørstad et al., 2005). The option of averaging the sum-scores may also be taken, as in the ABC Scale (Powell & Myers, 1995). The use of average scores might be easier to explain by the clinicians to respondents because the values are in the same range as the item scores themselves.

Step 5 Pilot testing

Pilot testing of a newly developed measure should be done using an intensive qualitative analysis of the items with a relatively small number of representatives (De Vet et al., 2011). To assess the content appropriateness of a new PROM for community-dwelling older adults, sample representatives from this group of individuals must be involved in the pilot testing because only the target population can judge the comprehensibility, relevance and completeness of the PROM (Wilson, 2018).

Acceptability and feasibility are other critical considerations during pilot testing (De Vet et al., 2011). Acceptability concerns whether the older people or clinicians are willing to do something, and feasibility refers to whether they can do it. The inputs from both older people and clinicians must ensure that the PROM will be suitable for the clinical setting. Clinicians will identify the PROM's utility for clinical practice, whereas the older people will express their ability to complete the PROM by themselves. Further, it is also important to establish the optimum length for the questionnaire. A lengthy questionnaire can risk a loss of concentration of motivation in the older adults (De Vet et al., 2011). A pragmatic suggestion is a list of between 10 and 30 items (Jørstad et al., 2005), although there is no ideal number of items to establish an accurate measure for the latent construct. An extensive collection of questions about a particular construct could be developed as an item bank using item response theory and be applied using computer adaptive testing (De Vet et al., 2012). In this case, the item characteristic curves of each item would be determined by item response theory analysis with items will be administered to the individual accordingly. A good example of the item bank is the PROMIS (Patient-Reported Outcome Measurement Information System) used for various constructs: pain, fatigue, emotional distress and physical functioning (Cella et al., 2007).

Pilot testing a preliminary PROM may be done by applying the RAND/UCLA Appropriateness Method (RAM) (Fitch et al., 2001). The RAM method was initially designed to obtain the collective judgement of experts to yield a statement regarding the appropriateness of performing a procedure at the level of patient-specific symptoms, medical history and test results, combined with the best available scientific evidence. The appropriateness criteria have been established for obtaining consensus (Fitch et al., 2001). One key benefit of using the

RAM method is the accessibility and convenience for different groups of experts, namely, community-dwelling older adults and healthcare professionals, by adopting the e-Delphi approach (Donohoe et al., 2012; McMillan et al., 2016). A limitation of this approach is that it precludes the application of two well-known techniques "think aloud" and "probing". The "think aloud" technique requires the patients to precisely say what they are thinking when filling in the questionnaire, and the "probing" technique requires the researcher to question patients in detail about the perceived content and interpretation of the items. These techniques would allow researchers to go deeper than simply asking complete questions relating to comprehensibility issues or problems faced with the response categories. To mitigate such limitations, PROM developers need to critically review and analyse the feedback given to evaluate the participants' understanding of the questions.

Step 6 Field testing

Field testing aims to gain an insight into the PROM structure through, for example, examining its dimensionality, reliability and validity. Analysing the psychometric properties for multi-item instruments used to measure unobservable constructs is vital to assure the measure can be purposefully used (De Vet et al., 2011).

Field testing entails quantitative analysis of the PROM using modern measurement testing techniques such as factor analysis (FA), classical test theory (CTT) and item response theory (IRT) (McKenna, Heaney, Wilburn, et al., 2019). FA, an extension of CTT, is the most used method to examine the data dimensionality (Kline, 1994). The goal of FA is to investigate how many meaningful dimensions can be distinguished in a construct. According to De Vet et al. (2011), when the conceptual phase of the development of a PROM has been well-thought through, confirmatory FA (CFA) can be immediately applied instead of an exploratory FA (EFA) to explore the dimensions of the PROM. In this context of evaluating the PROM that measures balance recovery confidence, CFA would be sufficiently applied to confirm the hypothesis that the PROM is a unidimensional instrument. In a confirmatory analysis, fit parameters testing would be used to confirm whether the data fit the hypothesised factor structure (Jöreskog, 1969).

CTT and IRT are two measurement theories used to assess the psychometric properties of a measurement instrument (Abedalaziz & Chin, 2011). CTT is a traditional quantitative approach to test the validity and reliability based on the included items (Cappelleri et al., 2014). CTT is based on the assumption that every observed score is a function of an individual's true score and random error (Tractenberg, 2010). In contrast, IRT, such as the Rasch Measurement Theory (RMT), works on the probability of a person level on an item as a function of the person ability and the item difficulty (Bond & Fox, 2015). RMT evaluates a scale against a mathematical measurement model and analyses the scale at the level of each item and each person (Bond & Fox, 2007). CTT focuses on the total score of a measure, whereas RMT targets more precisely the characteristics of individual items. RMT will allow developers to establish whether an item's response scale is functioning as expected and, if not, suggest improvements. If the PROM does not meet specific requirements in field testing, the PROM can still be adapted.

Developing a PROM is an iterative process in which the creative development activity is alternated with thorough evaluation (De Vet et al., 2011). As the development of PROM is not a prescriptive process, a study protocol should be prospectively lodged to detail the scope of the evaluation to make the development process transparent.

2.6 Conclusion

Self-efficacy relates to an individual's belief in their capabilities to successfully perform in a specific situation. A significant inquiry on falls-related self-efficacy can inform the direction of fear of falling, falls efficacy and balance confidence. These latent constructs have been measured interchangeably by clinicians and researchers using different PROMs. This is conceptually problematic. Balance control and balance recovery control are interrelated but distinct. Perceived balance recovery control is a construct that needs to be studied to help community-dwelling older adults prevent falls.

A PROM for balance recovery confidence (self-efficacy) is needed to provide some understanding of the perceived ability in older adults to arrest a fall. A tailored PROM can facilitate a more in-depth clinical reasoning process for the aspects of balance recovery abilities across various fall-risk situations, leading to better treatment planning. The literature review described in this chapter laid the necessary foundations for developing a balance recovery confidence scale for community-dwelling older adults, by detailing the theoretical understanding of self-efficacy, presenting the existing knowledge about falls-related PROMs, reflecting the role of balance recovery control, and describing the methodology of PROM construction.

Chapter 3

Falls efficacy instruments for community-dwelling older adults: a COSMIN-based systematic review (Study 1)

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"Two roads diverged in a wood, and I – I took the one less travelled by, And that has made all the difference."

– Robert Frost.

3.1 Introduction

As stated in Chapter 1, a systematic literature review of important measurement properties of existing PROMs is indispensable before developing a new PROM. First, PROM developers need to ascertain that there are no existing PROMs that can effectively measure the specific concept of interest; developers should refrain from designing a new PROM where a good one exists, in order to avoid duplication and/or confusion with the results produced by existing instruments. Second, PROM developers should investigate whether an existing PROM could be adapted to the construct of interest, saving time and effort. It could be seen as unethical to unnecessarily burden healthcare professionals and the target population with the development of a new PROM. Third, such a review would provide useful input, since unsuitable PROMs can offer valuable information on what a new PROM should and should not look like (De Vet et al., 2011).

Chapter 2 reports a systematic review prioritising two key measurements properties of falls efficacy-related PROMs - content validity and structural validity. These help developers to judge the appropriateness of a PROM to measure its designated construct (Prinsen et al., 2018). Appropriateness refers to the extent to which instrument content is suitable for a specific construct (Terwee et al., 2018). Based on COSMIN's definitions (COSMIN, 2021), content validity refers to the degree to which the content of the PROM is an adequate reflection of the construct to be measured. Structural validity is defined as the degree to which the scores of the PROM are an adequate reflection of the dimensionality of the construct to be measured. Previous systematic reviews of falls efficacy-related PROMs investigated the psychometric considerations which dominantly focused on reliability and validity. A review of the content validity and structural validity studies using the COSMIN guidelines would supplement information.

The systematic review was prospectively lodged into the PROSPERO database (Appendix 1A). This first study attempts to justify the need for a balance recovery confidence scale for community-dwelling older adults and, if there is a need, to inform its development. The chapter is published in *BMC Geriatrics*, 21(21), 1-10.

3.2 Abstract

Falls efficacy is a widely-studied latent construct in community-dwelling older adults. Various self-reported instruments have been used to measure falls efficacy. In order to be informed of the choice of the best measurement instrument for a specific purpose, empirical evidence of the development and measurement properties of falls efficacy related instruments is needed.

The Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) checklist was used to summarise evidence on the development, content validity, and structural validity of instruments measuring falls efficacy in community-dwelling older adults. Databases including MEDLINE, Web of Science, PsychINFO, SCOPUS, CINAHL were searched (May 2019). Records on the development of instruments and studies assessing content validity or structural validity of falls efficacy related scales were included. COSMIN methodology was used to guide the review of eligible studies and in the assessment of their methodological quality. Evidence of content validity: relevance, comprehensiveness and comprehensibility and unidimensionality for structural validity were synthesised. A modified GRADE approach was applied to evidence synthesis.

Thirty-five studies, of which 18 instruments had been identified, were included in the review. High-quality evidence showed that the Modified Falls Efficacy Scale (FES)-13 items (MFES-13) has sufficient relevance, yet insufficient comprehensiveness for measuring falls efficacy. Moderate quality evidence supported that the FES-10 has sufficient relevance, and MFES-14 has sufficient comprehensibility. Activities-specific Balance Confidence (ABC) Scale–Simplified (ABC-15) has sufficient relevance in measuring balance confidence supported by moderate-quality evidence. Low to very low-quality evidence underpinned the content validity of other instruments. High-quality evidence supported sufficient unidimensionality for eight instruments (FES-10, MFES-14, ABC-6, ABC-15, ABC-16, Iconographical FES (Icon-FES), FES–International (FES-I) and Perceived Ability to Prevent and Manage Fall Risks (PAPMFR).

Content validity of instruments to measure falls efficacy is understudied. Structural validity is sufficient for a number of widely-used instruments. Measuring balance confidence is a subset of falls efficacy. Further work is needed to investigate a broader construct for falls efficacy.

3.3 Background

Escalating consumption of healthcare services globally, associated with high rates of falls-related morbidity in rapidly ageing demographics, has become a major public health concern among policymakers, researchers and clinicians (Hartholt et al., 2018; Pua et al., 2017; WHO, 2018). Falls efficacy can be better addressed among older adults to maximise their independence, promote maintenance of an active lifestyle and counter burdensome associations (Yoshikawa & Smith, 2019). Falls efficacy as a latent construct in community-dwelling older adults has been widely studied in research and clinical practice (Schoene et al., 2019). Conceptualised using Bandura's self-efficacy theory (Bandura, 1977), the assessment of falls-related self-efficacy conventionally focuses on beliefs and confidence about one's ability to undertake activities of daily living without falling (Tinetti et al., 1990).

Over the last three decades, falls efficacy has been studied alongside other falls-related psychological constructs, i.e., fear of falling and balance confidence (Moore & Ellis, 2008). Commonly-used self-reported instruments used to measure falls efficacy include the Falls Efficacy Scale (FES) (Tinetti et al., 1990), Modified Falls Efficacy Scale (MFES) (Hill et al., 1996), Activities-specific Balance Confidence (ABC) Scale (Powell & Myers, 1995), CONFbal scale of balance confidence (CONFbal) (Simpson et al., 2009), Falls Efficacy Scale-International (FES-I) (Yardley et al., 2005) and Iconographical Falls Efficacy Scale (Icon-FES) (Delbaere et al., 2011). Selecting appropriate instruments to measure falls efficacy is obscured by operational heterogeneity amongst relevant psychological constructs such as fear of falling and balance confidence (Moore & Ellis, 2008). High-quality psychometric evidence should underpin the selection of specific instruments.

Researchers and clinicians have used different instruments to measure falls-related psychological constructs interchangeably. The first of such scales, FES (Tinetti et al., 1990), was developed in 1990. The FES, underpinned by established theoretical models of cognitive process underlying emotions, had been used to measure fear of falling, i.e., low falls efficacy scores to indicate high fear of falling in older adults (Tinetti et al., 1990). However, this conflation of related or mediating but essentially distinct theoretical constructs has been criticised. Falls efficacy may be used to mediate the relationship between fear of falling and falls (Li et al., 2005). Further, falls efficacy and fear of falling can be influenced differently by other psychological concepts, including depression (Hughes et al., 2015). Expansive assessment scales with good psychometric properties, i.e., The Survey of Activities and Fear of Falling in the Elderly (SAFE) (Lachman et al., 1998), The University of Illinois at Chicago

Fear of Falling Measure (UICFFM) (Velozo & Peterson, 2001) and the Geriatric Fear of Falling Measure (GFFM) (Huang, 2006) may facilitate a broader understanding of the fear of falling amongst other emotional (e.g., anxiety) and behavioural (e.g., activity avoidance) psychological elements.

Since the mid-1990s, other instruments have been further developed to address the FES's varied limitations, including the ABC (Powell & Myers, 1995), which had been shown to be highly correlated to the FES (.86) (Hotchkiss et al., 2004). The ABC was conceptualised to measure balance confidence within broad-ranging assessments of functional activities. The abbreviated version of the balance confidence measure, ABC-6 (Peretz et al., 2006), was developed from patient groups with Parkinson's disease and high-level gait disorders who reported the highest level of fear in their task performance. These instruments were frequently identified as measures of fear of falling and had limited clinical utility to assess balance confidence in older and frailer people who are unable to perform high-level activities (Simpson et al., 1998).

By the end of the 2000s, falls efficacy instruments were advocated for measuring the latent construct of balance confidence (Hadjistavropoulos et al., 2011). The cue question in ABC-Simplified (ABC-S) was reworded from "How confident are you that you will not lose your balance or become unsteady when you …" to "Up to what point are you confident that you will maintain your balance when you do the following activities?" (Filiatrault et al., 2007). Another instrument, CONFbal, derived using a 21-item instrument, 'Confidence in Everyday Activities' (Hallam & Hinchcliffe, 1991), was used to measure an older and frailer person's cognitive (belief) rather than emotional (fear) constructs with the intent of physiotherapy-focused rehabilitation training (Simpson et al., 2009).

Some evidence, including that from systematic reviews of falls-related psychological concerns in community-dwelling older adults, suggested that assessing falls efficacy and balance confidence was tautologic due to the commonality of items amongst instruments (Hadjistavropoulos et al., 2011). However, conflicting evidence has also challenged accepting balance confidence and falls efficacy to be isomorphic constructs. For example, a recently developed scale, Perceived Ability to Prevent and Manage Fall Risk (PAPMFR), was used to measure a wide range of falls-related perceptions and treats falls efficacy conceptually as a broad entity (Yoshikawa & Smith, 2019).

Previous efforts were made to recommend ‘gold standard’ instruments for specific falls-related psychological constructs for clinical use in two antecedent systematic reviews. Jostad et al. (2005) presented key measurement properties of the different instruments, including details of the populations in which measures have been tested, as well as information on scaling, to aid researchers and clinicians with their selection of an instrument. Moore & Ellis (2008) focused attention on the psychometric properties of common instruments used in independent-living and community-dwelling older adults and recommended that MFES, FES-I and ABC Scale could be used to measure falls efficacy and balance confidence. However, neither antecedent review offered a critical evaluation of each instrument’s content validity, empirical evidence to justify its use, and hence, the inherent quality of the evidence.

Content validity, which refers to “the degree to which an instrument measures the construct it purports to measure”, would provide empirical evidence to justify the use of appropriate instruments (Mokkink et al., 2010). Countering this fundamental gap in the literature could facilitate confidence among researchers and clinicians in their selection of instruments to measure falls efficacy. The Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) methodology facilitates a systematic review of measurement instruments. It offers a hierarchical psychometric process by which any endorsed instrument would have needed to satisfy priority and bias-free evidential thresholds of both content and structural validity (i.e., scores of an instrument adequately reflect the dimensionality of the construct to be measured) (Prinsen et al., 2018). Thus, transparent and evidence-based recommendations can be made for the selection of appropriate instruments to measure intended constructs (Prinsen et al., 2018).

To the best of the authors’ knowledge, there have not been any systematic reviews that had adopted the COSMIN methodology to evaluate falls efficacy-related instruments. The purpose of this paper is to systematically review the content and structural validity of falls efficacy-related scales for community-dwelling older adults, using COSMIN guidelines.

3.4 Methods

Protocol and registration

This review was conducted in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses Protocol (PRISMA) guidelines (Moher et al., 2009). A protocol for this systematic review was registered in PROSPERO (Ref-CRD42019124366).

Eligibility criteria

Studies were included if instruments measuring constructs relating to 'falls efficacy', 'fall-related self-efficacy' and 'balance confidence' in community-dwelling older adults, including translated and culturally adapted versions. Development studies of falls efficacy instruments that interpreted fear of falling were included because of the convolved history. However, studies were excluded if titles were related specifically to and measured constructs such as 'fear', 'anxiety' as well as 'activity avoidance'.

Search strategy and selection criteria

A comprehensive language-unrestricted search was conducted between 1st January 1990 and 31st May 2019 amongst Medline (EBSCOhost), Web of Science Core Collection, PsychInfo (EBSCOhost), Scopus (scopus.com) and Cinahl Plus with full text (EBSCOhost) databases. COSMIN-guided searching consisted of three groups of search terms using Boolean operators, detailing: (1) construct of interest, (2) target population and (3) measurement properties (see Appendix 1D).

Studies that focused on the development of falls efficacy related instruments measuring falls efficacy or balance confidence were included for the assessment of content validity (Table 3.1). Content validity studies were eligible if they were full-text original articles that featured community-dwelling older adults or professionals (e.g., falls-related researchers, clinicians) in order to assess the relevance, comprehensiveness, or comprehensibility of the content of at least one instrument. Cross-cultural adaptation studies of instruments were included if comprehensibility pretesting of the adapted questionnaire within the target population had been performed. Similarly, the availability of content validity studies for instruments in comparable populations was included. Structural validity studies were included only as full-text original articles about community-dwelling older adults, assessing instrument dimensionality via factor or item response theory analysis (Terwee et al., 2018).

Two independent reviewers (SS; CWT) interrogated database-derived titles and abstracts for eligibility and, subsequently, full texts for potential inclusion. Consensus was sought, but any disagreements were resolved by an additional team-based reviewer.

Table 3.1 Instruments measuring falls-related self-efficacy or balance confidence.

Instrument (Abbreviation)	Recall period[a]	Number of items	Response options	Total score range	Interpretation of results
List of falls efficacy scales					
Falls Efficacy Scale - 10 items (FES-10)	Undefined	10	1-10	10-100	Higher score indicates lower efficacy
Modified Falls Efficacy Scale - 11 items (MFES-11)	Undefined	11	1-3	11-33	Higher score indicates higher efficacy
Modified Falls Efficacy Scale - 12 items (MFES-12)	Undefined	12	1-4	12-48	Higher score indicates higher efficacy
Modified Falls Efficacy Scale - 13 items (MFES-13)	Undefined	13	0-10	0-130	Higher score indicates higher efficacy
Modified Falls Efficacy Scale - 14 items (MFES-14)	Undefined	14	0-10	0-140	Higher score indicated higher efficacy
Perceived Ability to Prevent and Manage Fall Risks (PAPMFR)	Undefined	6	1-5	6-30	*item scores were reversed-coded to represent higher scores indicate higher efficacy.
Revised Gait Efficacy Scale - 8 items (GES-8)	Undefined	8	1-10	8-80	Higher score indicates higher efficacy
Gait Efficacy Scale - 10 items (GES-10)	Undefined	10	1-10	10-100	Higher score indicates higher efficacy
Perceived Control Over Falling (PCOF)	Undefined	4	1-4	4-16	Higher score indicates higher efficacy
Perceived Ability to Manage Risk of Falls or Actual Falls (PAMF)	Undefined	5	1-4	5-20	Higher score indicates higher efficacy
Balance Self-Perceptions Test (BSPT)	Undefined	20	1-5	20-100	Higher score indicates higher efficacy

Table 3.1 Instruments measuring falls-related self-efficacy or balance confidence (In continuation)

Instrument (Abbreviation)	Recall period[a]	Number of items	Response options	Total score range	Interpretation of results
List of balance confidence scales					
Activities-specific Balance Confidence scale – Short (ABC-6)	Undefined	6	0-100	0-600	Higher score indicates higher efficacy
Activities-specific Balance Confidence scale – Simplified (ABC-15)	Undefined	15	0-3	0-45	Higher score indicates higher efficacy
Activities-specific Balance Confidence scale (ABC-16)	Undefined	16	0-100	0-1600	Higher score indicates higher efficacy
CONFbal scale of balance confidence (CONFbal)	Undefined	10	1-3	10-30	Higher score indicates lower efficacy
List of scales not measuring falls efficacy or balance confidence					
Iconographical Falls Efficacy Scale (Icon-FES)	Undefined	30	1-4	30-120	Higher score indicates greater concerns of falling
Falls efficacy scale – International (FES-I)	Undefined	16	1-4	16-64	Higher score indicates greater concerns of falling
Mobility Efficacy Scale (MES)	Undefined	10	1-4	10-40	Higher score indicates greater concerns of falling

[a]On recall period, ‘undefined’ relates to the respondents considering how they currently felt, even though no specified time period was provided.

Quality assessment and data extraction

The COSMIN checklist guided assessing the methodological quality of studies detailing an instrument's development, content validity and structural validity (Prinsen et al., 2018; Terwee et al., 2018). The 35 criteria ensured the relevance of an instrument's items and quality amongst cognitive interviewing or other piloting of comprehensibility and comprehensiveness. A further 31 criteria assessed a study's methodological quality of content validity involving the relevance, comprehensiveness, and comprehensibility within the target population, as well as relevance and comprehensiveness amongst professional participants. Four criteria evaluated the appropriateness of the statistical methods assessing the structural validity of an instrument. Criteria were characterised on 4-point rating scales, namely, "very good", "adequate", "doubtful" (reflecting methods that had not been described clearly) or "inadequate" (reflecting methods that had not been described); with overall ratings regulated by recording lowest rating among relevant items (Terwee et al., 2018). Ultimately, overall ratings about studies' methodological qualities influenced the interpretation of evidential quality of the psychometric measurement property of the instrument (Prinsen et al., 2018).

Measurement properties of studies were evaluated via COSMIN and their distribution amongst three pairings of two reviewers (SS, CWT; SS, JL; SS, TX), with discussions determining consensus. Information extracted included the construct to be measured, target population, and context of use (instrument development studies); patient characteristics (concept elicitation and cognitive interview studies; validity studies); and results (validity studies). Data were extracted by the first reviewer who had been paired, while the second reviewer double-checked the accuracy of the extracted information.

Evidence synthesis

The following steps were conducted to synthesise evidence by each pair of reviewers (SS, CWT; SS, JL; SS, TX). First, the results of instrument development and content validity studies were rated according to guided criteria to evaluate relevance, comprehensiveness and comprehensibility. Each criterion was rated as sufficient (+), insufficient (-) or indeterminate (?). Second, an overall result was obtained by pooling all available studies and reviewers' ratings on the same instrument (regardless of language and country) (Terwee et al., 2018).
The studies on structural validity were rated according to a recommended criteria guide published by Prinsen et al. (Appendix 1E) (Prinsen et al., 2018). Taking all evidence into account, the overall structural validity of the instrument was rated as sufficient (+), insufficient (-), inconsistent (±) or indeterminate (?).

Third, the quality of evidence was rated according to a modified GRADE approach considering the study quality, consistency of results across studies and reviewers' rating (for content validity only). The overall rating was graded for the quality of the evidence using a modified GRADE approach (high, moderate, low or very low) (Prinsen et al., 2018).

3.5 Results

From an initial 2058 records, 95 were retrieved for full-text review, and 24 were selected (Figure 3.1). Seventy-one records were excluded: 44 did not include constructs relating to falls-related self-efficacy or balance confidence, 11 assessed other measurement properties, six did not assess measurement properties, two were conducted on different populations, two were abstracts, one was a thesis, one was in a citation, and four were written in other languages (i.e., Persian, German, Dutch). Thirty-five records were included: 24 full-text articles met eligibility criteria, and 11 additional articles from citation tracking were used to evaluate instrument development and content validity (49 studies), and structural validity (14 studies).

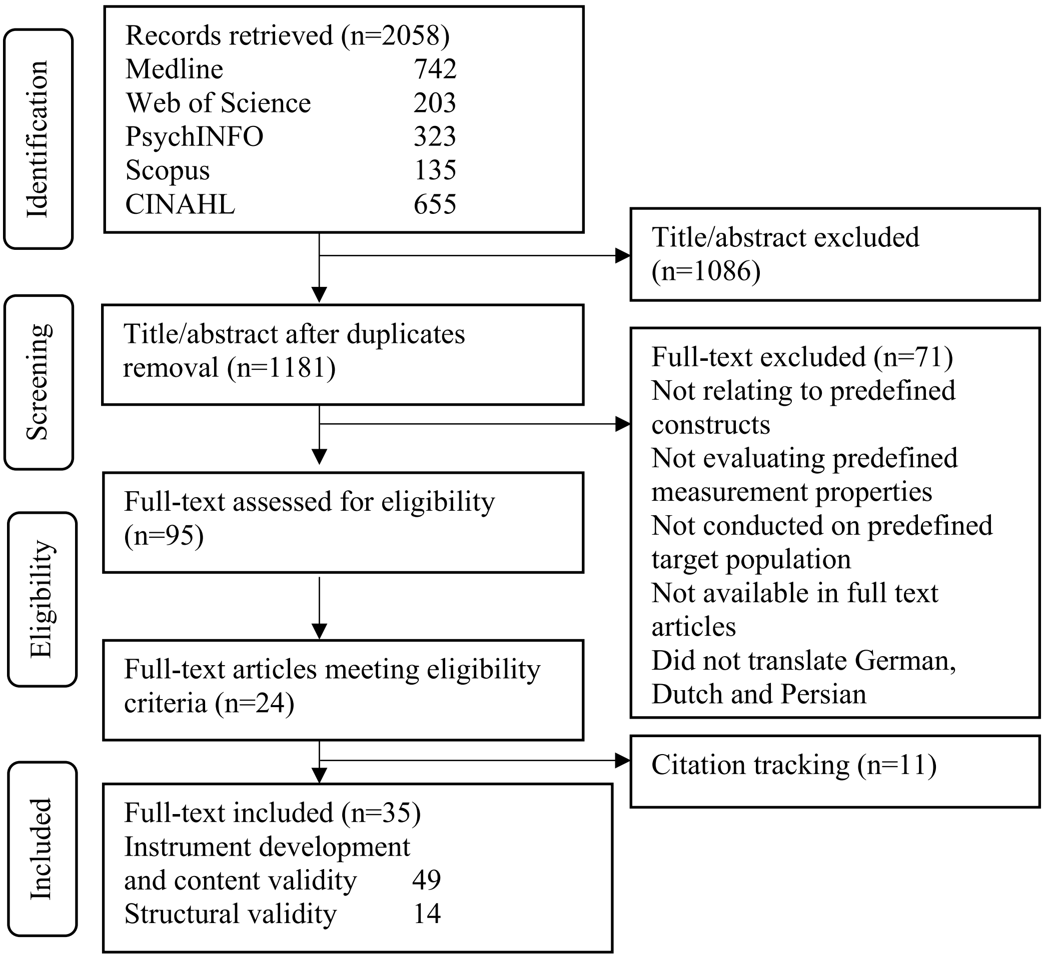

Figure 3.1 Flow chart of results of search strategy and selection of records.

Content validity

Quality of instrument development studies

A summary of the studies detailing construct definition, target population, and the intended context of use for the 18 instruments was presented (Appendix 1F). Nine studies were related to scales measuring falls efficacy. Four studies were related to the construct of balance confidence. Three studies were related to scales with the title relating to falls efficacy; however, the studies measured concerns about falling rather than constructs relating to falls efficacy or balance confidence.

Concept elicitation was identified as inadequate for 15 instruments because no target population had been involved in their development. For the other instruments (i.e., ABC-16, CONFbal and Mobility Efficacy Scale (MES)), concept elicitation was doubtful because of unclear methods. Among all studies relating to an instrument's development, only Icon-FES featured cognitive interviews with older adults. However, the quality of cognitive interviews was doubtful because the characteristics of the sample population and methodology of the interview process were not described.

Quality and results of content validity studies

Thirty-four studies had involved a target population, with 13 studies involving professionals. There were no studies on the content validity of the Gait Efficacy Scale (GES)-8 found. Among all instruments, ABC-16 had the highest number of 18 studies conducted involving older adults (32%) and professionals (54%), respectively. For scales involving the target population in assessing content validity, only one study (MFES-13) was of adequate quality to assess its relevance, comprehensibility and comprehensiveness. Two studies on relevance (FES-10 and ABC-6) were of inadequate quality, and one study on comprehensibility (FES-10) was of inadequate quality. Fifteen content validity studies involving target populations were cross-cultural adaptations that included a pretest of the translated instruments.

In these studies, six studies assessing relevance were of doubtful quality, while six studies assessing comprehensibility were also of doubtful quality. All other studies were of either inadequate or indeterminate quality. None of the studies assessed comprehensiveness adequately. A significant number of content validity studies involving patients (44%) were cross-cultural adaptations that included a pre-test of the translated instruments (FES-10, MFES-13, MFES-14, ABC-6, ABC-16) with the most significant number of studies on ABC-

16 (60%). These studies were of doubtful (47%), inadequate (13%) or indeterminate (40%) quality.

Out of the 13 content validity studies involving professionals, 10 were cross-cultural adaptation studies. Two studies on the original instruments explored the relevance of the FES-10 and the comprehensiveness of the Icon-FES. However, both were doubtful of quality (Delbaere et al., 2011; Tinetti et al., 1990). All studies that had included cross-cultural adaptation research involving six instruments (FES-10, MFES-13, MFES-14, ABC-15, ABC-16, Icon-FES) were of doubtful or indeterminate quality.

Evidence synthesis for falls efficacy scales

Among all instruments evaluating falls efficacy, MFES-13 had high-quality evidence demonstrating sufficient results for relevance (based on one adequate quality study and reviewers' rating) (Karström et al., 2002), and insufficient results for comprehensiveness (based on one adequate quality study and reviewers' rating) (Karström et al., 2002). Moderate quality evidence was only available for FES-10, which had sufficient results for relevance (based on one doubtful quality study); MFES-13, which had inconsistent results for comprehensibility (based on one adequate quality study and one doubtful quality study); and MFES-14, which had sufficient results for comprehensibility (based on two doubtful quality studies) (Aleksic et al., 2018; Karström et al., 2002; Parry et al., 2001; Perrot et al., 2018). For all other related instruments measuring falls efficacy, evidence quality had generally been low to very low. No relevant studies of content validity studies and related studies were of inadequate quality based on reviewers' ratings.

Evidence synthesis for balance confidence scales

Among all instruments evaluating balance confidence, moderate-quality evidence was only available for the ABC-15. It displayed sufficient results for relevance (based on one content validity study of doubtful quality) (Filiatrault et al., 2007). However, insufficient results for comprehensiveness and sufficient results for comprehensibility were supported by very low-quality evidence. Similarly, for instruments measuring balance confidence, evidence quality had generally been low to very low (see Additional file 7). There had been no relevant studies of content validity studies, and based on reviewers' ratings, even related studies had shown inadequate quality.

Evidence synthesis for scales with titles relating to falls efficacy

Three scales with titles relating to falls efficacy, Icon-FES, FES-I and MES, were developed to measure fear of falling (concerns about falling) (Delbaere et al., 2011; Lusardi & Smith, 1997; Yardley et al., 2005). The Icon-FES was the only scale to have been underpinned by moderate-quality evidence to display sufficient results for relevance and comprehensiveness (based on one doubtful quality study) (Delbaere et al., 2011). Other assessments for Icon-FES, FES-I and MES were rated as low to very low by reviewers given the absence of quality within any relevant content validity studies.

Structural validity

Quality and results of studies

A total of 14 studies assessed structural validity of falls-related self-efficacy (4 studies) (Hill et al., 1996; Perrot et al., 2018; Yoshikawa & Smith, 2019), balance confidence (8 studies) (Arnadottir et al., 2010; Ayhan et al., 2014; Filiatrault et al., 2007; Guan et al., 2012; Mak et al., 2007; Schott, 2014; Wang et al., 2018) and falls efficacy related titled scales (2 studies) (Delbaere et al., 2011; Yardley et al., 2005). The majority of authors used exploratory factor analysis (EFA, 72%) (Ayhan et al., 2014; Guan et al., 2012; Hill et al., 1996; Mak et al., 2007; Perrot et al., 2018; Schott, 2008, 2014; Yardley et al., 2005; Yoshikawa & Smith, 2019). The other studies used the IRT Rasch model (7%) (Arnadottir et al., 2010), IRT polytomous model (7%) (Filiatrault et al., 2007) or more than a single method of analysis (14%) (Delbaere et al., 2011; Wang et al., 2018). 93% of the studies were of at least adequate quality, 64% were of high quality, and 29% were of adequate quality. Only one study was of inadequate quality because an insufficient sample size had been used for analysis (Guan et al., 2012).

Evidence synthesis

All studies on FES-10, MFES-14, ABC-6, ABC-15, ABC-16, Icon-FES, FES-I and PAPMFR reported positive results and provided high-quality evidence of sufficient unidimensionality. All the other instruments displayed indeterminate ratings.

3.6 Discussion

Development and content validity of falls efficacy related scales

Our synthesised findings from the published literature showed a lack of high-quality evidence for falls efficacy-related scales. Of 11 scales specifically measuring falls efficacy and its relevance, only the MFES-13 demonstrated high-quality evidence. However, MFES-13 showed insufficient comprehensiveness and inconsistent results of comprehensibility supported by high and moderate-quality evidence, respectively. The FES-10 and MFES-14 were supported by moderate-quality evidence for both sufficient relevance and comprehensibility. By contrast, both scales had very low-quality evidence supporting their comprehensiveness.

For scales measuring balance confidence, only the ABC-15 had sufficient relevance supported by moderate-quality evidence, with very low-quality evidence supporting both its insufficient comprehensiveness, as well as sufficient comprehensibility. Furthermore, evidential quality for the content validity of the remaining 14 instruments was low to very low. As such, this review demonstrated that current evidence is inadequate in the recommendation of any existing instruments for the measurement of measure balance confidence.

Furthermore, none of the 15 scales designed to assess either balance confidence or falls efficacy offered sufficient quality or consistency of evidence for content validity to support their unreserved use in community-dwelling older adults. Despite their routine contemporary use, only four scales (MFES-13, FES-10, MFES-14 and ABC-15) had been underpinned by partial relevant evidence.

Instruments with titles relating to falls efficacy but measuring other constructs such as fear of falling (FES-I, Icon-FES and MES) had been categorised separately. The FES-I's developers stated that their instrument assessed concerns about falling, even though the term 'Falls Efficacy' had been retained in the title to acknowledge the historical development of the scale (Yardley et al., 2005). Icon-FES (Delbaere et al., 2011), developed from literature on the measures of fear of falling, showed sufficient relevance and comprehensiveness but with only moderate-quality evidential support. Further concurrent research amongst scales of fear of falling would reconcile selection preferences.

Structural validity

Eight instruments (FES-10, MFES-14, ABC-6, ABC-15, ABC-16, Icon-FES, FES-I and PAPMFR) demonstrated sufficient unidimensionality relating to either falls efficacy or balance confidence, with support from high-quality evidence.

Nevertheless, unidimensionality might not ascertain the construct of interest would be measured adequately or that no important concepts would be missed, of which had been a fundamental concern, emphasising the pivotal role of content validity within psychometric analyses (Terwee et al., 2018). Failures in adopting proper methodologies within instrument development, including during concept elicitation or compromised cognitive interviewing in a target population, may lead to confusion in selecting instruments.

This review has provided two additional findings. First, the search identified a limited number of studies purposefully investigating into the content development, content validity, and structural validity of falls efficacy related scales. Several articles did not surface through the search strategy using COSMIN-guided Boolean operators of measurement properties. Eleven full-text articles were added through citation tracking, and they were related to fall-related clinical intervention trials. The falls efficacy related scales that were opportunistically constructed for the clinical trials deserve further investigation of their measurement properties.

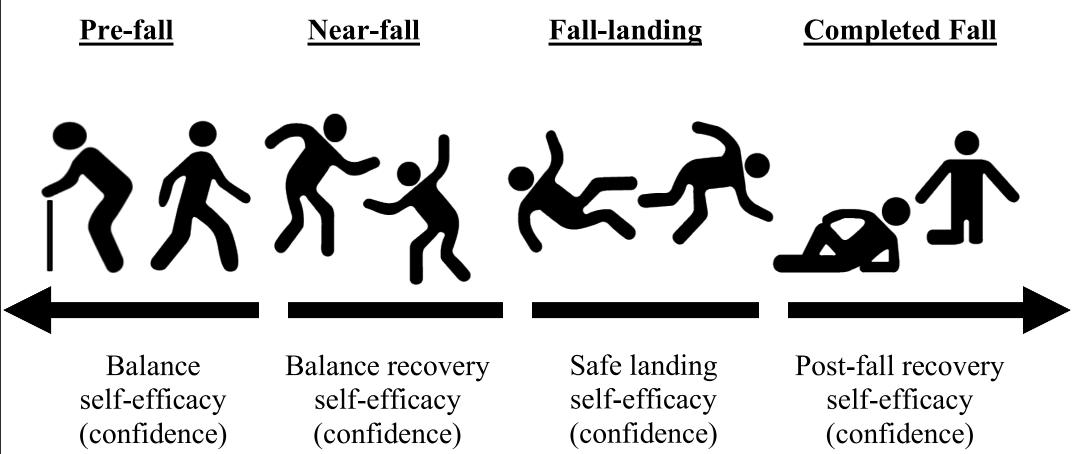

Figure 3.2 Falls-related Self-Efficacy Continuum Model.

Second, our evaluation of the instruments' content has identified that the conceptual framework of the constructs of falls efficacy and balance confidence differed amongst instruments and should not be interpreted uniformly. The 11 instruments measuring falls efficacy revealed content containing four domains of self-efficacy, which addressed the potential of falling. The four domains may be expressed in a continuum of situational-specific phases of pre-fall, near-fall, fall-landing and a completed fall (Figure 3.2).

Balance efficacy (or balance confidence) and balance recovery in pre-fall and near-fall phases, respectively, are defined as the perceived abilities to undertake activities of daily living without losing balance and to execute balance recovery manoeuvres to prevent falling.

Similarly, efficacy in fall-landing, post-fall and completed fall phases reflect abilities to fall safely, to get (helped) up and to accomplish actions after falling, respectively.

This knowledge, acquired through appropriate self-reported instruments, would help researchers and clinicians work with community-dwelling older adults in reconciling their perceived abilities and to have their actual abilities assessed and trained, through outcome-based emerging rehabilitation work, such as perturbation-based balance training and safe falling techniques training programs (Moon & Sosnoff, 2017; Papadimitriou & Perry, 2017). While there may not be an all-purpose measure of perceived self-efficacy in managing a range of circumstances surrounding falling adequately, different measures might facilitate a greater understanding of the abilities of community-dwelling older adults in managing both falling and personal efficacy effectively.

Limitations of the study

This review limited its scope to exclude instruments with titles relating to or those measuring constructs such as 'fear', 'anxiety' and 'activity avoidance'. This potentially risk the exclusion of certain instruments, such as the Short Falls Efficacy Scale-International. We were persuaded of the latter constructs' distinctiveness compared to the review's focus and could have had an unrealistic expectation that high-quality evidence about falls efficacy and balance confidence could be derived from them. Furthermore, a language limitation amongst the review team hindered its ability to translate, review and accurately rate the quality of evidence of four articles on ABC-16, written in German, Dutch, and Persian. Similarly, rating of evidence qualities amongst the review articles may have had been hampered inadvertently by the review team not having contacted the respective study authors in seeking clarification about their published descriptions of study designs (e.g., interview methodologies).

3.8 Conclusion

Chapter 3 has presented a systematic review that applied the COSMIN methodology to thoroughly assess the content and structural validity of a set of falls efficacy-related instruments in community-dwelling older adults. The objectives of the first study were met as follow:

Objective 1: To critically appraise and summarise the evidence on the development, content validity and structural validity of patient-reported outcome measures measuring falls-related self-efficacy in community-dwelling older adults.

In summary, the review identified that three PROMs, the Falls Efficacy Scale-International, the Iconographical Falls Efficacy Scale, and the Mobility Efficacy Scale that were constructed to measure fear of falling. They may not be suitably used to measure falls efficacy. Fifteen PROMs constructed for measuring falls efficacy and balance confidence did not have sufficient quality or consistency of evidence for their content validity. Many of these PROMs did not adequately involve the target population to evaluate the content for its relevance, comprehensibility or comprehensiveness thoroughly. More high-quality methodological studies are needed to evaluate the content validity of these PROMs for community-dwelling older adults. The most commonly used PROMs for falls efficacy, e.g., Falls Efficacy Scale-10 items and balance confidence, e.g., Activities-specific Balance Confidence-16 items, met sufficient unidimensionality. This meant that these scales were designed to measure a single aspect of the construct of interest.

Objective 2: To identify the gaps in knowledge from the evidence obtained from the systematic review.

While many PROMs are reported to be unidimensional, the content may not measure the construct of interest adequately or have covered important concepts comprehensively. Two PROMs (the PAPMFR and PAMF scales) posited falls efficacy as a formative construct. The conceptualisation of these PROMs contradicted the proposition that falls efficacy and balance confidence are synonymous (Hadjistavropoulos et al., 2007). This has raised the question of whether have the measurements of falls efficacy been adequate. Using a formative conceptual model, balance confidence is recognised as one aspect of falls efficacy. The other aspects of falls-related self-efficacy include balance recovery confidence, safe landing confidence and post-fall recovery confidence could be measured by some items from the PAPMFR and PAMF scales; however, they did not have sufficient quality or consistency of evidence for their content validity.

Objective 3: To obtain information to justify and inform the development of a new PROM of balance recovery confidence.

The systematic review has confirmed the absence of a suitable PROM to measure balance recovery confidence. The review also suggested that the target population should be involved from an early stage of PROM development to ensure that the content is relevant, comprehensible and comprehensive. Representatives of the target population can be considered indispensable experts to complement a team of discipline-specific (healthcare) experts to help PROM developers to compile a comprehensive list of relevant items for the PROM (De Vet et al., 2011). Information from the other falls-related self-efficacy PROMs can be helpful in deciding what the new PROM should or should not look like – for example, its name, instructions, response options and number of items.

Chapter 4

Near-falls in Singapore community-dwelling older adults: a feasibility study (Study 2)

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"No work is insignificant. All labour that uplifts humanity has dignity and importance and should be undertaken with painstaking excellence."

– Martin Luther King Jr.

4.1 Introduction

After establishing the need to develop a balance recovery confidence scale for the community-dwelling older adults through a literature review in Chapter 3, the next step is to determine whether the concept of balance recovery is relatable to the target population. According to the COSMIN's guideline, the construct measured by a PROM should be clear to the target population (Terwee et al., 2018).

Chapter 4 details the second study, which was conducted in Singapore. A convenience sample group of community-dwelling adults aged 65 years and older was recruited. This feasibility study recruited 30 older adults to report daily if they had experienced any near-falls or falls across a 21-day period. If they were to experience a near-fall, they had to state whether they used their hands, legs or other parts of the body to stop the fall. The study attempted to determine whether community-dwelling older adults were able to identify a near-fall and the balance recovery manoeuvres used. The study also opportunistically investigated other aspects that might be useful to inform future studies, such as the recruitment process, retention rate, use of near-fall and fall definitions. The study was prospectively lodged into Clinicaltrial.gov records (Appendix 2A). Ethical approvals were obtained from Queen Margaret University (Appendix 2B) and Singapore Institute of Technology (Appendix 2C) before study commencement. Informed consent was obtained from all participants. Templates have been listed in Appendix 2D and Appendix 2E.

The findings of this study suggested that the sample of Singapore community-dwelling older adults could identify and relate to the concept of balance recovery. They reported no difficulties distinguishing between near-falls and falls. When a near-fall occurred, they were able to identify the balance recovery manoeuvres used to arrest the fall. This study supported the importance of having a balance recovery confidence scale for the community-dwelling older adults. Its preliminary findings showed that slightly more than half of the sampled target population experienced one or more near-falls within three weeks, suggested that near-falls are common among community-dwelling older adults. A normative data of balance recovery confidence in older adults obtained by a future large-scale study could give a greater understanding of the agency in older adults to deal with a fall. The findings of the feasibility study were disseminated to different platforms, such as the QMU DCA Annual Conference and the institutional repository. The chapter is published in *Pilot and Feasibility Studies*, 7(25), 1-10.

4.2 Abstract

A near-fall is defined as a loss of balance that would result in a fall if sufficient balance recovery manoeuvres are not executed. Compared to falls, near-falls and its associated balance recovery manoeuvres have been understudied. Older adults may not recognise a near-fall or identify the use of their balance recovery manoeuvres to prevent a fall. The consensus on the methods to collect near-fall data is lacking. The primary objective of this study was to determine the feasibility of recruitment and retention. Secondary objectives were to establish evidence that Singapore community-dwelling older adults can identify near-falls and associated balance recovery manoeuvres. Texting and calling methods were explored as reporting methods.

This study took place in Singapore (September to October 2019). Participants were healthy, community-dwelling adults aged 65 or older. Recruitment was done through poster advertisement, and all participants gave informed consent. Participants attended a briefing session and reported their near-fall or fall incidence over 21 days using daily texting or calling. The primary outcome measures were the recruitment rate, retention rate, preferred modes for data reporting and ability to report near-falls or falls. Secondary outcomes included the self-reported incidence of falls and near-falls. Thirty older adults were recruited in 5 weeks. All participants completed the study. They understood near-fall concepts and were able to report the occurrence and relevant balance recovery manoeuvres used to prevent a fall. 87% (26/30) chose to text, while 13% (4/30) selected calling as their reporting method. One actual fall (0.16%) out of 630 responses was reported. Thirty-six incidents (5.7%) of near-falls were recorded. Sixteen participants (53.3%) experienced near-falls, and half of this group experienced two or more near-falls. The use of reach-to-grasp strategy (36%), compensatory stepping (52.8%), and other body regions (11.2%) were used to prevent the fall.

The study provided evidence that studying near-falls in Singapore community-dwelling older adults is feasible and can be applied to a large-scale study. Recruitment and retention rates were good. Older adults were able to identify near-falls and balance recovery manoeuvres. Both texting and calling were feasible reporting methods, but texting was preferred.

4.3 Background

Falls in older people can lead to devastating health and social consequences, including serious injuries, hospitalisation, loss of independence, diminished quality of life and depression (Hartholt et al., 2018; WHO, 2018). Global estimates of the burden of falls have remained substantial (James et al., 2020), i.e., falls have been ranked as the 18th leading cause of the age-standardised rate of disability-adjusted life years and have been identified to be the second leading cause of death due to unintentional injuries (GBD 2017 DALYs and HALE Collaborators, 2018).

Recent studies have begun recommending that clinicians should pay more considerable attention to near-falls (Gazibara et al., 2017; Nagai et al., 2017). Near-falls relate to a loss of balance that would result in a fall if sufficient balance recovery mechanisms are not activated (Maidan et al., 2014). These mechanisms, which include the postural adjustments ("fixed-support" strategies) and use of upper and lower limbs ("change-in-support strategies"), are critical recovery strategies preventing a fall caused by perturbations, e.g., slips, trips and missteps, collisions or other interactions with the environment and destabilising effects of volitional movement (Maki et al., 2003; Maidan et al., 2014).

Near-falls in older people are common and can be a risk factor for falls. Near-falls occur more frequently compared to actual falls (Nagai et al., 2017). More than half of the community-dwelling older adults have experienced occasional or frequent near-falls (Arnold & Faulkner, 2007; Basler et al., 2017), and a third have reported a near-fall at least once a month (Arnold & Faulkner, 2007; Nagai et al., 2017). The experience of near-falls among older adults is an independent predictor of a subsequent fall irrespective of the physical frailty in community-dwelling older adults (Dinh et al., 2009). Despite the high incidence and predictive nature of near-falls, there are very few studies examining related issues. One reason is that adults often do not recognise or attach any significance to the transient event (Teno et al., 1990).

While everyone tacitly knows what a near-fall is, a concrete definition of a near-fall has been lacking. A vague understanding can create erroneous interpretation of information between multiple stakeholders, e.g., patient, physician and researchers (Kellogg International Work Group, 1987). However, it has been challenging to define near-fall comprehensively for laypeople (Hauer et al., 2006). The existing interpretations have been unspecific about the balance recovery manoeuvres used to arrest a fall. Some of these interpretations have included "a loss of balance regained before striking the ground" (Teno et al., 1990), "events where subject almost falls but is able to catch him/herself or to stop the fall" (Buchner, 1993) or "misstep relating to a trip, slip or other loss of balance in which recovery occurred to prevent a fall" (Srygley et al., 2009).

Maidan et al. (2014) detailed various recovery mechanisms suggesting that at least two of the following compensatory mechanisms should be activated to determine the event as a near-fall: (i) unplanned movement of arms or/and legs; (ii) unplanned change in stride length; (iii) lowering of the centre of mass (iv) unplanned change in stride velocity (v) trunk tilt. However, such jargony descriptions pose comprehensibility challenges for older adults. A simpler definition of a near-fall is needed for older adults' understanding.

Various documentation methods to study falls, such as questionnaires, fall diaries or telephone calls, had been used widely (Dinh et al., 2009). However, these methods had not been studied much with collecting near-fall data. One notable concern is the accuracy of the data reported. Some older people have expressed recall difficulty (Cumming et al., 1988) with issues of under-reporting and over-reporting, which may create erroneous data collection (Hauer et al., 2006). The errors reported by previous studies have included forgetting to record a fall in the falls diary or reporting a salient event into that particular period which occurred outside of the recall period (i.e., "telescoping") (Lachenbruch et al., 1991).

To reduce these errors, Ryan et al. (1993) applied a data collection method of using a daily telephone call (calling) at a prearranged time to improve data accuracy. None of the study participants had reported any difficulty recalling a fall or near-fall event daily over the 3-week study period. The authors reported a high compliance rate of 96.7%. While calling had been a helpful method to collect near-fall data, this method was applied three decades ago and should be evaluated in today's context when many people have started becoming active mobile phone users. A census study conducted in Singapore reported 98% of households own at least one mobile phone (Department of Statistic Singapore, 2019). 95% of the Singapore population using mobile phones to browse the internet (Singapore Business Review, 2018). Today, texting is a common mode of communication. A comparison between calling and texting as a preferred method among community-dwelling older adults to collect near-falls or falls data needs further investigation.

Singapore, being one of the most densely populated countries globally (Lee et al., 2016), faces an unprecedented demographic shift towards an ageing society. The resident population age 65 years and over will significantly increase from 1 in 6 (590,000) in the Year 2020 to 1 in 4 (900,000) by the Year 2030 (Yuen & Soh, 2017). This rapid transition to a hyper-aged society poses significant challenges to access, quality, efficacy and funding for healthcare services. Initiatives to promote "successful ageing" and "ageing-in-place" in the community, including the creation of a conducive senior-friendly environment for older people to move around safely and confidently within their homes and also within their community, have been continually studied (MOH, 2014). However, the impacts of these efforts on the person-environment interactions concerning near-fall or falls have been understudied.

To the best of the authors' knowledge, there have been no local studies on near-falls in Singapore community-dwelling older adults. The new knowledge gained from this work will provide a deeper understanding of the methods required to study near-falls in older adults. This research aimed to obtain evidence that to study near-falls in Singapore community-dwelling older adults is feasible, and the methods can be applied to a large-scale study. The objectives of this study are to:

- To evaluate the recruitment process and retention rate of community-dwelling older adults in a local study of near-falls.
- To assess the use of a briefing to explain the different definitions between a near-fall and a fall to the community-dwelling older adults.
- To determine the use of daily texting compared to calling as suitable data collection methods for an appropriate trial design relating to (i) participant preference (ii) adherence to protocol.

4.4 Methods

Study design and ethics

This feasibility study was an observational cohort study. Data protection and ethical approval were obtained from two institutional ethics review boards, Singapore Institute of Technology (reference number: 2019129) and Queen Margaret University (reference number: REP0197). This study conforms with the CONSORT extension to randomised pilot and feasibility trials, excluding specific items required for the randomisation nature of the study (Eldridge et al., 2016).

Participants and Setting

Poster advertisement was circulated to the network of older adults engaged by the Singapore Institute of Technology (SIT) for school assignments, residents' network centres and various clinical partners across Singapore. Between September and October 2019, interested older adults contacted the researcher through the contact details listed in the posters or given through word-of-mouth recommendations. They were asked by a researcher whether they were aged 65 years or older, living in the community and were able to read, write and communicate in English before a meeting was arranged at SIT or an agreed location in Singapore.

Table 4.1 Eligibility criteria.

Inclusion Criteria	Exclusion Criteria
65-year-old and above	Requiring any physical assistance from another person to walk within home
Ability to read, write and communicate in English	Known active malignant conditions
History of at least one near-fall or one fall within the last 12 months	Cardiovascular conditions, such as neurally mediated syncope, cardiac syncope, structural heart diseases, such as aortic stenosis or hospitalization for myocardial infarction or heart surgery within three months
Living independently in the community with or without the use of a walking aid	Pulmonary conditions, such as chronic severe obstructive pulmonary disease or oxygen dependence
Not having any cognitive dysfunction by achieving a score of 7 or less in the 6-item cognitive impairment test (6CIT) (Brooke & Bullock, 1999)	Musculoskeletal conditions, such as moderate to severe osteoarthritis that could affect balance control and muscle function, such as self-reported pain or dysfunction of the trunk and extremities, fractures or injuries in the extremities in the last six months.
Able to walk 6 meters within 12 seconds by performing the Timed Up and Go (TUG) test (Podsiadlo & Richardson, 1991)	Neurological conditions, such as Parkinson's Disease, sequelae of stroke, Amyotrophic Lateral Sclerosis, Multiple Sclerosis, severe Dementia or epilepsy
Able to catch a 30cm ruler with each hand using the Hand Reaction Time (HRT) test (Lacy & Williams, 2018)	Legal blindness, severe visual impairment, severe hearing impairment or legal deafness

During the meeting, they were provided study information, e.g., how the study would be conducted, what will be expected of them, the study's eligibility criteria (Table 4.1). As the study required participants to be able to execute common balance recovery strategies, such as reach to grasp and compensatory stepping, older adults who were interested to participate in the study needed to meet certain requirements, such as being able to catch a 30cm ruler with each hand using the Hand Reaction Time test (Lacy & Williams, 2018), and to walk 6 meters within 12 seconds using the Timed Up and Go Test (Podsiadlo & Richardson, 1991). The cut-off value of 12 seconds for the Timed Up and Go Test was based on Centers for Disease Control and Prevention's (2017) guideline to identify the high risk of older adults for falling. They were informed that participation would be voluntary. If they did not meet the eligibility criteria, they were given general information about falls prevention. An opportunity to ask questions was offered, and the consent form was completed if they agree to participate. In line with good practice, participants were given SGD$50 as a thank you for taking part, reimbursing them for their time, contribution and any expenses incurred, e.g., sim-card cost, travelling cost. This was not used to induce participation in the study.

Pilot sample size

Based on Ryan et al. (1993) study, we estimated an 80% response rate and a 10% dropout rate for our research. We adopted a sample size of 30, which had been identified to be a reasonable number for a feasibility study (Billingham et al., 2013). A projected number of 630 responses (30 subjects for 21 days) would be obtained for the research.

Data collection

The researcher completed the data collection with the participants using a standardised data extraction form to record demographic data (age, race, gender, educational level, housing type, living situation, personal mobility, falls history and near-fall history), cognitive functioning using the Six-item Cognitive Impairment Test (6CIT) (Katzman et al., 1983), upper limb reaction function using the Hand Reaction Time Test (HRT) (Lacy & Williams, 2018) and lower limb physical function using the Timed Up and Go Test (TUG) (Podsiadlo & Richardson, 1991).

Cognitive functioning

The 6CIT is a brief and straightforward validated tool used for cognitive screening in community-dwelling older adults (Brooke & Bullock, 1999). Participants needed to complete three tests of temporal orientation (year; month; time), two tests of attention (counting backwards from 20 to 1; reciting the months of the year in reverse) and short-term memory (5-item address). The total score was recorded, with higher scores indicating greater impairment.

Upper limb reaction function

The HRT (Lacy & Williams, 2018) is a performance measure to determine whether the participant will be able to execute a grasping manoeuvre quickly. A 30-centimetre ruler will be dropped between the participant's thumb and index finger, with instructions to "catch" the ruler between the fingers as quickly as possible. The participant had to grip the ruler after it is dropped without letting the ruler land on the floor. The test was used to establish whether the participants had adequate upper limb reaction ability.

Lower limb physical function

The TUG is a reliable and valid test for quantifying functional mobility in older adults (Podsiadlo & Richardson, 1991). Participants were timed to complete the task of raising from an armchair, walk 3 meters, then walk back at their normal pace to sit down in the armchair in a safe manner. The time taken to complete the task was recorded.

Key research outcomes

Briefing to explain a fall and near-fall

One primary outcome measure was to determine the feasibility of conducting a presentation to explain the different meanings between a near-fall and a fall to the community-dwelling older adults. Operational definitions of falls and near-falls were presented to the participants. These definitions were consistent with those in the literature using language and concepts that aimed to be clear, relevant and easily understandable by the older participants.

A fall definition was adopted, in concordance with the PROFANE-group consensus statement, as "an unexpected event in which the participant comes to rest on the ground, floor, or lower-level" (Hauer et al., 2006). Explaining the concept of falls in a lay perspective to the participants included scenarios involving a slip or a trip or any event causing a loss of balance resulting in the individual landing on a lower level, including the floor, ground or furniture such as a chair or bed. The participants were informed that intentional causes such as a deliberate push by another person or a medical occurrence such as heart attack, fainting, stroke, seizure were not considered as falls in the study.

Near-fall was defined as an event when the individual slips, trips, or loses balance but uses the hand(s) or leg(s) or body part to recover balance and prevent a complete fall. This definition aimed to be relevant, comprehensive and understandable to the older participants. Participants were then presented with several scenarios (Table 4.2) and asked whether each scenario reflected a fall, a near-fall or no fall. If the participant identified the situation as a near-fall, the researcher asked what balance recovery manoeuvre was used to prevent the fall. At the end of the briefing, the researcher ensured no further questions from the participants about differentiating a fall, near-fall or no fall event.

Table 4.2 Scenarios given to participants.

Types of scenarios
1. Fall Scenario – The individual is walking along the street, trips over an object and loses balance. The individual landed on the floor.
2. Fall Scenario – The individual is getting dressed by the bed, loses balance and lands on the bed.
3. No Fall Scenario – The individual is walking across the room and starts to feel dizzy. The person sits on a nearby chair.
4. No Fall Scenario – The individual is walking along the street and is deliberately pushed by another person to the ground.
5. Near-Fall Scenario – The individual holds onto a rail after losing balance when the bus starts to move (hand strategy)
6. Near-Fall Scenario – The individual stumbles while walking and can restore balance by taking a few steps (leg strategy)

Collecting near-falls and falls data

After the briefing, the researcher obtained the participants' preferred mode of communication to report the incidence of near-fall, fall or no fall. Three options were provided: (1) a daily call or (2) a daily text or (3) either a daily call or text scheduled at a prearranged timing. There were no text reminders given during the day to avoid overburdening the participants. One scheduled text was sent each day, even if there was no text reply from the participant. For calling, a second call would be made an hour later than the scheduled timing if there was no response to the first call. No further calls were made if there was no response to the second call.

Over the next 21-days, the participants were asked two questions by the researcher daily, "Have you fallen in the past 24 hours?" and "Have you almost fallen in the past 24 hours?"

using the participant's preferred mode of communication. If "yes" was replied to the near-fall question, the participants were asked, "Did you prevent the fall using your hands or legs or any body part?" The participants then identified the balance recovery manoeuvre used to prevent the fall. If "yes" was replied to the fall question, the researcher checked if the participant could continue with the study.

A follow-up of 21-day duration was selected to replicate the study period applied by Ryan et al. (1993). All data were recorded in a logbook by the researcher. No details of the fall or near-fall events were obtained. Participants were informed that they could contact the researcher either through text or telephone if needed when it is only safe to do so.

Statistical analysis for the pilot study

The feasibility outcomes were summarized descriptively and narratively. Descriptive statistics were used to summarize recruitment, retention, sample characteristics, incidence frequency of near-falls and falls and the types of balance recovery mechanisms used in near-falls.

4.5 Results

Recruitment and retention

The recruitment for the study was estimated to be at a rate of three to five participants per week, and the study was projected to be completed in 8-12 weeks. The study was completed within eight weeks. Reasons for the successful expeditious completion were related to the study team's strong outreach efforts to older adults in the community. Of the 44 community-dwelling older adults screened, 30 were eligible for this study. The reasons for the exclusion (n=14) were a) 2 adults did not meet age criteria, and b) 12 older adults were non-English speaking, e.g., Mandarin. The remaining 30 participants met the eligibility criteria and were enrolled in the study. See Figure 4.1 for the CONSORT 2010 flow chart. At the end of the study, no participants dropped out of the study.

Participants' characteristics

The participants' characteristics were presented in Table 4.3. There were slightly more male (n=16, 53.3%) compared to female (n=14, 46.7%), aged between 65-85 years (72 ± 5.2). There was a fair ethnic representation of the Singaporean community with Chinese (n=22, 73.3%), Malay (n=5, 16.7%), Indian (n=2, 6.7%) and Eurasian (n=1, 3.3%). There was mixed participation of individuals with different education levels, including primary level (10%), secondary level (53%) and tertiary level (37%). About half of the group lived in a 5-room or executive flat-type property and the others in a 3-room flat (16.7%), 4-room flat (13.3%) and private housing estates (23.4%). The sample is a fair representation of the middle-class population of community-dwelling older adults aged 65 years and older in Singapore. Most of them were living with others (90%). All were community ambulant, with some using a walking stick in the community (10%). Thirteen participants (43.3%) had fallen at least once in the last year, and 10 participants (33.3%) had experienced one or more near-falls in the last month. Nineteen participants (63.3%) reported they did not, or rarely experienced a near-fall in the last year, while 11 (36.7%) reported occasional or frequent near-falls.

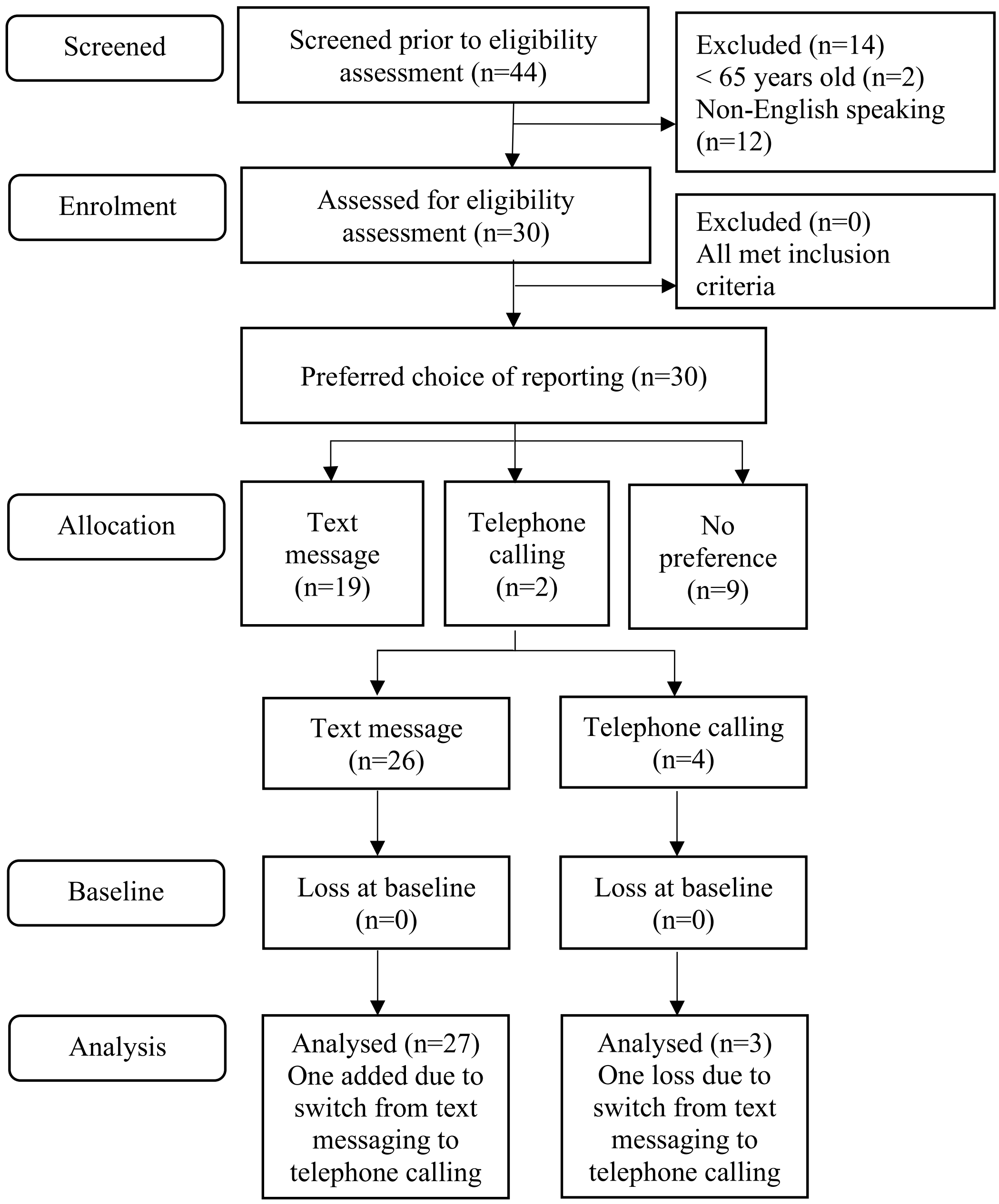

Figure 4.1 CONSORT 2010 Flow Diagram for the feasibility study.

Table 4.3 Baseline characteristics of participants.

Characteristic	N = 30
Age range (mean)	65-85 (72)
Gender	
Female, n (%)	14 (46.7)
Ethnicity	
Chinese, n (%)	22 (73.3)
Malay, n (%)	5 (16.7)
Indian, n (%)	2 (6.7)
Eurasian, n (%)	1 (3.3)
Housing type[a]	
3 room apartments, n (%)	5 (16.7)
4 room apartments, n (%)	4 (13.3)
5 room or executive apartments, n (%)	14 (46.7)
Condominium or other apartments, n (%)	5 (16.7)
Landed property, n (%)	2 (6.7)
Education level	
Primary, n (%)	3 (10)
Secondary, n (%)	16 (53.3)
College/University, n (%)	11 (36.7)
Living situation	
Alone	3 (10)
With others, n (%)	27 (90)
Personal mobility	
Independent	27 (90)
Use of walking stick, n (%)	3 (10)
History of falls in the last one year	
0	17 (56.7)
1 or more	13 (43.3)

Table 4.3 Baseline characteristics of participants (In continuation)

Characteristic	N = 30
History of near-falls in last one month	
0	20 (66.7)
1 or more	10 (33.3)
History of near-falls in last one year	
Never or rarely	19 (63.3)
Experience occasional or frequent	11 (36.7)
Six-Item Cognitive Impairment Test (points)	
0-3	26 (87.7)
4-7	4 (13.3)
Timed up and go test (seconds)	
<9.0	14 (46.7)
9.1-10.0	6 (20)
10.1-11.0	6 (20)
11.1-12.0	4 (13.3)
Able to complete Hand Reaction Time Test	30 (100)
Preferred mode of communication	
Daily telephone calls only	2 (6.7)
Daily text messages only	19 (63.3)
Daily telephone calls &/or text messages only	9 (30)

[a]Housing type –a person's affordability of different types of housing reflected by the type of property with private condominium or other apartments and landed property being the more expensive options compared to public housing, e.g., 3-, 4-, 5- room apartments. There are increasing governmental efforts to have more elderly-friendly and barrier-free environment for both public and private housing (Addae-Dapaah & Wong, 2001)

Choice of data reporting method

Out of the 30 participants, 19 requested texting, two chose to have calling, and the remaining nine had no preference for texting or calling. For those with no preference, seven participants eventually chose texting because they wanted the convenience to report their data at their availability. Two participants decided to receive a call because they preferred to talk to the researcher and address any concerns that might arise during the study period. During the study, one participant switched from calling to texting because she reported having difficulty talking due to her gum pain.

Compared to texting, calling was preferred when clarifications were needed. Two participants who chose to text called the researcher to clarify their near-fall. One participant asked if the event was a near-fall when he almost fell after he unintentionally bumped against another pedestrian while he was walking and using his phone. Another described his experience that he recovered using his body without using hands and legs after losing balance on a chair. The researcher recorded these incidents as near-falls, and the balance recovery manoeuvres were the use of hand and other body parts, respectively. The study did not record the details of these events.

Briefing of definitions on falls and near-falls

All participants completed a 30-minute one-to-one briefing session using a PowerPoint presentation. The use of short video clips illustrated different near-fall scenarios to aid participants' understanding of the concept of near-falls. All participants reported no issues in identifying and differentiating between falls and near-falls. All correctly answered the six test scenarios.

Research data collection

All participants reported their near-fall and fall incidence during the study period. A total of 630 events (i.e., no falls, falls or near-falls) (100%) were recorded across the study period. Eight participants did not report the data daily. The frequency of data reporting varied between two to four days. For calling, all participants needed more than one scheduled daily call to obtain the data over the study period. None of the participants reported any difficulty remembering whether they had a fall or near-fall during the study period. The concepts of falls and near-falls were well-understood by all participants. However, clarifications were needed for the "other body parts" balance recovery manoeuvres used to recover from a loss of balance, i.e., "using the hip to lean against the wall" or "body jerking up".

During the 3-weeks, one actual fall was recorded. This yielded a fall record of 0.1% (1 in 630 records) or the fall rate per person-year of 0.58. This fall rate is observed to be lower compared to the fall rate of 1.2 for a different population of community-dwelling older adults ages $\geqslant 70$ years (Blake et al., 1988). Near-falls were reported 36 times or a near-fall rate per person-year of 20.86. Among the thirty participants, sixteen participants (53.3%) experienced near-falls, and 50% of them experienced two or more near-falls. A comparison was made between older adults who experienced one or more near-fall (i.e., near-fallers) and those who did not experience a near-fall (i.e., non-near-fallers) during the study. The near-fallers had a mean age of 70 years and were four years younger than the non-near-fallers (74 years). The balance recovery manoeuvres used to arrest the fall were: reach-to-grasp strategy (36%), compensatory stepping (52.8%), and other body regions, e.g., hip and trunk (11.2%).

4.6 Discussion

Recruitment process and retention

This study had good participation and retention rate. There was an average of six older people recruited into the study each week, completing the recruitment in five weeks. There was no difficulty recruiting older people who were able to communicate in English. The profile of the sample suitably represented the Singapore older people community as a multi-ethnic society. They were able to report their encounters with near-falls (if any) based on their interactions between their regular activities of daily living and the environment. However, we found that some older participants were unable to participate in this study as the ability to communicate in English was listed as an eligibility criterion. For a future larger-scale study, the study materials may be translated into different languages, such as Mandarin, Malay, Tamil, to allow greater participation of older people.

Concerning retention, the high adherence of participants in our study was consistent with the study conducted by Ryan et al. (1993). It is postulated that the compliance of the older adults in the study was attributable to altruism and the convenience of reporting methods (Manton et al., 2018). Many older adults reported that they enjoyed participating in these research studies to stay mentally alert and keep updated on health-related issues. They also identified the importance of near-falls and relevant balance recovery manoeuvres as practical concepts towards helping themselves and other older people to prevent a fall. They shared that the reporting methods did not intrude on their regular lifestyle, and they found them convenient.

Briefing and working definitions

A 30-minute briefing session was sufficient to ensure that adequate information of the study provided enough understanding to older people without causing unnecessary mental fatigue (Commodari & Guarnera, 2008). While these sessions were conducted one-to-one, the researchers believed that the presentation could be conducted in a group setting during a larger-scale study. The working definitions provided were comprehensible. Older people had no difficulty in learning the definitions and differentiating a fall or near-fall. They were able to apply the definitions to different hypothetical situations and relate to their personal experience.

When encountered with a near-fall situation, the older adult was able to identify the balance recovery manoeuvres used to prevent the fall.

The clarifications requested by two participants about near-falls implied some improvement would be needed for the operational definition of near-falls. In the study, the definition of a near-fall was presented as an event where the individual slips, trips or loses balance but uses the hand(s), (leg)s or any body parts to recovery balance and prevent a complete fall. In future, the different types of events (i.e., the type of perturbations) and various balance recovery manoeuvres (i.e., use of the hand(s), leg(s) or body parts) could be further elaborated with the various causes of disequilibrium and the different ways to recover equilibrium respectively.

One suggestion would be to define a near-fall as an event when the individual may experience a fall due to external perturbations, such as a slip, a trip or external forces causing the individual to lose balance, or due to internal perturbations such as the movement of the individual resulting in the individual being destabilised (Maki & McIlroy, 1996). The other suggestion would be to have better explanations of the use of various body parts to arrest a fall for individuals to understand the mechanisms of avoiding the fall (Maidan et al., 2014). This could be the hand grabbing a handrail, the legs taking a few quick steps on the floor, the shoulder or hip leaning against a wall or the trunk moving to correct body stability. While all individuals might not easily resonate with all types of recovery strategies occurring during a near-fall, the explicit illustrations may increase awareness among the older people of the broader context of using various balance recovery manoeuvres to prevent a fall following perturbations (Maki et al., 2008).

Methods of collecting near-fall data

Data collection methods, such as telephone calls and diaries, had been used in previous studies to record near-falls (Ryan, 1993; Nagai et al., 2017). The application of using texting in this study to collect near-fall data is novel. The new knowledge obtained from the study is that older people preferred texting over calling. This provided evidence that many older adults were receptive to the use of technology in research. In this study, the older adults selected the use of texting to report near-falls data because of its convenience, i.e., they might be busy with other activities and could not pick up the call. They were overall comfortable using this mode of communication as they usually text among family and friends. However, calling might still need to be an option for the study of older people. Three participants who opted to call had mobile phones. They preferred the researcher to call them instead of texting because of their discomfort to text or preferred a more personal way of communication.

The evidence in this feasibility study demonstrated a positive predisposition towards texting as a choice of data reporting in Singapore. Both methods using texting and calling were highly successful for recording near-falls or falls. Both participants and the study team appreciated the flexibility of using texting. While scheduled timings were arranged with the participants, not all participants replied immediately to the text messages or picked up the call. All participants reported their data at their own time. It was, however, noted that calling is a more time-consuming method for the researcher to reach the participant. Overall, the use of texting and calling were feasible methods. These methods provided the convenience for older adults to report their falls or near-falls. It also helps to mitigate issues such as telescoping or forgetting to report an incidence. The risk remains that some older adults may still over-report or under-report the number of near-falls. To provide a clearer picture of the near-fall incidence among community-dwelling older adults, a large-scale and well-powered trial will be needed.

To reduce overburdening of the researchers, a larger-scale study would need to factor in the necessary resources (i.e., a financial budget to hire research assistants or time taken) to conduct the calling. Nevertheless, both ways confirmed these methods' potential use for obtaining data that may be easily forgettable. Based on participants' feedback and the researchers' subjective impressions, the frequency of using a twice-a-week interval to get falls or near-falls data is practical to implement, able to sustain the cooperation of the participants and easy for participants to retain any fall or near-fall details.

4.7 Conclusion

Chapter 4 has demonstrated that community-dwelling older adults were able to understand the different concepts of near-falls and balance recovery manoeuvres. This showed that the construct to be measured by the PROM of balance recovery confidence is relatable to the target population. The objectives of Study 2 were met:

Objective 1: To establish whether the concepts of near-falls and balance recovery manoeuvres are relatable to community-dwelling older adults.

The study presented that the sampled group of community-dwelling older adults had no difficulty distinguishing between falls, near-falls and the types of balance recovery manoeuvres used to arrest a fall. They were able to relate to several falls-related precarious scenarios posed to them.

Objective 2: To gain a preliminary understanding of the incidence of near-falls and the common types of balance recovery manoeuvres used to arrest a fall.

Of the group, 53.3% experienced one or more near-fall and one fall were records from the 630 reports they submitted. Different balance recovery manoeuvres were used to arrest falls including reach-to-grasp strategy (36%), compensatory stepping (52.8%), and the use of other body regions such as the hip and trunk (11.2%). The preliminary understanding obtained from this feasibility study suggested that near-falls are more common than actual falls. The use of upper and lower limbs is a common type of balance recovery manoeuvre to arrest a fall. However, it is imperative not to neglect the other types of balance recovery strategies adopted by community-dwelling older adults.

As this was a small-sampled size study, no post-hoc analysis was done. However, given the high incidence of near-fall, it may be plausible that older adults in different age groups or those with previous experience of falls, a greater fear of falling, different frailty status or a different comorbidity profile, could have different levels of balance recovery confidence. More studies are needed to understand the role and impact of balance recovery confidence in community-dwelling older adults.

Chapter 5

The Balance Recovery Confidence (BRC) scale: Content development and validation (Study 3)

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"A journey of a thousand miles starts with a single step."

– Lao Tzu.

5.1 Introduction

After justifying the need for and importance of a balance recovery confidence scale for community-dwelling older adults in the previous chapter, Chapter 5 details the content construction of the desired PROM. Content development and validity are arguably the most important properties of a PROM as they focus on whether the content corresponds with the construct to be measured (Terwee et al., 2018). Involvement of the relevant stakeholders - the target population and healthcare professionals – is an essential element of the development of the PROM (De Vet et al., 2011).

This chapter demonstrates PROM developers' pragmatic approach in integrating learning points from previous studies with new inputs offered by different stakeholders invited at this stage. While PROM development is an iterative process, a sound methodology for constructing content is crucial to obtain the best possible congruence between the PROM and the construct to be measured. The ultimate goal is a relevant, comprehensible and comprehensive instrument to measure the construct of interest in the target population. This third study was implemented in two stages. The first stage employed the Nominal Group Technique which involved 12 Singapore community-dwelling adults aged 65 years and older in constructing an exhaustive list of potential items to measure balance recovery confidence. The second stage employed a two-round modified Delphi Technique. This latter stage involved a new group of 10 Singapore community-dwelling adults aged 65 years and older and an international panel of 28 healthcare professionals representing physiotherapy, occupational therapy, nursing, medicine and podiatry. Through this stage, the PROM's name, instructions, response options and the final list of 19 items were decided for the PROM of balance recovery confidence from the consensus among the stakeholders of appropriateness in terms of relevance, comprehensibility and comprehensiveness.

The study was prospectively lodged into Clinicaltrial.gov records (Appendix 2A). Ethical approvals were obtained from Queen Margaret University (Appendix 3A) and Singapore Institute of Technology (Appendix 3B) before study commencement. Informed consent was obtained from all participants. Templates have been listed in Appendix 3C and Appendix 3D. Findings of the study have been shared in different platforms, such as the QMU DCA Annual Conference. The study is under review by an international peer-reviewed journal at the time of writing.

5.2 Abstract

The study aims to develop the content of a patient-reported outcome measure that measures self-perceived balance recovery confidence in community-dwelling older adults. A two-stage process was used to construct and validate the content of the measurement instrument. The Nominal Group Technique was used to co-create potential items with 12 Singapore community-dwelling adults aged 65 years or older. A two-round modified Delphi Technique validated the content using an international panel of 28 healthcare professionals and a new group of 10 older adults.

A total of 32 out of 99 generated items were identified to be important and congruent with the conceptual framework. The measurement instrument's name, instructions, response options and 19 items obtained consensus within healthcare professions and community-dwelling older adults. The instrument achieved adequate content and face validity to measure perceived ability in community-dwelling older adults to recover their balance and arrest a fall across different perturbation scenarios.

The content of the newly developed patient-reported outcome measure, the Balance Recovery Confidence (BRC) scale, is relevant, comprehensive, and comprehensible. Further field testing will provide empirical evidence of sufficient acceptability, internal structure, and psychometric properties for exploring the influence of the BRC scale in fall management practice.

5.3 Background

Falls are the second leading cause of injuries, hospitalizations and deaths in older adults (WHO, 2018). People aged 65 and older have the highest risk of falling, with approximately 30% of older people reporting a fall at least once yearly (NICE, 2017). Clinicians working with older people play a critical role in managing this threat. One key strategy would be to address falls-related psychological concerns in older adults and improve their agency to tackle potential falls (Dickinson et al., 2011). Various latent constructs, i.e., fear of falling, falls efficacy, and balance confidence, have been commonly measured using patient-reported outcome measures (PROMs). Targeted strategies are then employed to address specific psychological concerns, and concomitantly, improve the physical functioning and quality of life in older people (Halaweh et al., 2016; Bjerk et al., 2017).

The influence of falls-related psychological concerns has not yet been clearly defined within the literature because of potential interactions and conflations amongst the constructs (Hughes et al., 2015). For example, a PROM of falls efficacy, the Falls Efficacy Scale (FES) (Tinetti et al., 1990), was proposed to quantify fear of falling, illustrating the perceived intertwining relationships amongst constructs and temptation to deploy PROMs into different roles. However, the interchangeable use of PROMs to study the construct of interest in which the content may not be suitably developed can generate confusion within the literature (Moore & Ellis, 2008; Prinsen et al., 2018). Fear of falling, describing exaggerated concerns about falling that leads to excess restriction of activities, is an emotional construct and is distinctive (Abyad & Hammami, 2017). Some PROMs that may be purposefully used to measure fear of falling include the Falls Efficacy Scale-International (FES-I) (Yardley et al., 2005), the Survey of Activities and Fear of Falling in the Elderly (Lachman et al., 1998), and the Fear of Falling Avoidance Behaviour Questionnaire (Landers et al., 2011).

In contrast, falls efficacy has been described as the confidence in one's ability to undertake activities of daily living (ADLs) without falling (Tinetti et al., 1990), whereas balance confidence refers to the individual's belief about maintaining balance whilst performing ADLs (Powell & Myers, 1995). Some authors have posited that falls efficacy and balance confidence are isomorphic and that both constructs should be interpreted interchangeably (Hadjistavropoulos et al., 2011). This view can be conceptually problematic because some PROM developers have identified balance confidence as part of the formative understanding of falls efficacy. A recent systematic review investigating the development and content validity of PROMs for falls efficacy highlighted two PROMs: The Perceived Ability to

Prevent and Manage Fall Risks scale (Tennstedt et al., 1998) and the Perceived Ability to Manage Risks of Falls or Actual Falls scale (Yoshikawa & Smith, 2019), which reflected that falls efficacy and balance confidence should not be viewed interchangeably. As such, falls efficacy, being usefully understood as the perceived ability to prevent and manage the threat of a potential fall (Soh, Tan, Thomas, et al., 2021), facilitates a comprehensive approach for clinicians working with older adults to deal with different falls-related demands. Falls efficacy should be viewed as a set of different perceived confidence for balance, balance recovery, safe landing and post-fall recovery (Soh, Tan, Thomas, et al., 2021).

Balance recovery confidence, as another domain of falls efficacy, differs from balance confidence. Balance recovery confidence is defined as one's perceived reactive ability to recover balance in response to various internal and external perturbations, such as a slip, a trip or a loss of balance that can occur in common, everyday activities (Soh, Tan, Thomas, et al., 2021). Some examples of balance recovery confidence include the perceived capability to grasp a handrail or taking a firm step (or steps) to arrest a fall (Pijnappels et al., 2008; Pijnappels et al., 2010). This aspect of the personal efficacy of older people to react in various near-fall scenarios is essential. Soh et al. (2021) reported that 53.3% of a sample group of older adults in Singapore experienced one or more near-falls within three weeks, and this prevalence was congruent with other studies in different communities (Ryan, 1993; Basler et al., 2017). Reach-to-grasp strategy and compensatory stepping were common reactive balance recovery strategies (Soh, Tan, Lane, et al., 2021). Failing to execute necessary reactive recovery strategies could result in a fall (Maki et al., 2011). Given age-related physiological decline, perceived reactive balance recovery manoeuvres in older people should warrant more significant investigation (Pijnappels et al., 2008).

To the best of our knowledge, there is no existing PROM that adequately measures balance recovery confidence. This article aims to present the content generation and validation process of developing a PROM that measures balance recovery confidence in community-dwelling older adults. The new PROM will assist clinicians and researchers to further evaluate the risk of falls in older adults through the measurement of their self-efficacy in balance recovery. This work provides empirical evidence of the content validity of the balance recovery confidence scale, which aligns with the principles of the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) (Prinsen et al., 2018). Content validity is considered the most important measurement property for PROMs, and that a lack of clinimetric quality can adversely affect all other measurement properties (Terwee et al., 2018).

5.4 Methods

A two-stage process was applied to the PROM designed to measure balance recovery confidence involving the Nominal Group Technique (NGT) to generate the content and subsequently, a modified Delphi Technique (mDT) for its validation. Ethical approvals were obtained from two institutions: Queen Margaret University (Ref No.: REP0197) and Singapore Institute of Technology (Ref No.: 2019129). The study was prospectively lodged in the clinicaltrials.gov registry (NCT04087551).

Concept elicitation and item generation

A systematic review identified an absence of a PROM for balance recovery confidence (Soh, Lane, et al., 2021). A feasibility study was then conducted to determine whether balance recovery confidence was relatable to community-dwelling older adults (Soh, Tan, Lane, et al., 2021). The NGT was selected to generate an exhaustive list of items that fitted the unidimensionality of balance recovery confidence (McMillan et al., 2016). The NGT provided the efficiency and effectiveness within the process of constructing a comprehensive list of population-targeted relevant items without compromising quality for PROM developers (Prinsen et al., 2018).

Content validation

The preliminary content constructed using the NGT was refined using a mDT to meet an acceptable level of content validity, with facilitated consensus and convergence of opinions on key issues amongst the PROM's developers (McMillan et al., 2016). Invited experts accessed an online survey through the link given via email and rated the content over two rounds using the RAND/UCLA appropriateness scale; a 9-point Likert scale ranged from 1 (inappropriate) to 9 (appropriate) based on their judgement of the appropriateness to assess balance recovery confidence and gave necessary comments in a free-text box (Fitch et al., 2001). Appropriateness was defined as having the clarity, importance and relevance of evaluating the balance recovery confidence in community-dwelling older adults. The criteria for obtaining consensus were based on the RAND/UCLA appropriateness operational definition (Table 5.1) (Fitch et al., 2001).

Table 5.1 Criteria to establish appropriateness and agreement.

Level of appropriateness and definition
Appropriate (A): Panel median of 7-9, without disagreement
Uncertain (U): Panel median of 4-6 OR any median with disagreement
Inappropriate (I): Panel median of 1-3, without disagreement
Level of agreement and definition
Agreement (+): No more than 20% of panellists who had rated the indication outside the 3-point region (1-3; 4-6; 7-9) containing the median
Disagreement (-): At least a third of the panellists who had rated the indication in the 1-3 region, and at least three panellists rate it in the 7-9 region
Indeterminate (?): Not meeting the above two-level of agreement

Participants

The eligibility criteria of participants are presented in Table 5.2. Twelve Singapore community-dwelling adults aged 65 years or over were invited to participate in the NGT to generate the PROM's content. They were purposively sampled from within the feasibility study's population (Soh, Tan, Lane, et al., 2021).

Table 5.2 Eligibility criteria of participants.

For community-dwelling older adults for the Nominal Group Technique study and the modified Delphi Technique study
Inclusion criteria: 65-year-old or above, have an adequate understanding of the English language and living independently in the community with or without the use of a walking aid.
Exclusion criteria: Requiring any physical assistance from another person to walk within the home, presenting with clinical observable severe cognitive impairment, and unable to provide written consent to participate in the study
For healthcare professionals to participate in the modified Delphi Technique study
Representing one of the following professions: physiotherapy, occupational therapy, podiatry, nursing, and geriatric medicine.
Have at least 3-year experience in geriatric clinical work or related research studies.

For the mDT, an additional sample of community-dwelling older adults and a group of healthcare professionals representing physiotherapy, occupational therapy, nursing, medicine and podiatry were invited. Given that there was no known standard method to calculate an expert panel size for content validation (McMillan et al., 2016), a generous number of participants was invited to increase the variety of expertise to improve the methodological quality of the PROM development (Terwee et al., 2018). A minimum of 30 healthcare professionals (i.e., six individuals from five professions) and six community-dwelling older adults was viewed to form a robust expert panel size. Based on a 25% dropout estimate, a sample size of 50 was decided. A snowball sampling technique was used to recruit 10 community-dwelling older adults (Parker et al., 2019). Professional networks were used to identify 40 healthcare professionals. Potential participants were given a cover letter and a link to the study information and consent form using the JISC internet-based survey platform (JISC, 2021). Consent was obtained before the participants accessed the survey. All participants were allocated unique study codes for the purposes of anonymity during data analysis and to reduce the risk of bias.

Item generation through NGT

The NGT sessions were conducted in January 2020 at the Singapore Institute of Technology. Two trained facilitators provided oversight of each session in the following stages: Introduction; Silent generation; Round-robin; Clarification; Ranking; Debrief. All participants were given two questions in advance. They were: "What common and everyday activities that older people participate in (at home or outside the home) when a near-fall can occur?" and "How can older people avoid a fall in these near-fall events?". A guide was used by the facilitators in the sessions (Appendix 3F). Audio recordings were taken with permission to address any uncertainties that may arise during analysis. Three researchers (SS; TT; TX) analysed the data, determined the saturation of ideas and fitted the items into the conceptual framework of the balance recovery confidence scale (Figure 5.1) derived from the Bandura's self-efficacy conceptual model (Bandura, 1977). Two NGT sessions were conducted to determine the saturation of content generated. Following the NGT, the preliminary content was then refined and validated using the mDT.

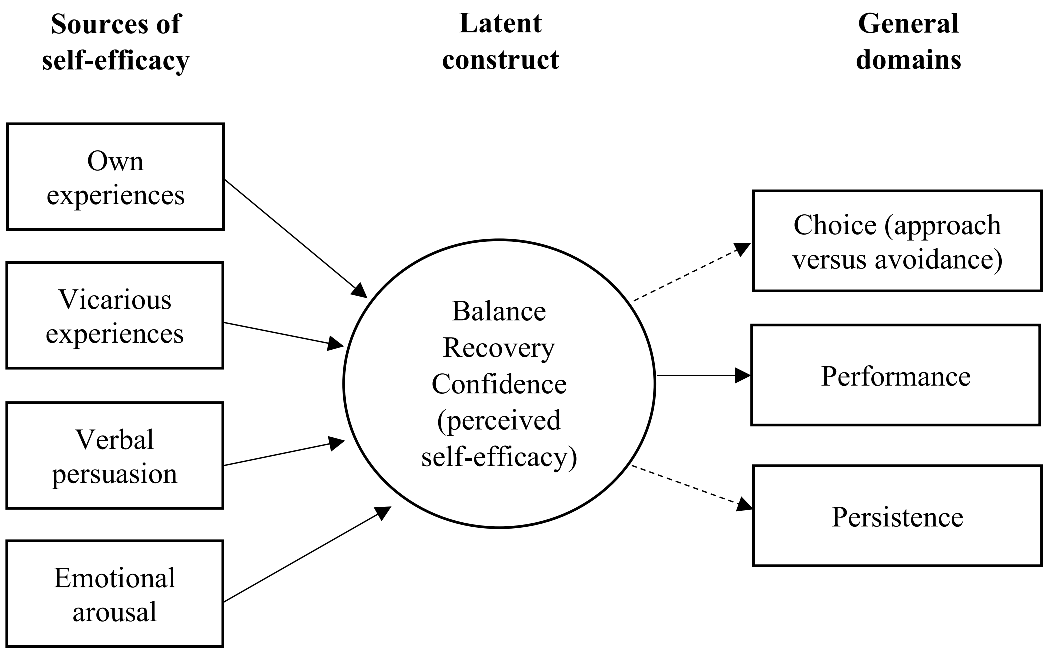


Figure 5.1 The conceptual framework of balance recovery confidence.

Content Validation- mDT Round 1

The first-round survey was sent to 50 invited experts via email in June 2020. All experts were asked to rate the level of appropriateness of the content, which included the instrument's name, instructions, response options, recall period, and the items' descriptor and illustration. Experts were requested to complete the survey within two weeks, with an interim reminder (invitation plus one week) email sent to non-responders.

Content Validation- mDT Round 2

The second-round survey was sent in August 2020 to those who responded in Round 1. Participants were given revised items that met the level of consensus agreement achieved in Round 1. An appropriate level is defined by the expert panel median rating of 7-9 on the RAND/UCLA appropriateness scale, without disagreement. Disagreement is defined as at least a third of the panellists having rated 1-3 in the RAND/UCLA appropriateness scale and a minimum of three panellists having rated an item in the 7-9 region of the scale. The criteria for agreement were met when no more than 20% of panellists had rated the indication outside the 3-point region (1-3; 4-6; 7-9) containing the median. An evaluation rubric (Table 5.3) was used to recommend an action to be taken when an item achieved criteria for consensus but where agreement levels were divergent amongst groups.

Table 5.3 Evaluation rubric to recommend actions on the items given the level of the agreement provided by both groups of participants.

Evaluation matrix		**Healthcare professionals**		
		Agree (+)	**Indeterminate (?)**	**Disagree (-)**
Community-dwelling older adults	**Agree (+)**	Include (Amend[a])	Likely include (Amend[a])	Likely include (Amend[a])
	Indeterminate (?)	Likely exclude (or Amend[a])	Likely exclude (or Amend[a])	Exclude
	Disagree (-)	Likely exclude (or Amend[a])	Exclude	Exclude

[a]All feedback provided by both the community-dwelling older adults and healthcare professionals were considered before making any amendments.

The ratings and summary of comments for each item in Round 2 were used to rationalize its upgrading and refinement. The operationalization of Round 2 was similar to Round 1. For both rounds, one researcher (SS) independently organized all the quantitative and qualitative data. The data were analysed with two other team members (JL; CW) to complete the development of the balance recovery confidence scale.

5.5 Results

Item generation

The demographic characteristics of the participants are presented in Table 5.4. Twelve eligible older adults completed the NGT with no withdrawals. The NGT "round-robin" stage generated 99 items. After clarifying and grouping similar ideas, 59 items were ranked. Saturation was achieved after the two NGT sessions. Three researchers (SS; JL; CW) reviewed the 56 items, which had at least a 1-point score for importance. Thirty-two items were identified to fit the performance domain (Figure 5.2). The other 24 items fitted to the domains of choice and persistence domains. Overall, all items aligned to the Bandura's conceptual framework on how a person perceived their abilities to cope with the given situations.

Content Validation

All 10 community-dwelling older adults completed the mDT study. Twenty-eight healthcare professionals participated in the study with only 22 completed the second round, yielding a response rate of 70% and 79% for first and second round respectively. In Round 1, the consensus of appropriateness was obtained with varying agreement from both groups of participants. From the list of 32 items, 19 items achieved consensus of appropriateness with agreement from both groups. Minor revisions were made to items according to the feedback given. Thirteen items were excluded for Round 2 because they did not meet the criteria set by the evaluation rubric. In Round 2, the name of the instrument, instructions, response options, recall period, and 19 items achieved consensus of appropriateness without disagreement (Figure 5.3). The summary of the content that reached an overall consensus is listed in Table 5.5. The overall list of items was rated as being comprehensive by both groups of participants. Participants rated the PROM to be appropriate to measure balance recovery confidence in community-dwelling older adults, achieving the face validity with an overall median rating of 8 on a 9-point Likert scale ranged from 1 (highly inappropriate) to 9 (highly appropriate). The final balance recovery confidence scale is presented in Table 5.6

Table 5.4 Demographic characteristics of the participants.

Community-dwelling older adults	**NGT (n = 12)**	**mDT (n = 10)**
Age range		
65 to 69 years old	5 (42)	7 (70)
70 to 74 years old	2 (17)	2 (20)
75 to 79 years old	3 (25)	1 (10)
80 to 84 years old	2 (17)	0 (0)
Gender		
Female	6 (50)	5 (50)
Male	6 (50)	5 (50)
Educational level		
Secondary	4 (33)	6 (60)
College/ University	8 (67)	4 (40)
Require use of a walking aid	1 (8)	0 (0)
Experience 1 or more falls in the past year	6 (50)	2 (20)

Table 5.4 Demographic characteristics of the participants (In continuation).

Healthcare professionals	**mDT (n = 28)**
Age range	
25 to 34 years old	7 (25)
35 to 44 years old	15 (53.6)
45 to 54 years old	5 (17.9)
55 to 64 years old	1 (3.6)
Gender	
Female	21 (75)
Male	7 (25)
Occupation	
Medical doctor	3 (10.7)
Physiotherapist	6 (21.4)
Occupational therapist	9 (32.1)
Nurse	8 (28.6)
Podiatrist	1 (3.6)
Researcher	1 (3.6)
Length of work experience	
3 to 5 years	2 (7.1)
6 to 10 years	4 (14.3)
More than 10 years	22 (78.6)
Location	
Singapore	23 (82.1)
UK	1 (3.6)
US	1 (3.6)
Malaysia	1 (3.6)
Australia	1 (3.6)
Hong Kong	1 (3.6)

Table 5.5 Summary of items that reached an overall consensus through modified Delphi Technique.

Content Aspect	CDA[a]			HCP[a]			Overall		
	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]
Name of the PROM	7	A	+	8	A	+	7	A	+
Instructions in the PROM	7	A	+	7.5	A	+	7	A	+
Response options	7	A	+	8	A	+	7	A	+
Items for the PROM									
BRC1: Recover from a loss of balance while walking up a flight of steps without railings.	7	A	?	8	A	+	8	A	+
BRC2: Recover from a loss of balance while walking down a flight of steps without railings.	7	A	?	8	A	+	8	A	+
BRC3: Recover from a loss of balance while walking to the toilet.	7	A	+	7.5	A	+	7	A	+
BRC4: Recover from a minor slip on a puddle of water.	7.5	A	+	8	A	+	8	A	+
BRC5: Recover from falling backwards when a vehicle (e.g., bus, train or tram) accelerates suddenly.	7	A	+	8	A	+	8	A	+
BRC6: Recover from falling forwards when a vehicle (e.g., bus, train or tram) stops suddenly.	7	A	+	8	A	+	8	A	+
BRC7: Recover from a minor slip while taking a shower.	7	A	+	8	A	+	8	A	+
BRC8: Recover from a loss of balance while stepping onto the escalator.	7	A	+	8	A	+	8	A	+
BRC9: Recover from a loss of balance while stepping off the escalator.	7	A	+	8	A	+	7.5	A	+
BRC10: Recover from a loss of balance while doing light exercises (e.g., stretching).	7	A	+	8	A	+	7.5	A	+

Content Aspect	CDA[a]			HCP[a]			Overall		
	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]	MR[b]	APPL[b] (A/U/I)[c]	AGRL[b] (+/-/?)[c]
BRC11: Recover from falling forwards while walking down a gentle slope.	7	A	+	8	A	+	8	A	+
BRC12: Recover from a trip while carrying groceries with both hands.	7	A	+	8	A	+	8	A	+
BRC13: Recover from a loss of balance while stepping over an object or obstacle (e.g., a one foot/30.48 cm wide drain).	7	A	+	8	A	+	8	A	+
BRC14: Recover from a loss of balance while avoiding a collision with another person (e.g., a jogger or a child on a bicycle).	7	A	+	8	A	+	8	A	+
BRC15: Recover from a loss of balance while reaching for overhead objects.	7	A	?	8	A	+	7.5	A	+
BRC16: Recover from a loss of balance while standing on a stool.	7	A	+	8	A	+	8	A	+
BRC17: Recover from a loss of balance while getting dressed in standing.	7	A	+	8	A	+	8	A	+
BRC18: Recover from a loss of balance while getting out of bed.	6.5	U	?	8	A	+	8	A	+
BRC19: Recover from falling backwards after standing up from a chair.	7	A	+	8	A	+	8	A	+
Comprehensiveness of the content	7.5	A	+	8	A	+	8	A	+
Appropriateness of content in the PROM to measure balance recovery confidence in community-dwelling older adults (Face validity)	7	A	+	8	A	+	8	A	+

[a] CDA, Community-dwelling older adults; HCP, Healthcare professionals
[b] MR: Median rating; APPL: Appropriateness level; AGRL: Agreement level. The level of appropriateness and the level of agreement is determined based on the Table 1 criteria.
[c] A: Appropriate; U: Uncertain; I; Inappropriate; +: Agreement; -: Disagreement; ?: Indeterminate

Table 5.6 The Balance Recovery Confidence (BRC) Scale with the illustration of 19 items.

Instructions to participants:

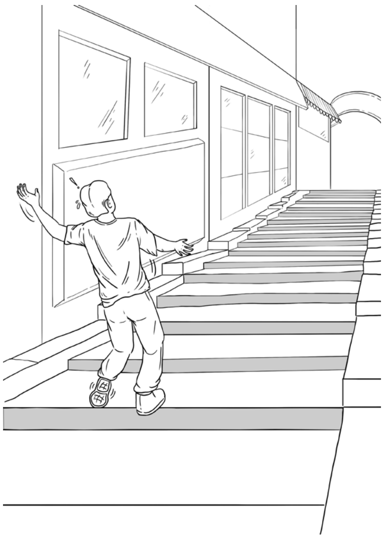
Please rate **how certain** you are, now, that you can **recover your balance** and arrest a fall in each of the following scenarios. Answer all questions to show whether you think you can recover from a loss of balance, trip or slip if the situation occurs.

Rate your degree of confidence by recording a number from 0 to 10 using the scale given below:

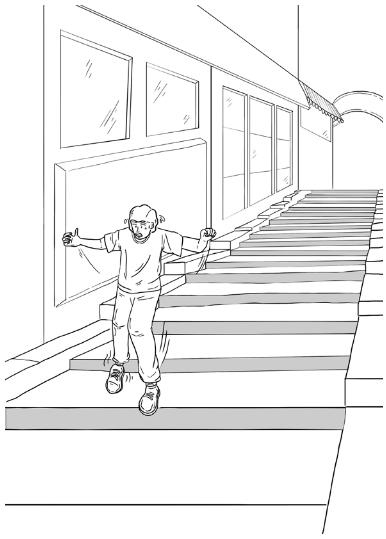
0	1	2	3	4	5	6	7	8	9	10
Cannot do at all					Moderately can do					Highly certain can do

Scenario		Score
1	Recover from a loss of balance while walking up a flight of steps without railings.	
2	Recover from a loss of balance while walking down a flight of steps without railings.	
3	Recover from a loss of balance while walking to the toilet.	
4	Recover from a minor slip on a puddle of water.	
5	Recover from falling backwards when a vehicle (e.g. bus, train or tram) accelerates suddenly.	
6	Recover from falling forwards when a vehicle (e.g. bus, train or tram) stops suddenly.	
7	Recover from a minor slip while taking a shower.	
8	Recover from a loss of balance while stepping onto the escalator.	
9	Recover from a loss of balance while stepping off the escalator.	
10	Recover from a loss of balance while doing light exercises (e.g.stretching).	
11	Recover from falling forwards while walking down a gentle slope.	
12	Recover from a trip while carrying groceries with both hands.	
13	Recover from a loss of balance while stepping over an object or obstacle (e.g. a one foot/30.48 cm wide drain).	
14	Recover from a loss of balance while avoiding a collision with another person (e.g. a jogger or a child on a bicycle).	
15	Recover from a loss of balance while reaching for overhead objects.	
16	Recover from a loss of balance while standing on a stool.	
17	Recover from a loss of balance while getting dressed in standing.	
18	Recover from a loss of balance while getting out of bed.	
19	Recover from falling backwards after standing up from a chair.	

Item 1. Recover from a loss of balance while walking up a flight of steps without railings.



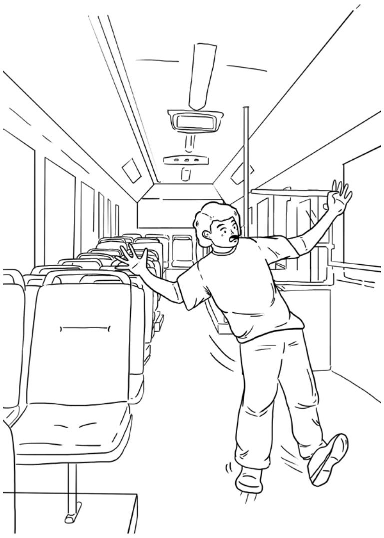
Item 2. Recover from a loss of balance while walking down a flight of steps without railings.



Item 3. Recover from a loss of balance while walking to the toilet.

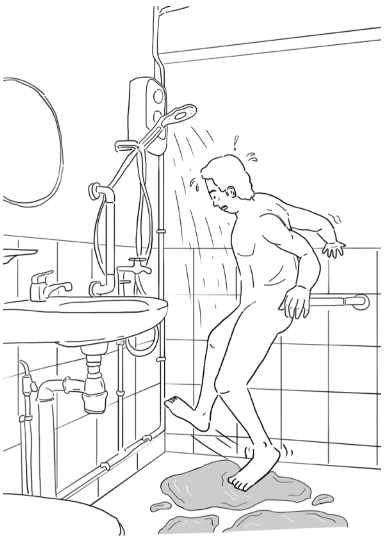
Item 4. Recover from a minor slip on a puddle of water.

Item 5. Recover from falling backwards when a vehicle (e.g., bus, train or tram) accelerates suddenly.



Item 6. Recover from falling forwards when a vehicle (e.g., bus, train or tram) stops suddenly.

Item 7. Recover from a minor slip while taking a shower.

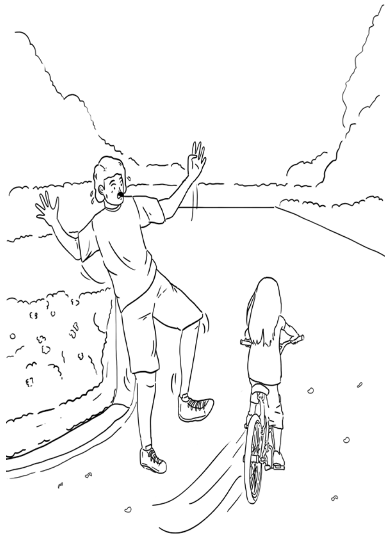


Item 8. Recover from a loss of balance while stepping onto the escalator.

Item 9. Recover from a loss of balance while stepping off the escalator.	Item 10. Recover from a loss of balance while doing light exercises (e.g., stretching).
	
Item 11. Recover from falling forwards while walking down a gentle slope.	Item 12. Recover from a trip while carrying groceries with both hands.
	

Item 13. Recover from a loss of balance while stepping over an object or obstacle (e.g., a one foot/30.48 cm wide drain).

Item 14. Recover from a loss of balance while avoiding a collision with another person (e.g., a jogger or a child on a bicycle).



Item 15. Recover from a loss of balance while reaching for overhead objects.

Item 16. Recover from a loss of balance while standing on a stool.

Item 17. Recover from a loss of balance while getting dressed in standing.	Item 18. Recover from a loss of balance while getting out of bed.
	

Item 19. Recover from falling backwards after standing up from a chair.

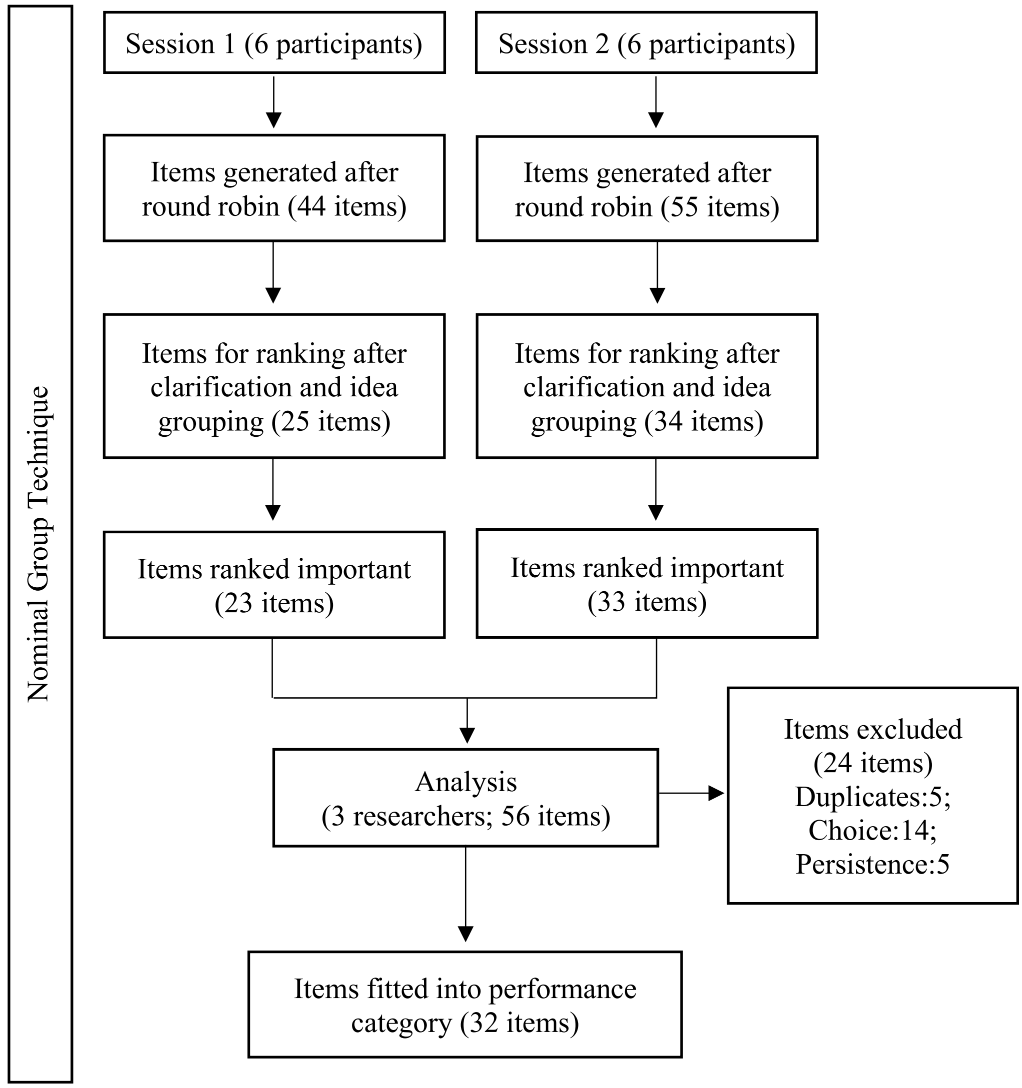



Figure 5.2 Items generated using Nominal Group Technique.

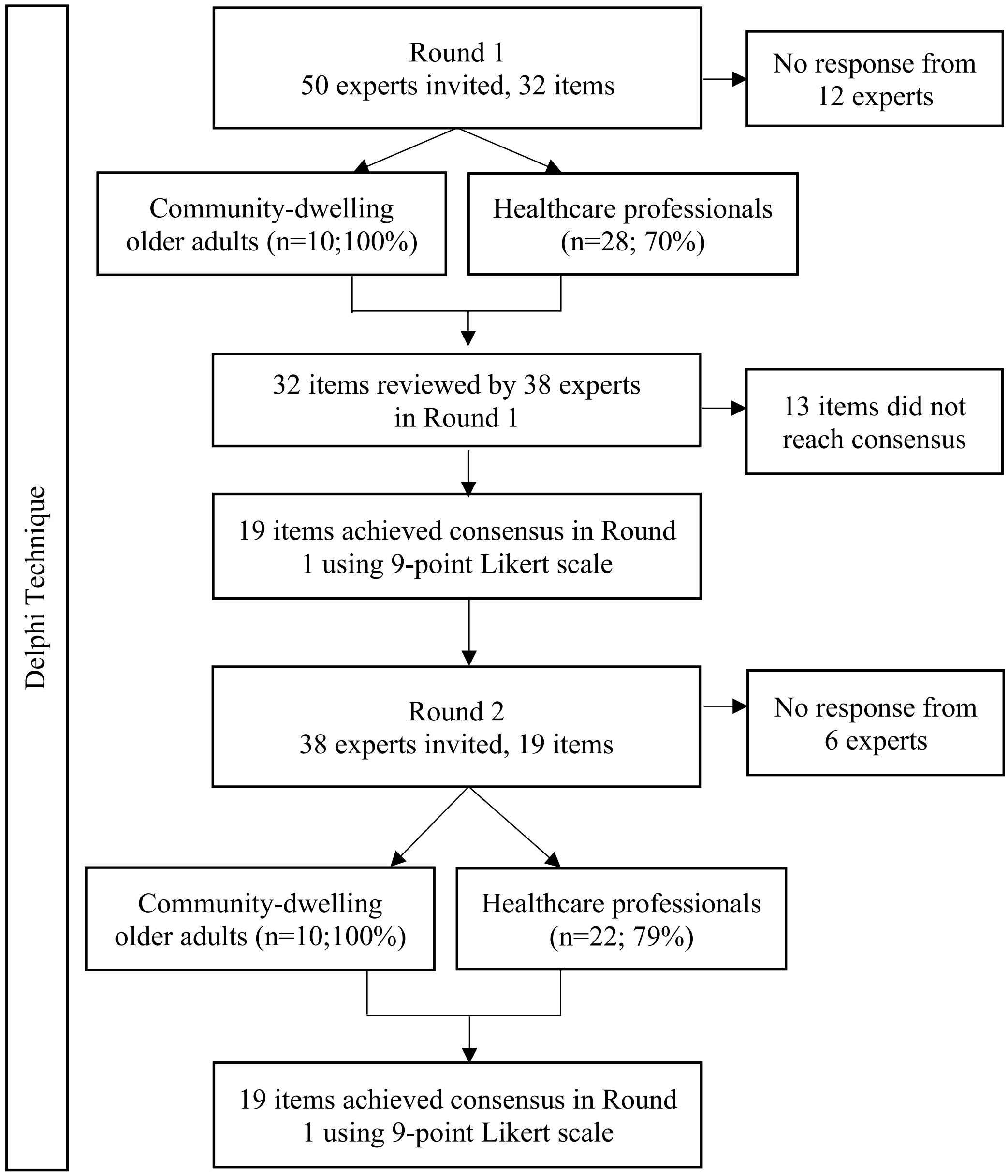


Figure 5.3 Items obtained consensus using modified Delphi Technique.

5.6 Discussion

The dimension of balance recovery confidence

The balance recovery confidence scale aims to be a unidimensional measurement instrument of perceived balance recovery confidence (self-efficacy). The measurement instrument contains items deemed important to measure balance recovery confidence by the community-dwelling older adults. These items were categorized using Bandura's self-efficacy conceptual framework to develop a reflective model for the latent construct (Bandura, 1977) and were viewed consistent with the falls-related literature (Komisar et al., 2019; Maki et al., 2011).

Content development and validation

De Vet et al. (2011) identified the need to involve suitable experts to ensure the relevance of a PROM. In this context, representatives of the community-dwelling older adults and various healthcare professionals involved in the care of older people participated in the balance recovery confidence scale's content development. While there have been no recommended guidelines for the specific characteristics or the number of representatives to be involved in the development of a new measurement instrument, the implicit assumption is that those involved should have some personal experience of the construct of interest that the measurement instrument is designed to measure. A reasonable number of experts should also be invited to account an expected dropout rate of between 20% and 30% for each round in Delphi studies (Bardecki 1984). In this study, while no community-dwelling older adults dropout, there was a dropout rate of 30% and 21% for healthcare professionals in the two phases. This was consistent with the expected attrition.

Both groups understood the purpose of the PROM and co-constructed the balance recovery confidence scale with the PROM developers (Soh, Gilmour, et al., 2021). This approach met the requirements set by the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) (Prinsen et al., 2018). The two consensus methods provided a robust and systematic approach toward constructing the balance recovery confidence scale. NGT provided an opportunity for PROM developers to clarify some preconceived ideas, which were assumed to be relevant for the target population. For example, items found in existing literature (i.e., content development studies of falls efficacy-related instruments) were introduced during the clarification stage to allow participants to deliberate on the relevance and importance of these ideas.

PROM developers were also able to obtain more significant insights into the content during the mDT. For example, the item "Recover from a minor slip while taking a shower" had a slightly higher consensus rating among community-dwelling older adults than the healthcare experts. A higher rating suggested that older adults related better to a potential minor slip occurring in a shower and the need for arresting the fall. Another item, "Recover balance while walking up a flight of stairs without railings", had a slightly lower consensus rating among community-dwelling older adults when compared to the healthcare experts' ratings. The difference was that some older adults felt that the railings should always be used when climbing stairs. In contrast, the focus of the healthcare experts was on the perturbation directions or the falling direction. The healthcare experts' evaluation of the content was based on their professional knowledge, skills and experience of working with older people (Higgs et al., 2008). Nevertheless, the involvement of different stakeholders is invaluable for PROM development due to the wide range of experience brought to bear on content creation (Terwee et al., 2018).

Comparisons between the balance recovery confidence scale and other existing falls efficacy scales or balance confidence scales

The explicit description of the balance recovery confidence scale development serves to differentiate itself from other falls-related PROMs. The balance recovery confidence scale aims to complement other PROMs to provide a greater understanding of the complexity of fall management. Perceived efficacy plays a crucial role in the functioning of a person (Bandura, 2006). Delbaere et al. (2010) highlighted that almost one-third of older people underestimate or overestimate their risk of falling. This suggested that clinicians need to administer appropriate PROMs and performance measures as part of fall risk assessment to allow individualized interventions to be prescribed.

5.6 Conclusion

Chapter 5 has presented the development and validation of content for the balance recovery confidence scale. The balance recovery confidence scale was designed to contain a number of items with a range of difficulty levels relating to recovery of balance in various situations, both indoor and outdoor, and the potential use of different balance recovery strategies such as reach-to-grasp and compensatory stepping. The objectives of Study 3 were met as follow:

Objective 1: To construct the content of a PROM measuring balance recovery confidence with community-dwelling older adults.

Ninety-nine items for the balance recovery confidence scale were generated by 12 Singapore community-dwelling adults aged 65 and older through two focus group sessions. After clarification and grouping of similar ideas, this was reduced to 59 items, which were then ranked for their importance to measure balance recovery confidence. A final list of 32 items was selected to fit the performance domain of the self-efficacy conceptual framework (Reeve, 2009).

Objective 2: To refine the preliminary content of the PROM with healthcare professionals and a new group of community-dwelling older adults.

The content list of 32 item was refined to 19 items using a two-round modified Delphi Technique. A new group of 10 Singapore community-dwelling older adults and 28 healthcare professionals representing physiotherapy, occupational therapy, nursing, podiatry and medicine participated in the first round. There were no dropouts among the 10 community-dwelling older adults in the study. Twenty-two healthcare professionals completed the second-round review.

Objective 3: To validate the content of a PROM measuring balance recovery confidence, ensuring its relevance, comprehensiveness and comprehensibility, for community-dwelling older adults.

The study showed that the name of the PROM, instructions, response options, recall period, and 19 items achieved the consensus of appropriateness without disagreement. Both groups of experts also rated the face validity that PROM as appropriate to measure the construct.

Chapter 6

Validation of a new patient-reported outcome measure of balance recovery confidence for community-dwelling older adults: a study protocol

Published as:

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"The really important thing is learning how to sceptically question and rely on empirical evidence."

– Lawrence M. Krauss

6.1 Introduction

Field testing is fundamental in the development of a PROM (De Vet et al., 2011). Chapter 5 showed the construction of the balance recovery confidence scale's content with the target population and healthcare professionals. For the next stage, PROM developers need to evaluate the acceptability of the PROM among the target population and obtain an insight into the structure of the data. Other measurement properties, namely the reliability and validity, should be established in order to gain a greater understanding of the PROM's psychometric properties as well as to inform PROM developers whether further iteration will be needed.

Chapter 6 reports a study protocol to evaluate the psychometric properties of the balance recovery confidence scale. Given limited resources, PROM developers need to prioritise key measurement properties. A study protocol would be useful for three reasons. The first step in this respect is a clear statement of the intended aims and methods to be applied in the field testing. This is viewed as *an agreement* between the PROM developers and the scientific community (Silverman and Kwiatkowski, 1998). Second, the study protocol would serve as a quality control tool during the validation of the PROM (Piantadosi, 2005). Third, *a priori* hypotheses (based on theories about the construct) would be formulated, whose plausibility could be judged by the academic community. This approach assists for conclusions to be drawn about the relationships between constructs measured by PROMs (De Vet et al., 2011). It also prevents PROM developers to manipulate interpretations, such as making positive conclusions on the basis of non-convincing data generated from the study. The study protocol to validate the balance recovery confidence scale for community-dwelling older adults was prospectively written and published in the *Physical Therapy Review*, 26(6), 457-466.

6.2 Abstract

Patient-reported outcome measures (PROMs) provide clinicians with a greater understanding of patients' perceived ability in their physical performance. Existing PROMs on falls efficacy provide meaningful information about the perceived ability in older people to perform common activities of daily living without falling. However, the perceived ability to recover balance from a slip, a trip, or volitional movements has been inadequately assessed. Balance recovery confidence relates to the judgment of self-reactive ability. The Balance Recovery Confidence (BRC) scale is a new PROM that measures perceived balance recovery self-efficacy. The purpose of the study protocol is to describe the first psychometric evaluation of BRC scale's measurement properties.

This study is a validation phase of a newly developed PROM conducted in Singapore. Two hundred community-dwelling older adults, aged 65 years and older, will complete five self-reported instruments (BRC scale, Activities-specific Balance Confidence Scale, Falls Efficacy Scale-International, Late Life Function and Disability Instrument-Function and Global Perceived Effect) and three performance measures (Hand strength dynamometer, 30-second Chair Stand, Mini BESTest). Classical Test Theory methods will assess acceptability, data completeness, targeting of the items, scaling assumptions, internal consistency reliability and construct validity. Factor analysis will establish unidimensionality. Rasch Measurement Theory will evaluate item fit, differential item functioning, response scale ordering, targeting of persons and items and reliability. This is the first validation study of the BRC. The study will give confidence among clinicians and researchers to use the BRC in fall management research and clinical practice.

6.3 Background

Patient-reported outcome measures (PROMs) have been widely used amongst physiotherapists to guide evidence-based treatment planning and delivery (Kyte et al., 2015). These self-reported instruments elicit information about the status of a patient's health condition directly from the patient without interpretation of the patient's response by a clinician or anyone else (FDA, 2009). This approach of obtaining 'patient-centred' data has been actively encouraged for clinicians to demonstrate measurable improvements in these clinical outcomes of their patients as part of daily practice (CSP, 2014; Johnston et al., 2018). A well-designed PROM can accurately capture the patient's own opinions on the impact of their condition, and its treatment, on their life (Kyte et al., 2015). However, a poor designed PROM can constitute a waste of resources and is unethical (Ioannidis et al., 2014).

According to the international COSMIN (COnsensus-based Standards for the selection of health Measurement INstruments) initiative, a PROM developed with a coherent and transparent methodology provides confidence amongst clinicians and researchers about the validity of the PROM and meaningfulness of its data (Prinsen et al., 2018).
Numerous PROMs have been developed to measure falls-related self-efficacy (falls efficacy) in older people. The conceptual frameworks of these PROMs have been underpinned by Bandura's self-efficacy theory (Bandura, 1977), describing how older people are empowered to effect change in themselves and their situations through their efforts. Self-efficacy is defined as the "beliefs in one's capability to organize and execute the courses of action required to produce given attainments" (Bandura, 1997).

The first of such PROM developed for older people on falls is the Falls Efficacy Scale (FES) (Tinetti et al., 1990). FES was operationalized to measure fear of falling as this type of fear was identified to be "low perceived self-efficacy or confidence at avoiding falls" (Tinetti et al., 1990). Over the last three decades, numerous PROMs have been further developed or modified from the original FES to measure various latent constructs, including falls efficacy, balance confidence and fear of falling. Some of these PROMs were the Modified Falls Efficacy Scale (Hill et al., 1996), Activities-specific Balance Confidence (ABC) scale (Powell & Myers, 1995), Falls Efficacy Scale International (FES-I) scale (Yardley et al., 2005), Iconographical Falls Efficacy Scale (Icon-FES) (Delbaere et al., 2011) and the CONFbal scale of balance confidence (Simpson et al., 2009).

Two previous systematic reviews, which aimed to recommend a 'gold standard' falls efficacy instrument, reported inconsistencies within and across studies in providing evidence of the validity in the different instruments (Jørstad et al., 2005; Moore & Ellis, 2008). The interchangeable interpretations between the various falls-related psychological constructs of falls efficacy, balance confidence and fear of falling have led to clinicians and researchers using different PROMs to measure the different constructs, and this may be conceptually problematic (Hughes et al., 2015).

A recently conducted systematic review on 18 PROMs for falls-related self-efficacy revealed that different items in the PROMs were related to the judgement of one's abilities to manage different falls-related circumstances (Soh, Lane, et al., 2021). The PROMs measuring falls efficacy, such as the Perceived Ability to Manage the Risk of Falls, or Actual Falls (Tennstedt et al., 1998) and the Perceived Ability to Prevent and Manage Fall Risk scale (Yoshikawa & Smith, 2019), had a list of items which were deemed expansive, concerning the perceived ability of individuals on performing activities without losing balance, preventing falls, falling safely or getting up or helped up from the floor. This suggested that falls efficacy may be better defined as the perceived ability to manage the threat of fall (Payette et al., 2016). The PROMs used for balance confidence, such as the ABC scale (Powell & Myers, 1995), the CONFbal scale of balance confidence (Simpson et al., 2009), and the Modified Falls Efficacy Scale (Hill et al., 1996), had items focusing on the perceived ability of individual to performing ADLs without losing balance or falling. This implied that balance confidence is a subset domain of falls efficacy. Fear of falling, which relates to a lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing (Tinetti & Powell, 1993), differentiates itself from the self-efficacy construct (Bandura, 1977). Some common PROMs used by clinicians for measuring fear of falling would include the Survey of Activities and Fear of Falling in the Elderly (Lachman et al., 1998), the Fear of Falling measure (Velozo & Peterson, 2001), the FES-I scale (Yardley et al., 2005) and the Iconographical FES (Delbaere et al., 2011).

Bandura (2006) viewed that using a "one-measure fits all" approach toward understanding self-efficacy in individuals potentially limit the understanding of people's beliefs in their different capabilities needed to produce given attainment on targeted domains of functioning. In this sense, a general falls efficacy scale would provide limited relevance towards understanding the agency of older people to manage falls. This suggested that different measures reflecting a range of circumstances surrounding falls would be needed. An appropriately constructed PROM on specific domains of falls efficacy would facilitate a greater understanding amongst clinicians and researchers of the personal effectiveness in older people to deal with falls.

Balance recovery is a crucial rehabilitation outcome, given that most falls were related to different types of perturbations (Tokur et al., 2020). Stevens et al. (2014) had reported that 68.5% of falls were caused by “lost balance, unsteady or wobbly”, “trip, caught foot, clumsy or tangled feet” and “slip”. To successfully arrest a fall, the individual will need to effectively and efficiently execute various change-in-support manoeuvres such as reach-to-grasp or compensatory stepping to recover balance in response to a balance perturbation (Maki & McIlroy, 2006; Rinaldi et al., 2018; Tokur et al., 2020). Clinicians have been focusing on training the reactive ability in older people to avoid a fall by using perturbation-based training to simulate a slip, a trip or a loss of balance for the older adults to train this skill. (Shumway-Cook & Woollacott, 2017). This mode of practice aims to intentionally cause the individual to lose balance during task or activity performance for the individual to catch oneself through a progressive, graded perturbation intensity (Okubo et al., 2019). The goal of the rehabilitation intervention is to improve reactive balance recovery abilities using change-in-support manoeuvres to restore equilibrium, which contrasts itself from conventional balance training that concentrates predominantly on fixed support strategies in keeping balance.

Many PROMs on falls efficacy and balance confidence have been conventionally interpreted conceptually to measure the perceived ability to perform varying activities without losing balance (Hadjistavropoulos et al., 2011). For example, the instructions from FES direct the respondent to answer, ‘How confident are you that you do the following activities without falling?’ (Tinetti et al., 1990) or the question from the ABC, which asks the respondent, ‘How confident are you that you will not lose your balance or become unsteady when you…’ (Powell & Myers, 1995).

There has been an absence of a PROM that measures the perceived ability to recover one’s balance from perturbations such as a slip, a trip, or a loss of balance caused by volitional movements (Maki et al., 2008; Soh, Lane, et al., 2021). These issues have led to the development of a newly developed PROM to measure balance confidence in community-dwelling older adults, known as the Balance Recovery Confidence (BRC) scale. Presently, the psychometric properties of the BRC scale are unknown. The psychometric properties of the BRC scale should be examined as well as to understand its relationship with other falls-related psychological concerns such as balance confidence, fear of falling and physical performance in community-dwelling older adults.

Study aims and objectives

This protocol aims to outline the intended approach to the first evaluation of the BRC scale's psychometric properties. There are several measurement properties such as unidimensionality, validity (to what extent does the instrument measure the construct it purports to measure) and reliability (the degree to which measurement is free from error) of the PROM that is needed to be studied (De Vet et al., 2011).

This psychometric validation aims to provide evidence that the PROM can be purposefully used in practice, given that rigorous methods have been applied for the development and validation of the BRC scale. For the study, balance recovery confidence is defined as the perceived ability to recover one's balance from perturbations, such as a slip, a trip, or a loss of balance that can occur in common, everyday activities. This focus will leave little ambiguity about precisely what is being measured. The resulting questionnaire is intended to be approximately 20 questions and should not take longer than 10 min to complete. The instrument is not intended to be used as a diagnostic tool of impaired specific balance recovery mechanisms.

The BRC scale allows clinicians and researchers to quantifiably determine the balance recovery confidence in older adults and use the scale as a conduit for understanding older people's perspectives when encountering different perturbations during their daily activities.

The objectives are to:

1. To evaluate the measurement properties of the BRC scale, i.e., unidimensionality, acceptability, targeting, scaling assumptions and reliability using Classical Test Theory (CTT) and Rasch Measurement Theory (RMT) in the Singapore community-dwelling older adults.
2. To assess the construct validity of the BRC scale against commonly used PROMs and performance measures in the Singapore community-dwelling older adults.
3. To evaluate the items, response categories, and scale structure of the BRC scale using RMT in an English-speaking sample of community-dwelling older adults in Singapore.

6.4 Methods

This study protocol is a prospective validation study conducted to assess the psychometric properties of a newly-developed PROM. The study is proposed under Bandura's guide to developing self-efficacy scales (Bandura, 2006) and uses the procedures recommended by De Vet et al. (2011) to develop a PROM. This approach provides evidence for developing a PROM that measures the construct that is intended to be measured and provide evidence of its use as an outcome measure in clinical practice and research trials.

Development of the BRC scale

The BRC scale was developed iteratively with the following stages: concept identification, concept elicitation, pilot testing for instrument refinement and instrument validation (Soh et al., 2020; Soh, Gilmour, et al., 2021). The balance recovery concept had been previously identified through literature review, a systematic review conducted on falls efficacy related instruments for community-dwelling older adults (Soh, Lane, et al., 2021) and a feasibility study was done to establish that the balance recovery concept was relatable with the target population (Soh, Tan, et al., 2021).

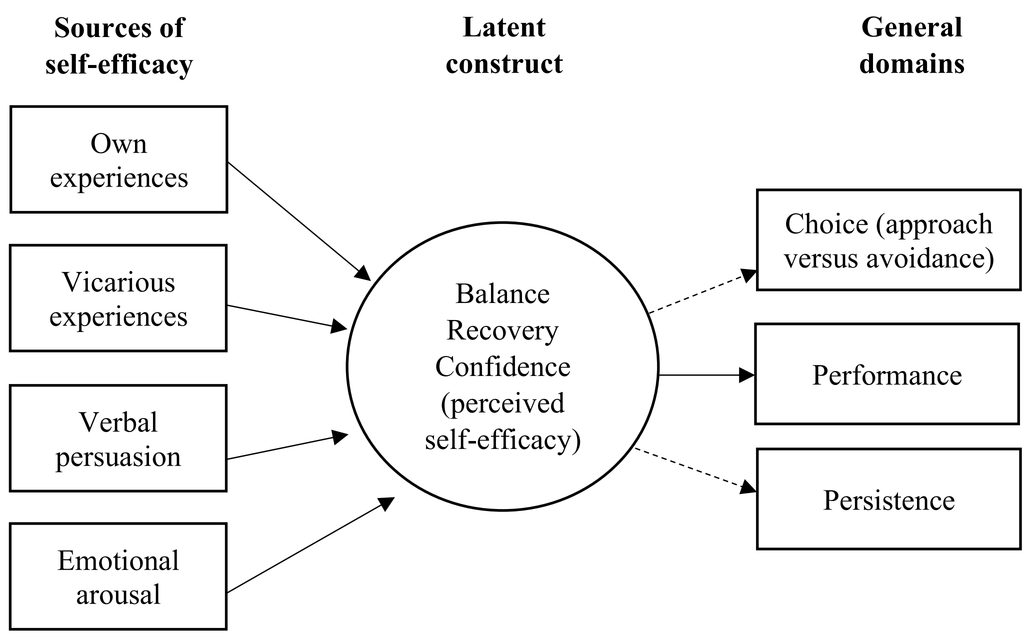

Figure 6.1 The conceptual framework of the PROM that measures balance recovery confidence (BRC).

Construction of BRC scale's items was completed with twelve community-dwelling older adults, aligning to the reflective conceptual model of the instrument (Figure 6.1). The preliminary BRC scale was pilot tested using Delphi with a new group of community-dwelling older adults and an international panel of medical and healthcare professionals. The content was refined accordingly to the feedback given by both panels of experts to meet an acceptable level of content validity.

Psychometric evaluation of the BRC scale

Assessing unidimensionality

The unidimensionality of the BRC scale to measure balance recovery confidence needs to be determined for the scoring of items (i.e., the certainty to recover the balance across different situations is because of their balance recovery confidence). Structural validity is defined as 'the degree to which the scores of a measurement instrument are an adequate reflection of the dimensionality of the construct to be measured' (Mokkink et al., 2010). The understanding of the structural validity will give evidence that the BRC scale adequately reflects the dimensionality of the balance recovery confidence construct in community-dwelling older adults.

Assessing acceptability, targeting, scaling assumptions and reliability

Acceptability refers to the questions of whether or not respondents would be willing to complete the PROM (De Vet et al., 2011). Acceptability will be informed through data completeness (i.e., missing or incomplete data for items and sample). Data completeness will establish the extent to which scale items are scored, and total scores can be computed.

Targeting may be defined as 'the extent to which the range of the variable measured by the scale matches the range of the latent variable in the study sample (Gorecki et al., 2013). Targeting will be assessed on the ability of the BRC scale to span the entire scale range, skewness, and the floor and ceiling effects (De Vet et al., 2011).

The examination of scaling assumptions assesses the legitimacy to group items into a scale to produce a scale score (Streiner et al., 2015). Reliability is defined as 'the degree to which the measurement is free from measurement error' (De Vet et al., 2011). The reliability of the BRC scale will be assessed for internal consistency reliability and test-retest reliability. The internal consistency reliability establishes the inter-relatedness among items and is an assessment of the unidimensionality of a scale or subscale. The test-retest reliability evaluates the scores remaining the same for repeated measurements over time for patients who have not changed (De Vet et al., 2011).

Table 6.1 Hypotheses for construct validity.

Hypotheses to patient-reported outcome measures	
1	A moderate positive correlation (0.30-0.59) was expected between the BRC scale and the ABC scale (for balance confidence). While BC and BRC are unique, they are relatable constructs of balance control. The ABC scale focuses on perceived ability to stay balanced during activity performance and BRC scale focuses on perceived balance recovery performance.
2	A moderate negative correlation (0.30-0.59) was expected between the BRC scale and FES-I (for fear of falling). BRC and fear of falling, while conceptually different, are relatable, given that low BC may have a high fear of falling.
3	A moderate positive correlation (0.30-0.59) was expected between the BRC scale and LLFDI. Both instruments measure perceived physical performance of an individual. LLFDI focuses on perceived ability to do specific activities, and BRC scale focuses on perceived balance recovery performance.
Hypotheses to performance measures	
1	A strong positive correlation (≥ 0.60) was expected between the BRC scale and HSD. HSD measures handgrip strength. Handgrip strength is necessary for reach-to-grasp manoeuvres to recover balance.
2	A strong positive correlation (≥ 0.60) was expected between the BRC scale and CST. CST measures lower limb strength. Lower limb strength is necessary for compensatory stepping manoeuvres to recover balance.
3	A strong positive correlation (≥ 0.60) was expected between the BRC scale and MBT. MBT measures the anticipatory and reactive ability for balance and balance recovery. MBT and BRC measure related constructs of balance control.

PROMs: Patient-reported outcome measures; BRC: Balance Recovery Confidence; ABC: Activities-specific Balance Confidence; BC: Balance Confidence; FES-I: Falls Efficacy Scale – International scale; LLFDI: Late Life Function and Disability Instrument-Function component scale; HSD: Hand strength dynamometer; CST: 30-second chair stand test; MBT: Mini BESTest

Assessing the construct validity

Construct validity may be defined as the extent to which the scores of an instrument are a valid measure of the latent construct (De Vet et al., 2011). The construct validity of the BRC scale will be assessed by applying criteria specified by the COSMIN initiative. The COSMIN specifies that construct validity may be assessed by testing a priori hypotheses based on the literature and the experience of the study team (Prinsen et al., 2018). The construct validity of the BRC scale will be assessed by the degree to which the sum score of the BRC scale is consistent with predefined hypotheses regarding the relationship between the BRC scale and the other measures. Six hypotheses have been formulated listed in Table 6.1.

Assessing the items, response categories and scale structure

The item fit refers to the degree of mismatch between the pattern of the actual observed responses and the Rasch modelled expectations (De Vet et al., 2011). Specifically, whether the pattern for each item across persons investigated fits the Rasch measurement model. The response categories of the BRC scale (i.e., the number of categories and their definitions) will be evaluated whether the options are sufficient or should be adjusted to provide better coverage of the latent construct of balance recovery confidence. The scale structure will be explored whether the relative distribution of items matches the range of the respondents' latent trait.

Recruitment and Data Collection

The participants' eligibility criteria are presented in Table 6.2. Recruitment will be done through posters dissemination and word-of-mouth recommendations through Singapore Institute of Technology (SIT) Health and community partners. Interested participants will be briefed about the research by a team member. Consent will be obtained when the older adult meets the eligibility criteria and has decided to participate in the study.

All participants will complete a self-reported demographic questionnaire, four questionnaires which are the BRC scale (Soh et al., 2020), ABC Scale (Powell & Myers, 1995), FES-I (Yardley et al., 2005), Late Life Function and Disability Instrument-Function (LLFDI-F) (Haley et al., 2002) and three performance measures: Jamar hand strength dynamometer (Durkin, 2014), 30-second chair stand test (Jones et al., 1999) and Mini BESTest (Franchignoni et al., 2010) (Table 6.2). The Mini BESTest has been recommended as a comprehensive balance performance test that can be applied practically in research practice (Sibley et al., 2015). It also assesses the component of balance recovery performance.

Table 6.2 Study eligibility criteria for recruitment of participants.

Eligibility criteria for community-dwelling older adults	
Inclusion criteria	**Exclusion criteria**
65-year-old and above	Requiring any physical assistance from another person to walk within home
Have an adequate understanding of the English language	Presenting with clinical observable severe cognitive impairment
Living independently in the community with or without the use of a walking aid	Unable to provide written consent to participate in the study

After seven days, participants will be asked to complete the BRC scale and the Global Perceived Effect (GPE) scale (Kamper et al., 2010). The GPE scale is used to ensure participants' perception of their abilities remained unchanged during the seven days. The time interval of 7 days had been reported to be sufficient to minimize recall bias (DeVon et al., 2007). Participants will be asked if they have experienced a fall, near-fall or encountered any incident that might affect their balance recovery ability over the past seven days. The procedure is reflected in the CONSORT flow diagram (Figure 6.2). All participants will be coded with a unique identifier generated by an online code generator, and no personal identifiable information will be retained by the study team.

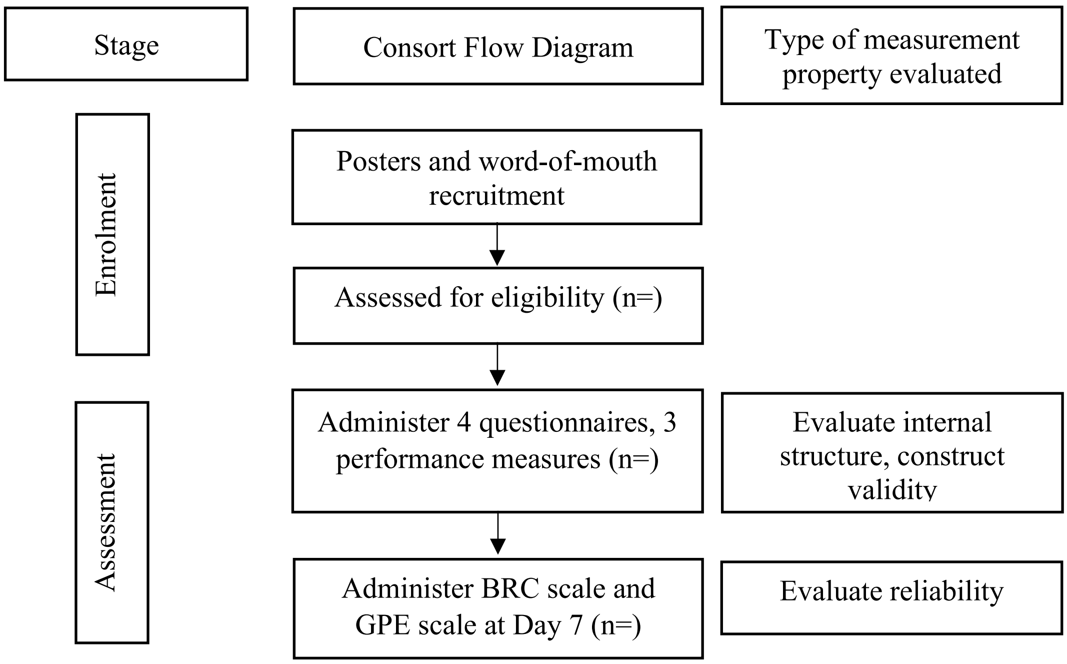

Figure 6.2 CONSORT flow diagram.

Sample size

The sample size is determined at 200 based on the recommendations made by Cappelleri et al. (2014) and De Vet et al. (2011). The determination of sample sizes in studies of PROM validation is, in part, dependent on the properties of the scale itself. The minimum sample size is calculated at four to ten participants per item of the scale (De Vet et al., 2011). BRC scale contains 19-item, which sets the minimum number of participants is 76. For classical test theory (CTT) measurement, an appropriate sample size provides rigorous quantitative analyses of standard errors. For the one-parameter Rasch model polytomous items analysis, the item difficulty (and person measure) calibration can be evaluated to be within one logit of a stable value with 95% confidence (Linacre, 1994). The sample size of 200 accommodates a dropout rate of up to 50%, would allow the psychometric properties of the newly developed scale to be adequately assessed with two measurement theories.

Statistical analysis

Quantitative data will be analysed and interpreted through two measurement test theories using IBM SPSS Statistic V.26.0 (for CTT) and Winsteps V.4.5.0 (for RMT). CTT is a traditional quantitative approach to test the validity and reliability based on its items (Cappelleri et al., 2014). This approach is based on the assumption that every observed score is a function of an individual's true score and random error (Tractenberg, 2010). To supplement evaluating the measurement instrument using CTT, RMT is employed to understand the probability of a person's level on an item as a function of the person's ability and the difficulty of the item. RMT evaluates a scale against a mathematical measurement model and analyses the scale at the level of each item and each person (Bond & Fox, 2015). CTT focuses on the total score of a measure, whereas RMT targets more specifically the characteristics of individual items. RMT will allow developers to establish whether an item's response scale is functioning as expected and, if not, suggest improvements.

Various psychometric properties are assessed using the CTT and the RMT. Factor analysis will be undertaken to assess the structural validity of the BRC scale and establish its unidimensionality. The acceptability of the BRC scale will be established by the percentage of missing data for each item and the percentage of people for whom a PROM score can be computed. The amount of missing item-level data less than 5% missing will be considered acceptable. Targeting is assessed by the score distribution, including skew of scale scores and presence of floor and ceiling effects through item-level response descriptive statistics. A low floor and ceiling effect will be defined as <15% of the sample (De Vet et al., 2011).

The Rasch model will empirically demonstrate how respondents use the BRC scale's rating, informing future iterations of the BRC scale to ensure it yields high-quality data (Bond & Fox, 2015). Tests of scaling assumptions examine item-total correlations, mean scores and SD. When checking for homogeneity, the heuristic that items should correlate with the total score above 0.20 will be applied. Item-total correlations will be calculated using the Pearson product-moment correlation. The internal consistency reliability of the BRC scale will be assessed by calculating inter-item and item-total correlations and Cronbach's alpha.

The person separation index (PSI) will estimate the spread or separation of the person on the measured variable (Bond & Fox, 2015). A PSI > 0.7 will be considered an adequate measure of reliability. Test-retest reliability of the total score will be assessed using the intraclass correlation coefficient (ICC). The scores are expected to remain stable with a high intraclass correlation of 0.80 hypothesized.

The construct validity of the BRC scale will be evaluated with the different outcome measures using Pearson's correlation coefficient. The item fit of actual observed response to Rasch model will be assessed by examining item infit and outfit statistics (Bond & Fox, 2015). Mean square standardized residual (MNSQ) within the 0.5-1.5 range is considered acceptable for productive measurement. Mean square values less than 0.5 indicate overfit (i.e., the items are too predictable relative to the Rasch model), while mean square values greater than 1.5 are indicative of too much noise (randomness) relative to the Rasch model (Bond & Fox, 2015).

The response category order will be assessed using the Rasch probability curves, examining the data for category disordering and threshold disordering (Linacre, 1994). The examination will indicate whether the response options selected are adequate or should be adjusted to provide better coverage of the latent trait, justifying whether the scale structure should be adjusted or sufficiently constructed.

6.5 Discussion

There is no existing PROM that measures balance recovery confidence in community-dwelling older adults. BRC scale aims to be meaningfully used in falls rehabilitation, especially in work focusing on improving the balance control of older adults. This protocol describes the rationale, design and methodology of developing the BRC scale based on well-established international guidelines for its purposeful use (De Vet et al., 2011).

6.6 Conclusion

Chapter 6 has described the psychometric properties prioritised for evaluation during the field testing of the BRC scale. If the BRC scale is found to have good psychometric properties, it will be a useful outcome measure of balance recovery confidence in community-dwelling older adults. This chapter has met the objective of detailing the study protocol on how the newly developed PROM will be field tested prior to reporting the findings of the BRC scale's psychometric properties in the next chapter.

Chapter 7

The Balance Recovery Confidence (BRC) scale: Initial evaluation of psychometric properties (Study 4)

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"The grand aim of all science is to cover the greatest number of empirical facts by logical deduction from the smallest number of hypotheses or axioms."

– Albert Einstein

7.1 Introduction

Chapter 7 presents the field testing of the BRC scale. A newly constructed PROM should be field tested to evaluate the suitability of its psychometric properties for use in clinical practice and research. Empirical evidence needs to demonstrate that the PROM is acceptable to the target population, reliable and valid (De Vet et al., 2011). Content validity was evaluated in Chapter 5. Criterion validity (the evaluation of the PROM against a gold standard for the construct to be measured) could not be tested since there is no such gold standard for balance recovery confidence. Construct validity, which refers whether the PROM provides the expected scores based on existing knowledge about the construct, would be tested, as would reliability - defined as the extent to which scores obtained for individuals who have not changed are the same for repeated measurement, such as scorings taken across two different times (test-retest).

This study was conducted in Singapore with 84 community-dwelling adults aged 65 and older had participated. The measurement instruments that were used for comparisons with the scores from the BRC scale included PROMs (the Activities-specific Balance Confidence, Falls Efficacy Scale-International and Late Life Function and Disability Instrument-Function scales) and performance-based measures (Handgrip strength dynamometer, 30-second Chair Stand test and Mini BESTest). Classical Test Theory and the Rasch Measurement Theory were used to present the acceptability, internal structure, reliability and validity of the BRC scale for the target population. The study was prospective lodged into Clinicaltrial.gov records (Appendix 5A). The study protocol had indicated that the study aimed to achieve a sample size target of 200, however, the number was curtailed by the COVID-19 pandemic. Nevertheless, the study was able to achieve a sample size of 84 to meet the minimum number of 76 participants needed for a PROM validation study. The statistical analysis methods were adjusted to accommodate a smaller sample size number. Ethical approvals were obtained from Queen Margaret University (Appendix 5B) and Singapore Institute of Technology (Appendix 5C) before study commencement. Informed consent was obtained from all participants. Templates have been listed in Appendix 5D and Appendix 5E. The study's findings have been shared in different platforms, such as the QMU DCA Annual Conference. The study is under review by an international peer-reviewed journal at the time of writing.

7.2 Abstract

This study aims to provide an initial evaluation of psychometric properties of a patient-reported outcome measure (PROM) that measures balance recovery confidence in community-dwelling older adults. Eighty-four community-dwelling older adults, aged 65 and older, completed the BRC scale, Activities-specific Balance Confidence (ABC) scale, Falls Efficacy Scale-International (FES-I) scale, Late Life Function and Disability Instrument-Function (LLFDI-F) scale and three performance measures (Handgrip strength dynamometer, 30-second Chair Stand, Mini BESTest). Classical Test Theory and the Rasch Measurement Theory were used to present the acceptability, internal structure, reliability, validity of the BRC scale.

The BRC scale was well accepted by community-dwelling older adults. The scale was unidimensional with good internal consistency (α = .975) and test-retest reliability (ICC = 0.944). BRC scale had moderate correlations with the ABC scale (.54), FES-I scale (.57), LLFDI-F scale (.41). These findings met the *a priori* hypotheses set for BRC scale compared against other PROMs. The findings of the relationship between BRC scale and performance measures were mixed when compared *a priori* hypotheses. The BRC scale was expected to have strong correlations with the different performance measures. The study found BRC scale to have negligible to weak correlation with handgrip strength (0.18), and 30-second chair stand test (0.09). This implied that balance recovery confidence is different from handgrip strength and lower limb strength performance. The BRC scale had moderate correlation with Mini BESTest (.51). The correlation found between BRC scale and Reactive Postural Control performance (.62) suggested that balance recovery confidence has a slightly closer congruence to reactive balance recovery performance than balance performance.

The BRC scale is a distinct PROM used to assess balance recovery confidence across various perturbation-type scenarios. The scale has excellent psychometric properties and has shown greater congruence to reactive postural control than the PROMs for balance confidence, fear of falling and perceived functional ability.

7.3 Background

Patient-reported outcome measures (PROMs) are increasingly used in clinical and research practice for assessing health outcomes from the patients' perspective (Wiering et al., 2017). PROMs offer distinct advantages, including the potential to empower patients, support clinical decision-making and drive clinical innovations (Kyte et al., 2015). PROMs with clearly defined constructs are clinically meaningful to guide practice and patient care (McKenna et al., 2019), whereas those with poor or unknown development methodology quality can risk unethically wasting resources (Ioannidis et al., 2014). Thus, selecting PROMs based on their key empirical clinimetric properties such as reliability and validity is paramount (Prinsen et al., 2018). The COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) initiative encourages this correct clinical practice and research usage (Prinsen et al., 2018).

In the context of fall management, different PROMs such as the Falls Efficacy Scale (FES) (Tinetti et al., 1990), modified Falls Efficacy Scale (mFES) (Hill et al., 1996), Activities-specific Balance Confidence (ABC) Scale (Powell & Myers, 1995), CONFbal scale of balance confidence (Simpson et al., 2009), Falls Efficacy Scale-International (FES-I) (Yardley et al., 2005), and Iconographical Falls Efficacy Scale (Icon-FES) (Delbaere et al., 2012) have been widely employed to measure different falls-related psychological concerns. Two systematic reviews examined the measurement properties of these PROMs (Jørstad et al., 2005; Moore & Ellis, 2008) but highlighted difficulties in deciphering congruence amongst targeted constructs and the assessment PROMs. The reviews elicited recommendations for robust clarification of the target construct and PROMs selected for their methodological quality (Hughes et al., 2015).

Reflecting the indispensable nature of prior reviewing of evidence to PROM's selection (De Vet et al., 2011), a systematic literature review on the content development and validity of existing falls efficacy PROMs was recently conducted (Soh, Lane, Xu, et al., 2021). The study found that two PROMs: the "Perceived Ability to Prevent and Manage Fall Risks" (PAMF) (Tennstedt et al., 1998) and the "Perceived Ability to Manage Risk of Falls or Actual Falls" (PAPMFR) (Yoshikawa & Smith, 2019), did not interpret falls efficacy synonymous with balance confidence. Instead, falls efficacy was interpreted as the perceived ability to manage a potential threat of a fall (Soh, Tan, et al., 2021). Different aspects of falls-related events, such as an individual's perceived self-efficacy to recover balance from perturbations, to land safely on lower ground, or to recover following a fall, were considered as potentially important factors for improving the capabilities of older people in managing the threat of falling (Soh, Tan, et al., 2021). The systematic review also reported an absence of items assessing balance recovery self-efficacy (confidence) amongst contemporary PROMs (Soh, Lane, Xu, et al., 2021). Falls efficacy, rooted within Bandura's self-efficacy theory (Bandura, 1977), reflects confidence in one's ability to manage different aspects of falling, therefore demands measurement by construct-specific tools (Bandura, 2006).

Balance confidence has been well understood as the perceived self-efficacy of performing activities without losing balance (Powell & Myers, 1995). In contrast, balance recovery confidence is distinct (Maki et al., 2008), relating to one's perceived ability of reactive balance recovery skills to arrest a fall (Maki & McIlroy, 2006). For example, whether one would be able to quickly grab a handrail to stop a fall from a slip when showering or whether one would be able to recover balance when falling backwards or forwards when climbing a flight of stairs without handrails. A PROM that measures balance recovery confidence is needed in fall management practice to quantify the impact of reactive balance abilities and have significant insights about managing tasks and situational demands in precarious scenarios, e.g., slip or trip or losing balance from volitional movements (Maki & McIlroy, 2006).

The Balance Recovery Confidence (BRC) scale has been constructed by the authors to offer a novel PROM for use in clinical practice and research studies. Its conceptual framework emerged from serial developmental studies and the literature's guidance, including Bandura's self-efficacy theory (Bandura, 1977) and Maki's change-in-support paradigm (Maki & McIlroy, 2006). This paper reports a preliminary assessment of the BRC scale's psychometric properties, including acceptability, dimensionality, internal structure, reliability, and validity.

7.4 Methods

Study setting

The study was registered under the clinicaltrials.gov registry (NCT04577365). A study protocol with a priori hypotheses was published (Soh, Lane, Gleeson, et al., 2021). Ethics approvals were obtained from the review committees of Queen Margaret University (Ref No.: REP0220) and Singapore Institute of Technology (Ref No.: 2020098).

Participants and procedure

A community-dwelling sample of older adults was recruited conveniently from Singapore Institute of Technology, St Luke's Hospital and through word-of-mouth recommendations. After meeting the eligibility criteria, participants' written consent was obtained. Participants had to be 65-year-old or older, able to read and write English, and were living independently in the community with or without the use of a walking aid. The exclusion criteria included an inability to provide informed consent, having clinical observable severe cognitive impairment, and needing physical assistance from another person to walk within the home. In the first session, participants completed four PROMs: The Late Life Function and Disability Instrument – Function (LLFDI-F) scale (Haley et al., 2002), ABC Scale (Powell & Myers, 1995), FES-I scale (Yardley et al., 2005) and the BRC scale. Participants then completed three physical performance tests: handgrip strength dynamometer (Durkin, 2014), 30-second chair stand test (Jones et al., 1999) and the mini-BESTest (Franchignoni et al., 2010). The Global Perceived Effect (GPE) scale (Kamper et al., 2010) and a retest of the BRC scale were administered in a second session arranged between one to two weeks later. The GPE was used as an exterior control criterion to evaluate the test-retest reliability of the BRC scale.

Self-reported Measures

Late Life Function and Disability Instrument – Function (LLFDI-F) scale (Haley et al., 2002): The LLFDI-F scale was used to evaluate the perceived difficulty that the person has in performing activities of daily living tasks. There were 32 items with response options of "none," "a little," "some," "quite a lot," and "cannot do." An additional eight items were given to those who used canes or walkers. The raw scores were transformed to scaled scores (0-100) using the score table (Haley et al., 2002). Scores closer to 100 indicated high levels of capability of participating in life tasks.

Activities-specific Balance Confidence (ABC) Scale (Powell & Myers, 1995): The ABC Scale was used to assess individuals' confidence in performing several progressively challenging balance and mobility tasks steadily. There were 16 questions, with answers ranging from 0% (no confidence) to 100% (complete confidence). The mean score was recorded. A higher score depicted a greater degree of confidence in performing activities without losing balance.

Falls Efficacy Scale – International (FES-I) scale (Yardley et al., 2005): The FES-I scale was used to measure the individual's concerns about falling relating to basic and more demanding activities. Sixteen questions were answered with a four-graded scale (1-4) of "not at all concerned", "somewhat concerned", "fairly concerned", and "very concerned". The total score, which ranged from 16 to 64, was recorded. A higher score reflected a greater level of concerns about falling.

Balance Recovery Confidence (BRC) scale (Soh, Gilmour, et al., 2021): The BRC scale assessed an individual's perceived ability to recover balance across several scenarios depicting different perturbations, e.g., a slip, a trip, or from volitional movements. Nineteen items were rated using an 11-point scale ranging from 0 (Cannot do at all) to 10 (Highly certain can do). The total score was 190, and the mean score was recorded. A higher score denoted a higher certainty of arresting a fall.

Performance Measures

Handgrip strength dynamometer: A hydraulic hand dynamometer (Lafayette Instrument, USA) was used to determine the isometric handgrip strength. Participants had to squeeze the dynamometer, and the highest maximum grip force (kg) obtained from both hands was recorded. The standardized protocol recommended by the NIHR Southampton Biomedical Research Centre guided the administration (Durkin, 2014).

30-second chair stand test (Jones et al., 1999): This quantitative measure was used to test functional lower extremity strength. Participants had to sit and stand from a chair without arms as many times as possible within 30 seconds. The test was administered by adopting the protocol recommended. The total number of sit-stands achieved was recorded.

Mini-BESTest (Franchignoni et al., 2010): The 14-item clinical test assessed four postural control systems: "Anticipatory Postural Adjustments" (sit to stand, rise to toes, stand on one leg), "Reactive Postural Responses" (stepping in 4 different directions), "Sensory Orientation" (stance – eyes open; foam surface – eyes closed; incline – eyes closed), and "Dynamic Gait" (gait during change speed, head turns, pivot turns, obstacles; cognitive "Get Up and Go" with dual-task). The total score was 28. A higher score depicted a greater level of functional balance. The score of the "Reactive Postural Responses" was used to inform reactive postural control (RPC). The range of RPC score was between 0 and 6, with 0 denoting fall or cannot step, and 6 being able to recover independently with a single, large step.

Sample size

Based on the study protocol presented in Chapter 6, the validation study aims to target 200 participants based on the recommendations made by Cappelleri et al. (2014) and De Vet et al. (2011). For classical test theory (CTT) measurement, an appropriate sample size provides rigorous quantitative analyses of standard errors. For the one-parameter Rasch model polytomous items analysis, the item difficulty (and person measure) calibration can be evaluated to be within one logit of a stable value with 95% confidence (Linacre, 1994). However, De Vet et al. (2011) also recommended that the determination of sample sizes in studies of PROM validation is also dependent on the properties of the scale itself (i.e., the minimum sample size is calculated at four to ten participants per item of the scale). Given that the BRC scale contains 19-item, this set the minimum number of participants for the initial validation study at 76. The mean square (fit) statistics would be relatively independent of the sample size for polytomous data (Smith et al., 2008).

Statistical analysis

A combination of classic and modern psychometric approaches, the Classical Test Theory (CTT) and Rasch Measurement Theory (RMT) were applied to analyse and interpret the quantitative data. The CTT is a traditional quantitative approach to test the validity and reliability based on its items (Cappelleri et al., 2014). This approach is based on the assumption that every observed score is a function of an individual’s true score and random error (Tractenberg, 2010). To supplement evaluating the measurement instrument using CTT, RMT is employed to understand the probability of a person's level on an item as a function of the person's ability and the difficulty of the item. RMT evaluates a scale against a mathematical measurement model and analyses the scale at the level of each item and each person (Bond & Fox, 2015). CTT focuses on the total score of a measure, whereas RMT targets more specifically the characteristics of individual items. RMT will allow developers to establish whether an item’s response scale is functioning as expected and, if not, suggest improvements. However, given that the minimum sample size of 76 was adopted, the statistical analysis method was updated to present the initial psychometric properties of the BRC scale. The statistical programs used to analyse the quantitative data were the R version 4.0.4 (R Core Team, 2020) and Winsteps version 4.8.2.0 (Linacre, 2021).

Acceptability and data completeness

The acceptability of the BRC scale was established by the extent to which the scale items were scored, the percentage of missing data for each item and the percentage of people for whom a

PROM score can be computed (De Vet et al., 2005). Less than 5% missing was considered acceptable. The score distribution, including skewness, was presented through item-level descriptive statistics.

Dimensionality

Confirmatory factor analysis was applied to quantify the extent of the BRC scale's expected unidimensionality. Analyses centred on COMIN's criteria (Prinsen et al., 2018).

Targeting of the items

The extend of congruence between the BRC scale and sample's expression of latent construct determined item-targeting. Scale scores spanning the entire range were examined. Floor and ceiling effects should not exceed 15% of the sample. Person-item threshold distribution mapping identified relative distributions of items that matched the range of the respondents' latent traits.

Mean square standardized residuals (MNSQ) assessed the exact fit of data modelling and any major quality-control problems of the BRC scale, with MNSQ < 0.5 and > 1.5 indicating overfit and too much noise, respectively.

Reliability

Cronbach's coefficient alpha calculated the BRC scale's internal consistency with values ⩾ 0.70 indicating adequacy. Intra-class coefficient (two-way agreement with the 95% confidence interval) indicated test-retest reliability, while person separation index (PSI) estimated the scale's capability for differentiating amongst individuals' responses, with > 0.7 reflecting sufficiency.

Construct validity

The hypotheses were made a priori in the study protocol (Soh, Lane, Gleeson, et al., 2021). The correlation coefficients between outcome measures were established using Spearman's rho.

7.5 Results

Participants

Eight-four participants were recruited from January to May 2021. The mean age of participants was 71.1 years (SD 4.5), and 59.5% were women. The characteristics of the participants are listed in Table 7.1. Five participants' data were not used for the test-retest reliability analysis. This was because three participants did not complete the retest of the BRC scale because of Covid-19 regulatory restrictions and two participants reported a fall before the retest assessment.

Acceptability and data completeness

The distribution of responses was broad across the score categories (Table 7.2). All response options (0-10) were used in all items except for three items (Items 3, 10 and 11), for which used response options ranged from 2 to 10. There were no missing scores. All participants completed the BRC scale. The distribution of the BRC scale scores was identified to have no significant departures from normality ($W=.97$, $p = 0.05$), with skewness of -0.32, kurtosis of -0.63 (SEM 0.22) (Table 7.3).

Table 7.1 Demographic characteristics of the participants.

Variables	n = 84
Age (years)	
Mean (SD)	71.1 (4.5)
Minimum – maximum	65 - 84
Gender	
Female (%)	50 (59.5)
Male (%)	34 (40.5)
Educational level	
Primary (%)	3 (3.6)
Secondary (%)	38 (45.2)
College/ University (%)	43 (51.2)
Living situation	
Alone (%)	12 (14.3)
With spouse (%)	50 (59.5)
With family / nonfamily (%)	22 (26.2)
Housing type[a]	
3-room (%)	6 (7.1)
4-room (%)	14 (16.7)
5-room / executive flat (%)	22 (26.2)
Condominium (%)	22 (26.2)
Landed (%)	20 (23.8)
More than three chronic conditions (%)	31 (36.9)
Walking independently without aids (%)	83 (98.8)
Experience one or more falls in the previous year (%)	29 (34.5)
Fall related psychological constructs baseline presentation	
Mean score of balance confidence (SD) (Range: 0-100)	89.19 (12.5)
Mean score of balance recovery confidence (SD) (Range: 0-10)	6.67 (2.05)
Mean score of fear of falling (SD) (Range: 16-64)	24.23 (7.07)
Mean score perceived difficulty of performing activities of daily living (SD) (Range: 0-100)	70.57 (12.31)
Physical performance	
Mean score of highest maximum grip strength in kg (SD)	24.65 (7.077)
Mean score of total number of sit-to-stand (SD)	15.36 (4.88)
Mean score of balance performance (SD) (Range: 0-28)	22.19 (3.02)

[a]Housing type: A person’s means are reflected by the type of property, with private condominiums and landed property being a more expensive option than public housing (3-, 4- and 5-room apartments). There are increasing government efforts to make both public and private housing older person friendly.

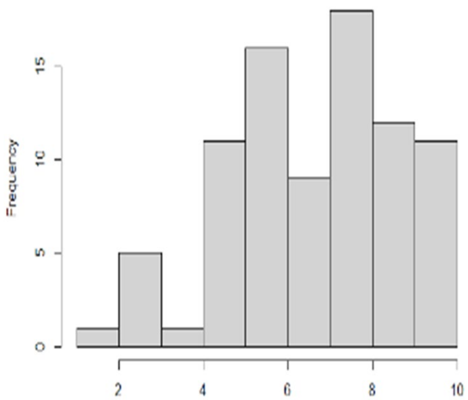
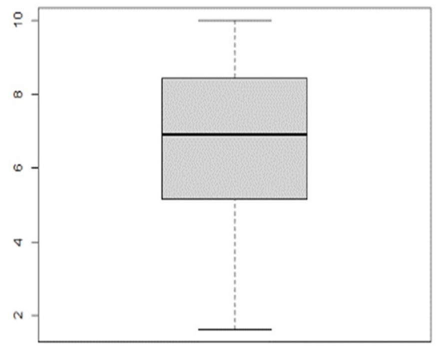
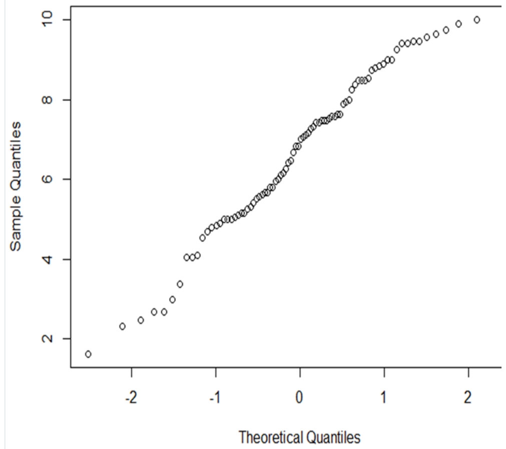
Table 7.2 Distribution of the sample population (n = 84) across the response categories of the Balance Recovery Confidence (BRC) scale.

BRC Scale Item	Distribution of responses (%) across 11 categories										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BRC1: Recover from a loss of balance while walking up a flight of steps without railings.	5.95	1.19	7.14	7.14	8.33	19.05	9.52	10.71	13.10	7.14	10.71
BRC2: Recover from a loss of balance while walking down a flight of steps without railings.	3.57	3.57	10.71	7.14	4.76	19.05	9.52	13.10	10.71	9.52	8.33
BRC3: Recover from a loss of balance while walking to the toilet.	0.00	0.00	2.38	2.38	1.19	19.05	4.76	15.48	13.10	20.24	21.43[a]
BRC4: Recover from a minor slip on a puddle of water.	3.57	1.19	5.95	7.14	4.76	16.67	13.10	5.95	17.86	13.10	10.71
BRC5: Recover from falling backwards when a vehicle (e.g., bus, train or tram) accelerates suddenly.	4.76	3.57	2.38	7.14	5.95	15.48	11.90	10.71	13.10	13.10	11.90
BRC6: Recover from falling forwards when a vehicle (e.g., bus, train or tram) stops suddenly.	2.38	3.57	3.57	2.38	5.95	20.24	10.71	9.52	14.29	15.48	11.90
BRC7: Recover from a minor slip while taking a shower.	2.38	4.76	1.19	1.19	9.52	14.29	11.90	15.48	15.48	13.10	10.71
BRC8: Recover from a loss of balance while stepping onto the escalator.	1.19	0.00	3.57	3.57	3.57	15.48	10.71	14.29	17.86	14.29	15.48[a]
BRC9: Recover from a loss of balance while stepping off the escalator.	1.19	0.00	2.38	4.76	5.95	8.33	7.14	17.86	19.05	16.67	16.67[a]

BRC Scale Item	Distribution of responses (%) across 11 categories										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BRC10: Recover from a loss of balance while doing light exercises (e.g., stretching).	0.00	0.00	2.38	1.19	4.76	15.48	3.57	17.86	14.29	16.67	23.81[a]
BRC11: Recover from falling forwards while walking down a gentle slope.	0.00	0.00	4.76	0.00	3.57	22.62	9.52	14.29	17.86	11.90	15.48[a]
BRC12: Recover from a trip while carrying groceries with both hands.	4.76	1.19	5.95	4.76	3.57	25.00	10.71	15.48	10.71	8.33	9.52
BRC13: Recover from a loss of balance while stepping over an object or obstacle (e.g., a one foot/30.48 cm wide drain).	4.76	1.19	3.57	5.95	7.14	23.81	10.71	8.33	15.48	13.10	5.95
BRC14: Recover from a loss of balance while avoiding a collision with another person (e.g., a jogger or a child on a bicycle).	1.19	0.00	1.19	7.14	4.76	17.86	11.90	13.10	17.86	9.52	15.48[a]
BRC15: Recover from a loss of balance while reaching for overhead objects.	1.19	0.00	3.57	4.76	7.14	11.90	13.10	15.48	15.48	13.10	14.29
BRC16: Recover from a loss of balance while standing on a stool.	5.95	1.19	4.76	4.76	9.52	16.67	10.71	9.52	17.86	9.52	9.52
BRC17: Recover from a loss of balance while getting dressed in standing.	1.19	1.19	0.00	4.76	1.19	19.05	9.52	8.33	16.67	17.86	20.24[a]
BRC18: Recover from a loss of balance while getting out of bed.	0.00	0.00	1.19	2.38	0.00	14.29	8.33	14.29	15.48	16.67	27.38[a]
BRC19: Recover from falling backwards after standing up from a chair.	4.76	0.00	2.38	2.38	1.19	13.10	8.33	15.48	11.90	19.05	21.43[a]

[a]The score distribution reflected that more than 15% of the participants in the extreme high-end category scored for the item. This indicated a ceiling effect for the items.

Table 7.3 Testing normality of the sample completing the Balance Recovery Confidence (BRC) Scale. The BRC average scores were plotted using - Histogram (3a), box and whisker plot (3b), normal QQ plot (3c), a normally distributed sample with 84 observations. The Shapiro-Wilk statistic associated with these data is W=.97, indicating no significant departures from normality were detected (p = .048).

(3a) Histogram of BRC average score.	(3b) Boxplot of BRC average score.	(3c) QQ plot of BRC average score.
		

Dimensionality

The data demonstrated that the BRC scale was unidimensional (See Table 7.4). A single factor loading of each item ranged from 0.727 to 0.921. The standardized root mean square residual (SRMR) was 0.057, meeting the criteria of < 0.08. Comparative fit index (CFI) and Tucker-Lewis Index (TFL) scores of 0.792 and 0.767, respectively, suggested that some improvement could be made for the structural validity of BRC scale in this sampled population. The uniqueness of the items in the BRC scale was low (0.15 to 0.47), which indicated that the variation in each item could be explained by the latent construct of balance recovery confidence.

Targeting of the items

There was no floor effect for all items (Table 7.2). Nine items (Items 3, 8, 9, 10, 11, 14, 17, 18, 19) were identified as having a ceiling effect, indicating that these items were easy for the sample population. The Wright map reflected that the BRC scale was well matched to the sample population (Figure 7.1). The sample population had a range of trait abilities from low to high level of balance recovery confidence. The item difficulty level was well structured without being extremely difficult or extremely easy.

The modelling fit statistics showed person ability estimate means of 0.86 logits (SD 1.46), which implied that this sample of older adults found the items in the BRC scale to be moderately challenging. A mean person ability estimates close to 0 demonstrated an average trait ability of the sample population. This implied that the trait ability was not of extremely high confidence or extremely low confidence. The standard deviation of 1.46 logits for the person estimate indicated an adequate spread of person measures. The mean of the infit and outfit mean squares, at 1.03 and 1.01, respectively, were harmonious with the Rasch-modelled expectations of 1. This indicated the data fitted well to the probabilistic Rasch model specification. The standardized fit Z values were around zero (infit Z = -0.5; outfit Z = -0.5). The variation of modelled fit scores for persons (infit Z SD = 2.3 and outfit Z SD = 2.3) suggested that most person ability estimates were transformed within the fit statistics. Five items (Items 2, 12, 14, 11, 15) were out of the conventionally accepted range of –2 to +2. Fourteen items in the BRC scale were graphically represented in a bubble chart to illustrate the measures and fit values (Figure 7.2).

Table 7.4 Evaluating the internal structure of the Balance Recovery Confidence (BRC) Scale using a combination of classic and modern psychometric approaches.

	Descriptive Analysis					**Rasch Analyses**		**Factor Analysis**	
	Mean	**SD**	**Median**	**Item difficulty**	**Item discrimination**	**Measure (logit)**	**Ability**	**Factor loading[a]**	**Uniqueness[b]**
Item 1	5.74	2.79	6	0.57	0.81	0.50	Mod. high	0.809	0.35
Item 2	5.64	2.76	6	0.56	0.76	0.54	Mod. high	0.763	0.42
Item 3	7.50	2.14	8	0.75	0.79	-0.47	Mod. low	0.808	0.35
Item 4	6.25	2.69	6	0.62	0.82	0.24	Mod. high	0.837	0.30
Item 5	6.19	2.79	6	0.62	0.83	0.27	Mod. high	0.829	0.31
Item 6	6.46	2.61	7	0.65	0.83	0.13	Mod. high	0.828	0.31
Item 7	6.49	2.52	7	0.65	0.82	0.12	Mod. high	0.834	0.30
Item 8	7.00	2.30	7	0.70	0.85	-0.16	Mod. low	0.871	0.24
Item 9	7.21	2.29	8	0.72	0.84	-0.29	Mod. low	0.870	0.24
Item 10	7.54	2.14	8	0.75	0.76	-0.49	Mod. low	0.789	0.38
Item 11	6.99	2.15	7	0.70	0.88	-0.16	Mod. low	0.894	0.20
Item 12	5.95	2.59	6	0.60	0.74	0.39	Mod. high	0.727	0.47
Item 13	5.98	2.56	6	0.60	0.82	0.38	Mod. high	0.833	0.31
Item 14	6.79	2.29	7	0.68	0.87	-0.04	Mod.	0.880	0.23
Item 15	6.81	2.34	7	0.68	0.91	-0.06	Mod.	0.921	0.15
Item 16	6.01	2.73	6	0.60	0.83	0.36	Mod. high	0.838	0.30
Item 17	7.27	2.33	8	0.73	0.75	-0.33	Mod. low	0.749	0.44
Item 18	7.79	2.01	8	0.78	0.79	-0.66	Mod. low	0.797	0.36
Item 19	7.21	2.62	8	0.72	0.76	-0.29	Mod. low	0.765	0.42

[a]Factor loading: The conventional, accepted cutoff of 0.40 is referred to as a meaningful factor loading. The data reflected that BRC scale is unidimensional.

[b]Uniqueness: Referred to as noise, which corresponds to the proportion of variability. The score ranges from 0 to 1. A high uniqueness for a variable indicates that the factors do not account well for its variance.

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MEASURE   PERSON - MAP - ITEM
              <more>|<rare>
    5           XX  +
                    |
                 X  |
    4               +
                 X  |
                 X  |
    3          XXX T+
                XX  |
                 X  |
    2       XXXXXX S+
             XXXXX  |
              XXXX  |
    1  XXXXXXXXXXX  +
          XXXXXXXX M|T BRC2
           XXXXXXX  |S BRC1   BRC12  BRC13  BRC16  BRC4   BRC5
    0 XXXXXXXXXXXX  +M BRC11  BRC14  BRC15  BRC6   BRC7   BRC8
        XXXXXXXXXX S|S BRC10  BRC17  BRC19  BRC3   BRC9
              XXXX  |T BRC18
   -1         XXXX  +
                XX  |
                   T|
   -2               +
              <less>|<freq>
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Figure 7.1 Wright map: The item-person map. The item description refers to the respective items listed in Table 2 BRC Scale items.

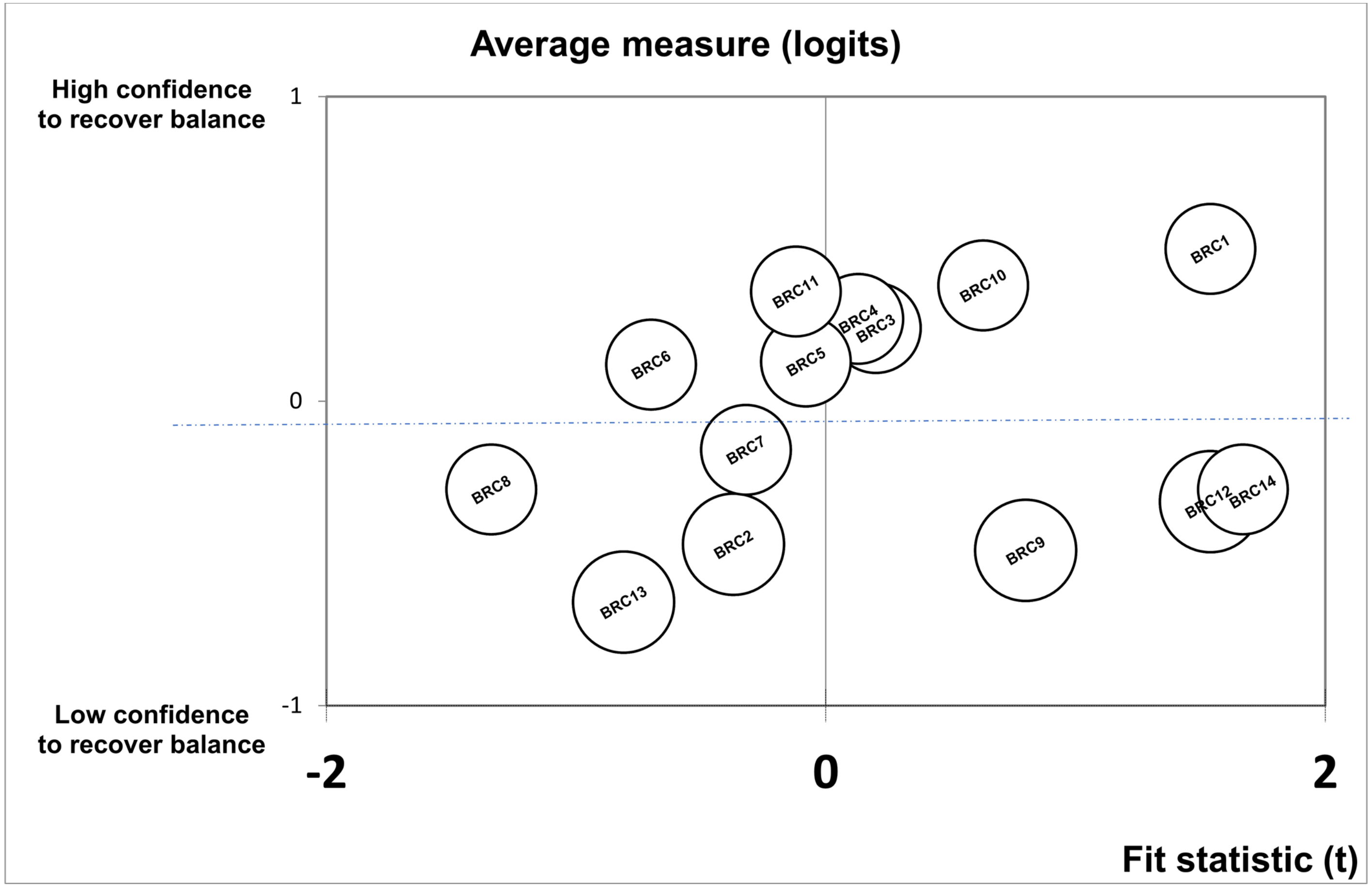

Figure 7.2 Bubble chart as a graphical representation of measures and fit values. Bubbles are named after the items listed in Table 7.2. Items assessing "high confidence" are at the top of the confidence continuum (positive logits), and items assessing "low confidence" are at the bottom (negative logits).

Reliability

The BRC scale had excellent internal consistency (α = .975). The reliability of the person ability estimates and the item difficulty estimates were high, indicated by 0.93 (person separation =3.76) and 0.94 (item separation = 3.99), respectively. The test-retest reliability was excellent (ICC = 0.944, CI of 0.891 to 0.969). The BRC scale's stability was calculated using 79 participants because two participants reported a fall before the retest assessment.

Construct validity

Moderate positive correlations were identified between the BRC scale, ABC scale, LLFDI scale, and Mini BESTest (Table 7.5). The BRC scale and the FES-I scale had a moderate negative correlation. There were weak correlations between the BRC scale, handgrip strength dynamometer, and 30-second chair stand test. The BRC scale and the reactive postural control section of Mini-BESTest (Section 4-6) were strongly correlated. The *a priori* hypotheses identified correlations: ≤ 0.29, 0.30-0.59, and ≥ 0.6 as weak, moderate, strong respectively.

Table 7.5 Correlation matrix for the four different PROMs and three performance measures.

Measures[a]	BRC	ABC	FES-I	LLFDI-F	HSD	CST	MBT	RPC
BRC	1.00	0.54	- 0.57	0.41	0.18	0.09	0.51	0.62
ABC	0.54	1.00	- 0.86	0.74	0.18	0.06	0.53	0.57
FES-I	- 0.57	- 0.86	1.00	- 0.68	- 0.08	- 0.09	- 0.43	- 0.54
LLFDI-F	0.41	0.74	- 0.68	1.00	0.31	0.13	0.51	0.50
HSD	0.18	0.18	- 0.08	0.31	1.00	0.17	0.26	0.23
CST	0.09	0.06	- 0.09	0.13	0.17	1.00	0.13	0.12
MBT	0.51	0.53	- 0.43	0.51	0.26	0.13	1.00	0.86
RPC	0.62	0.57	- 0.54	0.50	0.23	0.12	0.86	1.00

[a]Types of outcome measures are BRC: Balance Recovery Confidence scale, ABC: Activities-specific Balance Confidence Scale, FES-I: Falls Efficacy Scale – International scale, LLFDI-F: Late Life Function and Disability Instrument – Function, HSD: Handgrip strength dynamometer, CST: 30-second chair stand test, MBT: Mini-BESTest, RPC: Reactive postural control

7.6 Discussion

This study reports the initial assessment of psychometric properties of the BRC scale, which is well accepted by the sample of community-dwelling older adults in Singapore, measures a single factor, has good internal consistency and excellent stability. The study demonstrated the consistency of a priori hypotheses for relationships amongst the BRC scale and three other PROMs (ABC scale, FES-I scale, and LLFDI-F scale), but inconsistency for those amongst BRC scale and the three performance measures (Handgrip strength dynamometer, 30-second Chair Stand, and Mini BESTest). The latter could be attributable to self-reported measures and performance measures determining different aspects of functioning (Silva et al., 2015). Balance recovery is a dynamic motor skill requiring the elicitation of appropriate and rapid postural responses (Pijnappels et al., 2008); single task measures may not fully reflect this complexity. Postural control and muscle strength have been considered as different neuromuscular capacities (Granacher et al., 2011). Future studies could consider comparing BRC scale against other performance-based measures, such as the Choice Stepping Reaction Time Test (Lord and Fitzpatrick, 2001), Four Square Step Test (Dite and Temple, 2002), Perturbation-based Step and Grasp Reaction Test (Mansfield et al., 2010), Stepping Agility Test (Miyamoto et al., 2008), Voluntary Step Execution Test (Melzer et al, 2007), Gait Variability Test (Brach et al., 2008), Cognitive-Motor Dual-Task Paradigm Test (Langeard et al., 2021), and Timed Backward Walk Test (Hackney et al., 2009). A greater insight of the BRC scale compared against different measurement instruments designed for other performance-related constructs would deepen the understanding of the relationships between balance recovery confidence and physical performance such as voluntary motor movements, reactive movements, cognitive-motor dual-tasking demands, and varying locomotor tasks.

The evaluation of the BRC scale using a combination of classic and modern psychometric approaches for a sample of high functioning community-dwelling older adults had provided some interesting observations. First, the difficulty level of the 19 ‘near-fall’ scenarios were appropriately designed for a population of community-dwelling older adults who are functioning independently across indoor and outdoor environments. All items demonstrated no floor effect, reflecting that the completing the BRC scale was not too difficult for the target population. However, nine items (Item 3: Recover from a loss of balance while walking to the toilet, Item 8: Recover from a loss of balance while stepping onto the escalator, Item 9: Recover from a loss of balance while stepping off the escalator, Item 10: Recover from a loss of balance while doing light exercises (e.g., stretching), Item 11: Recover from falling forwards while walking down a gentle slope, Item 14: Recover from a loss of balance while avoiding a collision with another person (e.g., a jogger or a child on a bicycle), Item 17: Recover from a loss of balance while getting dress in standing, Item 18: Recover from a loss of balance while getting out of bed, Item 19: Recover from falling backwards after standing up from a chair) may be too easy. These scenarios should be explored for different target populations, such as frail older adults, those with stroke or Parkinson's, who may have more difficulty to arrest falls. The perceived ability to recover balance may potentially be more difficult for those with lower physical capacity and capabilities. Second, through the RMT, most individual items of the BRC scale were found to meet the Rasch model fit statistics. Five misfitting items were identified (Item 2: Recover from a loss of balance while walking down a flight of steps without railings, Item 12: Recover from a trip while carrying groceries with both hands, Item 14: Recover from a loss of balance while avoiding a collision with another person (e.g., a jogger or a child on a bicycle), Item 11: Recover from falling forwards while walking down a gentle slope, Item 15: Recover from a loss of balance while reaching for overhead objects). This suggested some uncertainty whether these items were appropriate for the target population. These items may need to be rewritten for better clarity or be eliminated. A more robust Rasch model using large sampling would provide better insights to inform the decision.

Nevertheless, there are several advantages to using the present version of the BRC scale. First, the BRC scale contains a broad range of realistic scenarios that could be used as discussion points with older adults. Second, the BRC scale generates information about an individual's perceived reactive balance recovery abilities. This would give a greater understanding of falls efficacy in older adults. Third, it could be useful as a PROM to evaluate the efficacy of interventions targeting reactive balance recovery, e.g., perturbation training. The 19-item BRC scale is easy to administer and needs about five to seven minutes to complete. It provides complementary information alongside other PROMs for different falls-related psychological constructs, e.g., balance confidence or fear of falling. Limitations to using the BRC scale include that the scale was constructed in English, field-testing was done in Singapore, and its responsiveness is still unknown. Further studies are needed to establish the BRC scale's clinical utility fully and to illuminate more of its measurement properties.

7.7 Conclusion

Chapter 7 has reported the psychometric properties of the newly developed BRC scale. Before this body of work, there has been an absence of a PROM specifically assessing balance recovery confidence. The Balance Recovery Confidence scale with its content developed and validated among community-dwelling older adults and healthcare professionals showed good psychometric properties that support its use in falls practice for older people. The objectives of study 4 were met as follow:

Objective 1: To assess the acceptability of the newly developed PROM among community-dwelling older adults.

Acceptability refers to whether the target population is willing to do something or not (De Vet et al., 2011). The acceptability of the BRC scale among community-dwelling older adults was good given that there were no missing data for all items; the older adults completed all questions.

Objective 2: To examine the factor structure of the newly developed PROM.

Factor analysis examined the dimensionality of the data. The BRC scale was constructed to be unidimensional, therefore confirmatory factor analysis was applied to test whether the data fitted a predetermined factor structure. Using the COSMIN criteria (2021), the BRC was shown to measure a single factor. However, further improvements, such as removal of redundant items, could improve its structural validity.

Objective 3: To evaluate the psychometric properties of the newly developed PROM with Singapore community-dwelling older adults.

Internal structure: The difficulty of items was considered appropriate for the target population. While no floor effect was observed for any of the items, nine items had a ceiling effect which implied that these items might be oversimple for the sample population. Based on Rasch Measurement Theory, the BRC scale had good targeting within the sample population; use of the person-item measure distribution map showed that the difficulty level of the BRC's items was appropriate for older adults with a wide range of balance recovery confidence.

Reliability: Test-retest reliability (ICC = 0.944, CI of 0.891 to 0.969) and internal consistency (α = .975) were excellent. The reliability of the BRC scale for person ability estimates (0.93 with person separation index of 3.76) and item difficulty estimates (0.94 with item separation index of 3.99) were excellent.

Construct validity: The BRC scale demonstrated good construct validity through challenging hypotheses. There was consistency of *a priori* hypotheses with other PROMs (ABC, FES-I scale and LLFDI-F scales). The BRC scale had moderate correlations with these PROMs. However, inconsistencies between *a priori* hypotheses and performance-based measures (Handgrip strength dynamometer, 30-second chair stand test, and Mini-BESTest) were found. The correlations found between BRC scale and Mini BESTest (.51), and between BRC scale and Reactive Postural Control performance (.62) suggested that balance recovery confidence could have a slightly closer congruence to reactive balance recovery performance than balance performance. This suggested that the theoretical understanding of relationships between balance recovery confidence, strength and balance performance need further exploration.

Chapter 8

Research dissemination

“ Impact is the good that researchers can do in the world.”

– Mark Reed.

8.1 Introduction

The term "research impact" includes the economic and societal contribution of research as well as its academic effect (Economic and Social Research Council, 2021). Impact should be considered throughout the endeavour of undertaking robust research so that knowledge can be generated and transformed to benefit society as a whole (Penfield et al., 2014). Generally, impact is rich and is not easily quantifiable. While some impacts can be described immediately, others unfold from accumulated knowledge. Presently, the impact from the development of the BRC scale is unknown. However, research outputs have emerged from the work via various platforms, such as conference sharing, publications, and professional network peer sharing.

Three publications have been reported to present the potential of influencing the future practice of falls prevention and management for older adults and PROMs development. The first publication, 'Falls efficacy: Extending the understanding of self-efficacy in older adults towards managing falls' was written following the completion of the systematic review on falls efficacy-related measurement instruments. Recognising that falls efficacy should be conceptualised with a broader interpretation beyond balance confidence, the publication aimed to encourage the adoption of an integral approach towards understanding falls efficacy by incorporating balance confidence, balance recovery confidence, safe-landing confidence, and post-fall recovery confidence. The second publication, 'Researcher as instrument: A critical reflection using nominal group technique for content development of a new patient-reported outcome measure' followed the completion of the content development of the BRC scale. The publication aimed to share reflective insights of the role of researchers in the development of a PROM. Applying essential practice skills, such as reflectivity and reflexivity, could encourage a person-centred practice of a PROM development. The third publication, 'Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders' reported the insights generated from the different stakeholders involved to develop the BRC scale's content. Having different stakeholders involved in the content development process would generate rich and meaningful insights for PROM developers. The publication aims to encourage other PROM developers to consider the involvement of different stakeholders when developing a PROM.

8.2 Research output 1

Falls efficacy: Extending the understanding of self-efficacy in older adults towards managing falls

Published as:

Soh, S. L. H., Tan, C. W., Thomas, J. I., Tan, G., Xu, T., Ng, Y. L., & Lane, J. (2021). Falls efficacy: Extending the understanding of self-efficacy in older adults towards managing falls. Journal of Frailty, Sarcopenia and Falls, 21(21), 131-138. https:doi.org/10.22540/JFSF-06-131

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8.2.1 Abstract

Falls efficacy is a widely studied construct. The understanding of falls efficacy has evolved over time. Falls efficacy was initially perceived to be suitably used as a measure of fear of falling. However, further research suggested that falls efficacy and fear of falling are distinct constructs, and therefore, would be inappropriate to be used as a proxy. Instead, some researchers posited that falls efficacy is synonymous with balance confidence. Falls efficacy has been conventionally understood as the perceived ability of individuals to perform activities without losing balance or falling. A recently conducted systematic review by the authors on existing falls efficacy related measures had revealed a fresh perspective of recognising falls efficacy as a perceived ability to manage a threat of a fall. Falls efficacy, with a broadened interpreted construct, relates to the individual's perceived self-efficacy of performing necessary actions needed in different scenarios, including pre-fall, near-fall, fall-landing and completed fall. The conventional interpretation of falls efficacy needs a rethinking of perspective. An extended understanding of falls efficacy would provide an integral approach towards improving the agency of individual to deal with falls and would enhance person-centred care.

8.2.2 Introduction

Falls efficacy was first introduced by Tinetti et al. (1990) to our community of clinicians and researchers in the field of gerontology as a potential construct used to determine fear of falling. Using Bandura's self-efficacy theory (1977), fear of falling was interpreted as low perceived self-efficacy in performing various activities, taking into account one's personal risk to experience a potential fall. The approach of assessing fear of falling was to ask individuals about their confidence in performing various activities without falling. Those who reported a significant lack of confidence were viewed to have a fear of falling (Tinetti et al., 1990). This initial conceptualisation of falls efficacy and fear of falling used in parallel led to much inquiry towards the perceived ability in older adults to manage falls (Hadjistavropoulos et al., 2011).

Over the last three decades, falls-related research has been focused on providing empirical evidence for different rehabilitation approaches on their efficiency and effectiveness towards improving falls efficacy or to address the fear of falling (Lachman et al., 1998; Bjerk et al., 2017). The understanding of falls efficacy has evolved. This article aims to provide a review of falls efficacy, highlight some current rehabilitation practices, and reiterate the importance of person-centred care through our reflection of falls efficacy.

8.2.3 Understanding falls efficacy

Self-efficacy relates to the individual's perception of one's capabilities to successfully complete a specific task or perform in a specific scenario (Bandura & Schunk, 1981). Self-efficacy is viewed as a measurable cognitive mechanism that mediates between thoughts/emotions and actions (Bandura, 1982). In contrast, the construct of fear is accounted for by both emotional aspects, e.g., anxiety and behavioural elements, e.g., activity avoidance (Hughes et al., 2015). Fear of falling commonly describes an exaggerated concern of falling that leads to excess restriction of activities (Abyad & Hammami, 2017). Given the different nature of self-efficacy and fear, different authors including Li et al. (2002), Hotchkiss et al. (2004), Hadjistavropoulos et al. (2007) and Hughes et al. (2015), have attempted to distinguish between falls efficacy and fear of falling.

Falls efficacy has been defined as the perceived self-efficacy to perform activities of daily living without falling (Tinetti et al., 1990). Stemmed from this perspective, the Falls Efficacy Scale (FES), the first measure of falls efficacy, was developed by clinicians to identify the "most important activities essential to independent living, that while requiring some position change or walking, would be safe and non-hazardous to most elderly persons" (Tinetti et al., 1990). Fear of falling, on the other hand, has been defined as the lasting concerns about falling that leads to an individual avoiding activities that one remains capable of performing (Hughes et al., 2015).

An early measure for this fear, the Falls Efficacy Scale – International (FES-I), was developed by colleagues from the Prevention of Falls Network Europe (ProFaNE). The original FES has been modified to assess the level of concern about falling when carrying out various activities (Yardley et al., 2005). Another construct, balance confidence, has also been studied closely alongside falls efficacy. The first measure of balance confidence, the Activities-specific Balance Confidence (ABC) scale, was constructed by having similar questions used for falls efficacy posed to clinicians and older adults (Powell & Myers, 1995). Recognising that the measures of falls efficacy and balance confidence had high correlations, Hadjistavropoulos et al. (2011) posited that falls efficacy had a tautological relationship to balance confidence and that the two constructs should be viewed to be "equivalent and interchangeable".

Since the original development of the FES and the ABC, different methodologies have been used to develop other measures for the different falls-related psychological constructs. In essence, measures of falls efficacy or balance confidence have been designed to understand the perceived ability of individuals to maintain balance while performing various activities. On the other hand, measures of fear of falling aim to identify the level of concerns about falling among older adults spanning different activities. Some widely used measures for the different constructs are listed in Table 8.2.1. The term "Falls Efficacy" was retained in the title for the measure of fear of falling to acknowledge the historical development of the scale (Yardley et al., 2005). It is necessary to reiterate that the fear measures such as the FES-I (Yardley et al., 2005) and the Iconographical FES (Icon-FES) (Delbaere et al., 2011) were conceptualised to measure the concerns of individuals about falling or fear of falling, and not falls efficacy.

Table 8.2.1 List of measures used for different constructs.

Construct	Definition
Falls efficacy	Perceived self-efficacy to perform activities of daily living without falling
Instruments	
FES-10, MFES-11, MFES-12, MFES-13, MFES-14, PAPMFR, PAMF	
Construct	**Definition**
Fear of falling	The lasting concerns about falling that leads to an individual avoiding activities that one remains capable of performing
Instruments	
FES-I, Icon-FES, GFFM, UIC FFM, SAFE, FFABQ, FFQ-R	
Construct	**Definition**
Balance Confidence	The individual's belief about their ability to maintain balance whilst performing activities of daily living
Instruments	
ABC-6, ABC-15, ABC-16, CONFbal	

FES: Falls Efficacy Scale, MFES: Modified Falls Efficacy Scale, PAPMFR: Perceived Ability to Prevent and Manage Fall Risks, PAMF: Perceived Ability to Manage Risk of Falls or Actual Falls, FES-I: Falls Efficacy Scale – International, Icon-FES: Iconographical Falls Efficacy Scale, GFFM: Geriatric Fear of Falling Measure, UIC FFM: University of Illinois at Chicago Fear of Falling Measure, SAFE: Survey of Activities and Fear of Falling in the Elderly, FFABQ: Fear of Falling Avoidance Behaviour Questionnaire, FFQ-R: Fear of falling questionnaire revised, ABC: Activities-specific Balance Confidence scale, CONFbal: CONFbal scale of balance confidence

As falls-related research advances, the interpretation of falls efficacy has changed. The initial understanding of falls efficacy, which had been interpreted as a measure of fear of falling in the 1990s, had several advantages (Tinetti et al., 1990). First, the operationalisation allowed objective, reliable and valid strategies to be developed based on measuring efficacy across a range of activities. Second, a measure of fear of falling could be made using a continuous scale response option. Third, associating fear with self-efficacy mitigated the perception that fear of falling was a psychiatric condition. However, further research revealed that falls efficacy and fear of falling, despite being highly correlated, were distinct constructs and should be measured separately by different measurement instruments (Hadjistavropoulos et al., 2011).

Falls efficacy was viewed to have a tautological relationship with balance confidence in the 2000s (Hadjistavropoulos et al., 2011) and was addressed through clinical strategies focused on improving balance, strength and increasing the level of physical activities among older adults (Arai et al., 2007; Rochat et al., 2008). To avoid any misinterpretation of the construct of interest, several authors such as Jorstad et al. (2005), Moore et al. (2008) and Hughes et al. (2015) called for the clinical and research community to clarify their construct of interest. These included areas in falls efficacy amongst other falls-related psychological constructs, including fear of falling, balance confidence and outcome expectancy, alongside selected measures.

Recently, a systematic review of different falls-efficacy related measurement instruments suggested that the interpretation of falls efficacy should be extended beyond the synonymous interpretation of falls efficacy and balance confidence (Soh, Lane, Xu, et al., 2021). To justify that call, two fall efficacy related scales, the “Perceived Ability to Prevent and Manage Fall Risks” (PAMF) (Tennstedt et al., 1998) and the “Perceived Ability to Manage Risk of Falls or Actual Falls” (PAPMFR) (Yoshikawa & Smith, 2019), were highlighted among eighteen other measurement instruments. Developers of PAMF and PAPMFR conceptualised falls efficacy based on a formative model, where many measures were developed based on a reflective model to assess falls efficacy.

The distinction between formative and reflective models was based on asking oneself whether the indicator “forms” or contributes to an underlying construct or if the indicator “reflects” an underlying construct (using a “thought test”), i.e., do we expect the items to change when the construct changes? (De Vet et al., 2011) The PAMF included the following items: (1) Finding ways to get up if they fell; (2) Finding ways to reduce falls; (3) Protecting themselves if they do fall; (4) Increasing their physical strength and (5) Getting steadier on their feet. The PAPMFR listed items including (1) Steadiness on their feet; (2) Balance while walking; (3) Ability to walk in their homes; (4) Ability to walk outdoors; (5) Ability to prevent falls and (6) Ability to find ways to get up if they fell. It was viewed that the items in both measures were used to form an understanding of falls efficacy. Yoshikawa and Smith (2019) reported that the items in PAPMFR aimed to cover a wide range of falls-related perceptions, which were addressed through their multi-modal falls management program.

8.2.4 A new perspective of falls efficacy

Drawing upon previous research, Soh et al. (2021) proposed that falls efficacy should be considered across a continuum from (1) Pre-fall; (2) Near-fall; (3) Fall-Landing and (4) Completed Fall (Figure 8.2.1) to provide a complete conceptual understanding of falls efficacy. In the pre-fall domain, balance self-efficacy or balance confidence refers to the perceived self-efficacy of performing activities without losing balance or falling. In the near-fall domain, balance recovery self-efficacy or balance recovery confidence relates to the perceived ability to recover balance in response to perturbations. For example, one might quickly grab onto a pole or take a few steps to recover balance after a trip or a slip. When the individual has inadequate reactive balance recovery abilities to regain balance, the fall is viewed as a consequential event (Maki et al., 2011).

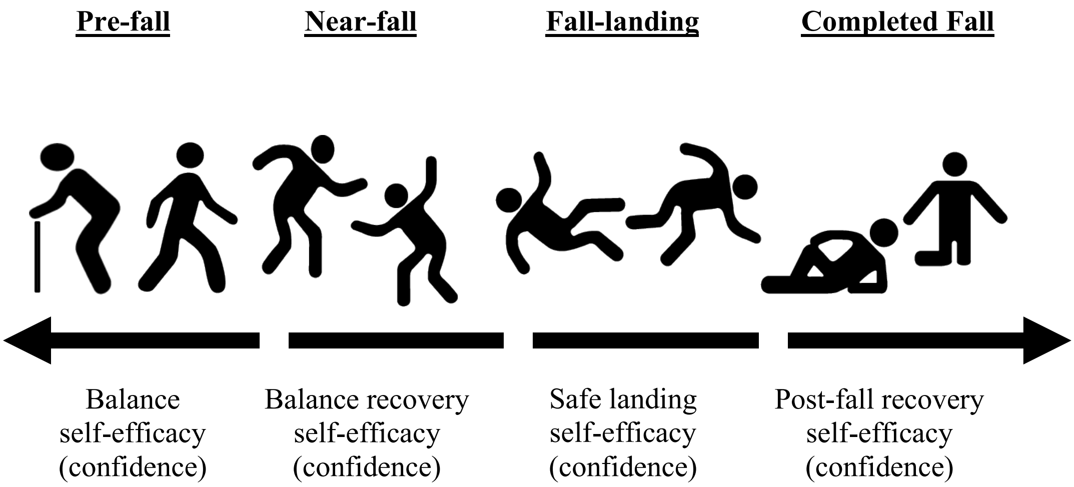

Figure 8.2.1 Extended interpretation of falls efficacy (Soh, Lane, et al., 2021).

Balance recovery strategies such as compensatory stepping and reach-to-grasp are necessary skills to arrest a fall (Gerards et al., 2017; Soh, Tan, et al., 2021). Balance recovery confidence differs from balance confidence, given that balance recovery confidence focuses on the perceived ability of one's reactive balance recovery skills to regain balance (Maki & McIlroy, 1997). Two other domains in the extended interpretation of falls efficacy refer to the fall-landing and the completed-fall. The fall-landing domain attends to the self-efficacy of falling safely onto the ground (Moon & Sosnoff, 2017) whereas the completed fall domain relates to the self-efficacy to recover from the fall (Gustavsson et al., 2018). Both domains attend to the consequences of an actual fall and should, therefore, be addressed with older adults to adequately deal with the dangers of falling. From this perspective, falls efficacy should be better defined as the perceived ability to manage a potential threat of a fall.

An extended interpretation of falls efficacy has its advantages. First, it encourages researchers and clinicians to give greater consideration to the actual construct which they target to address.

For example, the goal is to improve the reactive balancing ability in response to perturbations, to fall safely on the ground and reduce injurious falls, or perhaps being able to get up or get help effectively after a fall. If so, what would be the appropriate measures used to assess the effectiveness of the rehabilitation program? Second, falls efficacy would not be limited as a "danger-avoidance" approach, i.e., perceived ability to avoid falls. Approaching falls management by avoiding falls provides an in-depth understanding of clinicians working with older adults to tackle falls. Falls efficacy should include the perceived ability to address the fall itself (the danger), such as the loss of balance, landing impact, and post-fall recovery.

Hence, a broader interpretation of falls efficacy is needed to comprehensively understand the varying perceived abilities associated with the different demands relating to a fall. Finally, extending the interpretation of falls efficacy allows relevant measurement instruments to be appropriately used to evaluate the rehabilitation strategies. Bandura (2006) stated that there is no all-purpose measure of perceived self-efficacy. Instead, perceived self-efficacy measures must be tailored to each domain of functioning that is the object of interest.

8.2.5 Current rehabilitation practices for falls efficacy

Contemporary rehabilitation can be categorised based on a broader conceptual understanding of falls efficacy. Approaching current rehabilitation practices from an updated conceptual understanding of falls efficacy would provide a conceptual alignment (Terwee et al., 2018). A summary of measures suitable for the different domains is provided in Table 8.2.2.

Table 8.2.2 List of measures used for the different domains of falls efficacy.

Domain	**Construct**	**Focus of self-efficacy**
Pre-fall	Balance self-efficacy	On the individual's perceived performance of activities without losing balance or falling
Instrument		
FES-10, MFES-15, MFES-12, MFES-13, MFES-14, Five items in PAPMFR: "Steadiness on their feet", "Balance while walking", "Ability to walking in their homes", "Ability to walk outdoors", "Ability to prevent falls", GES-8, GES-10, Three items in PCOF: "I can reduce my risk of falling", "There are things I can do to keep myself from falling", "Falling is something I can control", Three items in PAMF: "Finding ways to reduce falls", "Increasing their physical strength, "Getting steadier on their feet", BSPT, ABC-6, ABC-15, ABC-16, CONFbal		

Table 8.2.2 List of measures used for the different domains of falls efficacy (In continuation).

Domain	**Construct**	**Focus of self-efficacy**
Near-fall	Balance recovery self-efficacy	On the individual's perceived ability to recover balance from different types of perturbations e.g., a slip or a trip or a loss of balance from volitional movements
Instrument		
No measure available. A scale of balance recovery confidence has been developed by the authors. The scale is currently evaluated for its psychometric properties.		
Domain	**Construct**	**Focus of self-efficacy**
Fall-landing	Safe landing self-efficacy	On the individual's perceived ability to fall on the floor or lower ground safely
Instrument		
One item in Perceived Ability to Manage Risk of Falls or Actual Falls (PAMF): "Protecting themselves if they do fall"		
Domain	**Construct**	**Focus of self-efficacy**
Completed fall	Post fall recovery self-efficacy	On the individual's perceived ability to get up or get help after a fall
Instrument		
One item in PAMF: "Finding a way to get up if they fell", one item in PAPMFR: "Ability to find a way to get up if they fall"		

FES: Falls Efficacy Scale, MFES: Modified Falls Efficacy Scale, PAPMFR: Perceived Ability to Prevent and Manage Fall Risks, GES: Gait Efficacy Scale, PCOF: Perceived Control over Falling, PAMF: Perceived Ability to Manage Risk of Falls or Actual Falls, BSPT: Balance Self-Perceptions Test, ABC: Activities-specific Balance Confidence scale, CONFbal: CONFbal scale of balance confidence.

Pre-fall domain

Pre-fall relates to the individual performing various activities without losing balance or falling. Much research on falls prevention has focused on this domain by identifying fall risk factors and implementing interventions to address these risks. The evidence-based fall prevention interventions can be broadly categorised as single-component interventions focusing on a specific fall risk factor (e.g., muscle weakness, poor balance, psychoactive medications and home hazards) or multi-component interventions that address several modifiable risk factors (Stevens et al., 2018).

A recent systematic review conducted by Sherrington et al. (2019) reported that exercise programs should include aspects of balance, functional exercises and resistance exercises in order to be effective in reducing the rate of falls and the number of older adults experiencing falls living in the community. Community-based interventions promoting behavioural changes, increasing falls-prevention knowledge and reducing home hazards are well-known approaches when working with older adults to avoid falls (Clemson et al., 2004; de Jong et al., 2019). In the pre-fall domain, commonly used measurement instruments include the FES, modified FES and the ABC.

Near-fall domain

The near-fall domain is a less studied area compared to the pre-fall domain. A near-fall is defined as a stumble event or loss of balance that would result in a fall if sufficient recovery mechanisms were not activated (Maidan et al., 2014). Balance recovery abilities are recognised to be crucial skills, given that the inability to recover from the loss of balance or perturbation would be considered the cause of a fall (Maki et al., 2008). According to Tokur et al. (2020), balance recovery capabilities are needed to respond to perturbations experienced in daily activities. The inability to recover from falls caused by slips, trips and loss of balance are common initiating events leading to falls among older adults (Timsina et al., 2017).

Rubenstein (2006) viewed that older adults were stiffer and less coordinated compared to young adults and hence would have impaired ability to arrest a fall in response to an unexpected trip or slip. Older adults with existing comorbidities are known to have poorer balance recovery abilities, risking a higher incidence of falls (Komisar et al., 2019). Nascent skill-specific rehabilitation interventions (e.g., perturbation-based training) have shown promising results to improve the execution of balance recovery reactive manoeuvres (McCrum, 2018; Okubo et al., 2019). Presently, there is no known measure for balance recovery confidence (Soh, Lane, et al., 2021), although a measure has been developed by an international multi-disciplinary study team and is currently under validation (Soh, 2021).

Fall-landing domain

Two other domains of falls efficacy should be considered to prepare older adults to adequately manage an unfortunate fall event following an irrecoverable loss of balance. The fall-landing domain relates to the individual landing at a lower level from an irrecoverable loss of balance.

Some ways to minimise physical injuries may include teaching techniques on safe landing (Moon & Sosnoff, 2017), as well as the use of hip protectors (Cameron et al., 2000) or appropriately designed flooring (Gustavsson et al., 2018). However, passive interventions do not rely on the individual's perceived ability to complete a task successfully. Therefore, the outcome measures used to evaluate the effectiveness of products, such as the use of hip protectors or compliant flooring, should suitably consider the use of measures to identify concerns about falling, such as the Falls Efficacy Scale-International (Yardley et al., 2005).

Completed fall domain

When the individual has fallen to the ground or onto a lower level, the individual should have the necessary resources to recover from the fall. The completed fall domain has established rehabilitation strategies which include the training of an older person to get up from the floor (Adams & Tyson, 2000). This mode of training instils some degree of confidence in their ability to deal with the "unexpected event" scenario in older adults.

Presently, there is an absence of a validated measurement instrument to determine the self-efficacy of safe landing or the recovery from a fall. Researchers and clinicians aiming to develop appropriate measures should conduct a systematic literature review for all existing instruments (De Vet et al., 2011). Moving forward with our practice, we reiterate the calls of Jørstad et al. (2005), Moore and Ellis (2008) and Hughes et al. (2015) that researchers and clinicians need to be mindful of the construct of interest, adequately stating them when using the different measurement instruments, so as to avoid research waste and to mitigate the risk of misinterpretation by fellow colleagues (Ioannidis et al., 2014).

8.2.6 Person-centred care

Applying a new perspective of falls efficacy is important in person-centred care practice (PCC). PCC highlights the importance of knowing the individual as a person and is a key component in engaging the person as an active partner for their care (Fors, 2015). Clinicians working with older adults should aim to preserve their identity and independence when managing different issues surrounding falls (Clancy et al., 2015).

A comprehensive approach should not only address ways of mitigating the risks of falling, but to advocate a spectrum of strategies, including improving reactive balance recovery abilities, learning skills to be a ‘safe faller’, and knowing the different ways of getting help after a fall. This would allow the older person to lead a fulfilling and flourishing life (Gustavsson et al., 2018). Clinicians have acknowledged the importance of working with the older person through a shared decision-making process: the foundation of patient-centred care, and in this case, older person-centred care (Barry & Edgman-Levitan, 2012). To have an effective, shared decision-making session, healthcare providers need to partner with their patients and support their patients in making health care choices consistent with their values and priorities.

The use of appropriate measures to understand specific constructs has been proposed as valuable tools to build mutual understanding between health care professionals and their patients (Kyte et al., 2015). Improper use of measures, e.g., for other purposes that they are validated for, can risk clinicians making inadequate clinical decisions, leading to patients not receiving the care they need. Given that person-centred care stems from the proper understanding of patient’s needs, then accurate information of their perceived self-efficacy is required to inform clinicians (de Leeuw et al., 2008; Streiner et al., 2015).

8.2.7 Moving forward

Working with older adults to deal with a complex phenomenon such as a fall requires a clear and comprehensive approach (Avin et al., 2015). A broader perspective of falls efficacy should improve agency in older adults to remain independent and be confident of overcoming the consequences of falling. Falls management is not just about avoiding the risks of falling (Gustavsson et al., 2018) but should include complementary strategies to deal with the falling process, as well as to recover from a fall. The notion of falls efficacy is a multidimensional construct that would encourage clinicians and researchers to work on specific issues of falls and falling.

Presently, there are well-established measurement instruments available to measure the self-efficacy of performing activities without losing balance or falling (pre-fall domain). Current measures of falls efficacy might suitably measure the construct of balance confidence. There is a need to further investigate the suitability of existing measures for the other domains of falls efficacy. If not, then new measures should be purposefully created.

Further research applying appropriate assessments and interventions would be needed to have a fuller understanding of falls efficacy in different settings. Falls efficacy may not have a tautological relationship with balance confidence. Falls efficacy should be viewed as the perceived self-efficacy to manage a fall, addressing four domains from pre-fall to post-fall. Lach (2006) had pointed out the need to consider both efficacy expectations and outcome expectancy in her article “Self-efficacy and fear of falling: in search of complete theory”. It may be plausible that the new perspective of falls efficacy would open the possibility to gain a better understanding of the effect of falling, as well as the effect of falling on the behaviour and health of older adults. An extended understanding of falls efficacy might possibly reshape how clinicians and researchers approach their practice to improve self-efficacy in older adults on falls.

8.2.8 Conclusion

Applying a new perspective towards falls efficacy may potentially drive a more meaningful direction toward falls management. The traditional understanding of falls efficacy has been purposeful in helping older adults maintain their independence. However, it may not be enough in empowering an older person to deal with an actual fall, e.g., improved agency in older adults to arrest a fall upon losing balance, fall safely or recover post-fall. An extended perspective of falls efficacy gives greater attention to the self-efficaciousness of handling a fall if the unfortunate event occurs. There is a need for clinicians and researchers to be explicit about the targeted construct of interest and select suitable self-reported measurement instruments to evaluate the efficacy of rehabilitation approaches for the intended construct.

8.3 Research output 2

Researcher as instrument:

A critical reflection using nominal group technique for content development of a new patient-reported outcome measure

Published as:

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8.3.1 Abstract

This article presents a critical reflection on the application of the 'researcher as instrument' concept within a study employing the nominal group technique. Twelve community-dwelling older adults were recruited to generate a list of items for a new patient-reported outcome measure on perceived ability to recover balance. The ontological position and epistemological stance of the first author are presented to provide a philosophical context of his lens and biases of his reflection.

The article aims to share reflective insights into the process of taking the role of researcher as instrument, to highlight the concept's strengths and limitations for other researchers and demonstrate how it is applied from the perspectives of a physiotherapist conducting person-centred research with older clients. Essential practice skills such as reflectivity and reflexivity are necessary for a researcher as an instrument to build a trusting relationship with participants in person-centred research. Novice researchers should explore their philosophical orientation to develop their research methodology and methods.

8.3.2 Introduction

Researcher as instrument refers to the researcher as an active participant in the research process (Hammersley & Atkinson, 1995). Early-stage researchers may find this difficult to comprehend, depending on their epistemological and ontological stance. For example, quantitative researchers could view that the role of a researcher is theoretically non-existent in quantitative studies. The use of the researcher as an instrument to collect data is a paradigmatic incongruence (Smith & Heshusius, 1986; Sechrest & Sidani, 1995). However, in person-centred practice research, there is an emphasis on principles such as collaboration, inclusion and participation of each person to contribute to the body of knowledge (McCormack & McCance, 2017).

This approach begets a question, "How can one being the researcher as instrument apply such important principles into my research method using the Nominal Group Technique (NGT) with a group of older people?" This article aims to demonstrate how my work as an active participant to develop trust with older people who are part of the research to develop a patient-reported outcome measure. This article was prepared in partial fulfilment of the lead author's doctoral studies programme.

8.3.3 My ontological and epistemological position

The researcher's ontological position (what composes nature and being), the epistemological stance (what knowledge is) will define the methodological (how knowledge can be best learned) and methods adopted (Crotty, 2005). Methodology, however, can be aligned to critical social sciences with the aspects of enlightenment, empowerment and emancipation prioritised by those focused on person-centred care (Manley & McCormack, 2003). The ability of an individual to embrace person-centred practice development within each of our paradigmatic stances can inherently create a more significant and more profound influence on our research outcomes and research impact.

As a physiotherapist, I seek to apply both objectivistic and interpretivistic clinical skills in my research. I posit that the traditional Cartesian materialism conception of the body, where the body is understood purely as a physical mechanism (Dennett, 1991) would be insufficient for the understanding of a person's problem. My work to develop a useful and relevant patient-reported outcome measure (PROM) for clinical practice is predicated on the beliefs that older people can express themselves and provide some phenomenological understanding of their body, addressing the limitations of reductionist paradigms. In order to do this, the building of trust, respect and rapport with the older people is crucial for the success of the research. Treating trust as a currency is pivotal to many positive outcomes (Terry & Kayes, 2019).

Pragmatism has emerged as my ontological position. A pragmatist researcher focuses on the anticipated outcome of the research – the actions, situations, and consequences of inquiry (Creswell, 2013). This approach will have the researcher paying attention to the applications of “what works”, dwelling on the solutions to problems (Patton, 1990). In this sense, I viewed that a pluralistic inquiry in my research involving different methods, NGT and various measurement testing theories, such as Classical Test Theory and Item Response Theory to varying stages of research involving multiple relevant stakeholders, i.e., community-dwelling older adults and healthcare professionals to ensure relevance, comprehensiveness and comprehensibility of the content.

8.3.4 Reflecting on my journey as Researcher as Instrument

Reflecting on my pragmatic stance and research work as a neophyte researcher, I asked myself, “What should I do to enable better outcomes for my research?”. The other questions of “So what?” and then “What should I do better for the next study?” should be reflected after the completion of the study. This reflective model adopted Rolfe’s reflective model centring on three questions: What? So what? Now what? (Rolfe et al., 2001). Besides Rolfe’s reflective model, Schön’s reflection-in-action and reflection-on-action (Schön, 1983) were applied for my critical reflection. The key aspect of this Schön’s framework is to have a reflective narrative with a series of questions about the situation. The following three aspects of the study are presented as my reflection on (1) Preparation of participants; (2) Preparation for the facilitation; (3) Dealing with the unexpected circumstances.

Preparation of participants

The “What?” question

The question reflected was, “What was done to prepare the participants?” In this study, we recruited twelve Singapore community-dwelling older adults who were purposively sampled from a previous study (Soh et al., 2021). They understood the essential concepts of the research and were able to provide relevant views to generate a list of items for the PROM. However, this did not imply that they would be truthful and forthcoming with their answers during the focus group session.

So what?

I reflected that the participants would need to be empowered and trust that their opinions are respected. They need to understand a collective learning experience can encourage higher achievement for the research (Johnson & Johnson, 2013). I considered that an honest and frank briefing session conducted by the researcher for the older people would prepare the participants adequately for the research. At the same time, these interactions will allow the researcher to further reflect on the concerns that the older participants may have (Schön, 1983). As the principal investigator, I met all the eligible older adults face-to-face to explain the research and the procedures of the NGT. They were informed about the study objectives and their roles as 'experts' in the study. The term 'expert' provided respect and empowerment to the participants (De Vet et al., 2011). Most questions raised by the older adults about the study were sufficiently covered within the participant information sheet. Some additional uncertainties such as, "Are there rest-breaks scheduled?" or "What if I have nothing more to add to the discussion?" reflected that the researcher should give further attention to their mental and emotional well-being. Older adults may easily be mentally fatigued during the study or be anxious about their roles. The researcher should be aware of the assurance needed by the participants. Further, it would be any researcher's ethical responsibility to minimise the potential discomfort of the participants.

Now what?

From this preparation, the most critical learning point was the need to build rapport with the older people before introducing my agenda. During my meetings, I had to adjust my briefing process to allocate adequate time for this aspect. Later, I reflected that this was about showing respect to them as persons. I asked myself how this process of building trust helped me in the preparation of the participants. I realised that when older people trust the researcher and have a greater sense of belief within themselves being able to participate in the study, there were lesser clarifications needed. A higher level of perceived self-efficacy in older people of their participation in the research can help ensure a successful study outcome.

Preparation for the facilitation

The "What?" question

The question reflected was, "What was done to prepare the facilitators and the environment?" I recognised that the trusting relationship with the participants needed to be maintained through the research. In conducting the NGT, the facilitators and the environment should be sufficiently prepared in order to keep the trust and encourage successful research outcomes.

So what (for the facilitators)?

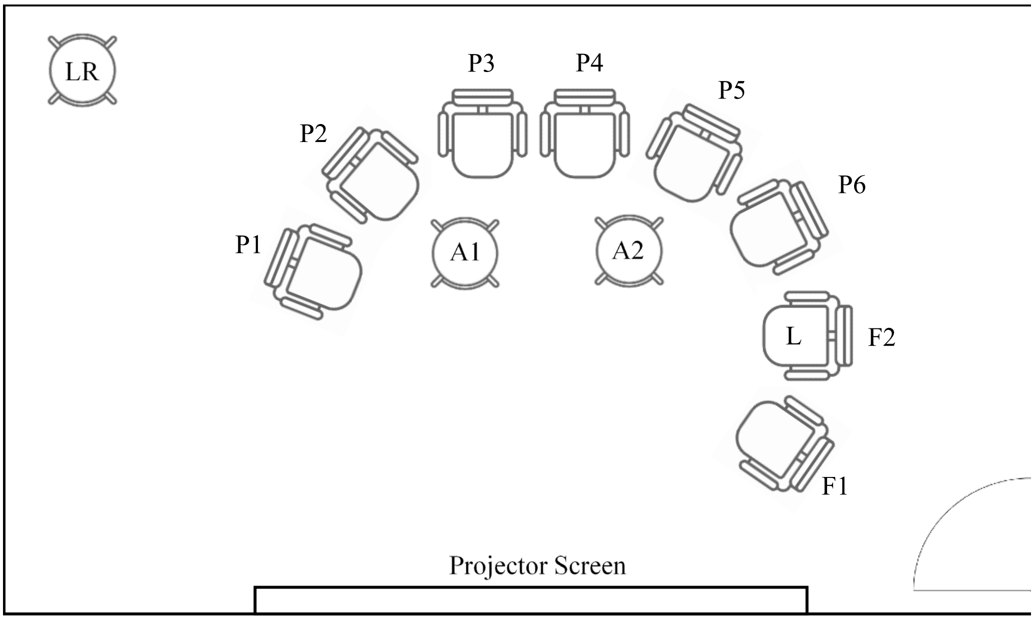
To improve the credibility of the facilitators, he or she should be an expert on the topic for discussion or an experienced non-expert (Glaser, 1980). Two researchers in the study team from Singapore were identified as the facilitators to reduce study bias. A lead facilitator was chosen amongst the two to ensure quality leadership and consistent facilitation (Gallagher et al., 1993). Both facilitators developed and used the topic guide for the NGT. Discussions on personal views about technical rationality and study's objectives were held before the session. Technical rationality relates to the opinion of professional knowledge shaping our thinking of our profession (Schön, 1983). The discussions were crucial for the facilitators to recognise their roles as domain experts would not influence the participants' views. There should not be a sense of power imbalance or undermining the participants' opinions (Sim & Waterfield, 2019).

Now what (for the facilitators)?

The respect displayed by the facilitators for the older people maintained the trust that the older people had. The dual roles as a facilitator and a researcher were akin to a tight-rope walker's know-how, balancing newly acquired knowledge from the participants with existing knowledge (Schön, 1983). The professional behaviours of the facilitators allowed the execution of appropriate facilitation techniques. I concluded that open and candid conversations between facilitators or researchers on topics such as the different roles, responsibilities, facilitation techniques are necessary for NGT.

So what (for the environment)?

A conducive environment was necessary for the well-being of the participants and the proper delivery of NGT. We orchestrated the room to be brightly lit and air-conditioned cooled sufficiently to ensure participants' and interviewers' comfort. A sign was placed outside the door to avoid unnecessary disruption. Tables and chairs were arranged in wide semi-ellipse orientation, facing a projected screen (Figure 8.3.1). The projected screen was in clear visibility to display participants' ideas. A technical trial was performed to display text on the screen using applications, i.e., Padlet (for sharing of ideas) and Microsoft Excel (for discussion and ranking) to ensure participants and facilitators had no issues reading the displayed text. Light refreshments were prepared to ensure that participants were comfortable in the setting.



Legend
P-Participants, F-Facilitator, A-Audio-recorder, L-Laptop, LR-Light Refreshments

Figure 8.3.1 Layout arrangement for a focus group discussion conducting the Nominal Group Technique (NGT).

Now what (for the environment)?

An important learning point was that attention should be given to prepare the built environment. A relaxed and comfortable environment for unfamiliar participants would foster open and honest dialogue (Nyumba et al., 2018). A proper set-up of the physical environment strengthens the conviction of trust in the participants that they are contributing to the study as an ‘expert’. A consistent and coherent display of thoughts, actions and physical environment would strengthen the trust relationship between the researchers and the participants. The researcher as an instrument must be adept at recognising various interactions, such as physical interaction with participants, and the built environment will play a role in bringing the participant into a world of inquiry in which their perspectives are truly valued as sources of discovery (Schön, 1983).

Dealing with unexpected circumstances

The “What?” question

The question reflected was, “What can a researcher as an instrument do during unexpected circumstances?” Reflexivity relates to the degree of influence that the researcher exerts, either intentionally or unintentionally, on the research process and findings (Jootun et al., 2009). The continuous process of reflection by the researcher on his or her values, preconception, behaviour or presence and those of the participants can enhance the quality of research through its ability to extend our understanding of how our positions and interest as researchers affect the research process (Jootun et al., 2009). To be reflexive, researchers adjust what they do and how they do it as a consequence of learning from their reflections at that moment.

So what?

An example of this reflexivity was our ability to modify our facilitator characteristics during the focus group sessions. In the beginning, both facilitators decided to adopt the facilitator characteristics of "objectivistic", neutrality" and "affirmative". The "objectivistic" characteristic was taken to accept that the ideas presented by the participants were factual, in the sense that the ideas did exist. For "neutrality" characteristics, the lack of extensive commentary by the facilitators was displayed throughout the session. The "affirmative" characteristic was expressed with a smile or a nod, illustrating a show of support. The facilitators' common statements expressed included "Thank you for your idea, can (name of next participant) share your idea", "Mmm.." and "Okay, thanks for sharing."

Closing to the end of the NGT discussion stage, the facilitators realised that preconceived ideas were not brought up by the participants. This posed a dilemma for the facilitators whether the items generated by the participants were sufficiently comprehensive. At that moment, the facilitators decided to adopt another characteristic, "naivety". The neutral characteristic is defined as 'not engaged on one side of an argument or another; neither affirming nor disapproving of respondent's stories' (Pezalla et al., 2012). Questions were phrased as innocuously as possible, e.g., "you mentioned about x, how about y?" or "What do you think of …". The ideas suggested by the facilitators were discussed amongst participants, which some ideas were taken as relevant, and others were viewed as irrelevant because older people would not be able to recover their balance if the situation occurs. This approach did not undermine the trust and rapport built with the participants and was acceptable in NGT. The opportunity to obtain immediate feedback is a unique feature of NGT when compared with other group decision-making processes (Table 8.3.1). The next NGT phase – ranking - allows participants to select which items were most important to them (McMillan et al., 2016).

Table 8.3.1 A comparison of the group decision-making processes (Potter, Gordon, & Hamer, 2004).

Attribute	Delphi	Focus Groups	Brainstorming	NGT
Face-to-face group meeting process	No	Yes	Yes	Yes
Generates a large number of ideas	Yes	Maybe	Maybe	Yes
Avoids focusing on a single train of thought	Yes	Yes	No	Yes
Encourages equal input from all participants	Yes	No	No	Yes
Highly structured process	Yes	Maybe	No	Yes
Meeting time usually 1-2 hours duration	No	Yes	Yes	Yes
Avoids 'quick' decision making	Yes	No	No	Yes
High degree of task completion	Yes	Maybe	No	Yes
Provision of immediate feedback	No	Maybe	Maybe	Yes
Measures the relative importance of ideas generated	Yes	No	No	Yes
Should be facilitated by an experienced leader	No	Yes	No	Yes

Now what?

All researchers need some degree of reflexivity to manage unexpected circumstances. In this example, we took on an appropriate facilitator characteristic to build a complete and fuller understanding of the topic without undermining the meticulous effort of building rapport and trust with the older people. The facilitators maintained professional behaviour throughout the NGT. Researchers can enhance their reflexivity through internal dialogue and constant scrutiny of 'what I know' and 'how I know it' (Jootun et al., 2009).

8.3.5. Reflection on limitations

Few limitations identified through my reflective journey were the time to build trusting relationships with participants, acquiring knowledge and understanding of the NGT approach as a consensus method, and the sole use of the naivety characteristic in facilitation which may limit discourse in discussions. My reflection is limited by my pragmatism philosophical lens and bias, recognising that different researchers may have other ontological and epistemological stances.

8.3.6. Conclusion

The authors believe this is the first paper demonstrating that the Researcher as Instrument can be applied in NGT for the content development of a patient-reported outcome measure. The researcher as an instrument needs to incorporate reflectivity and reflexivity towards building trust with participants while incorporating principles of collaboration, inclusion and participation in person-centred research. Recognising one’s philosophical orientation can provide a rewarding and fulfilling understanding of the findings that emerged.

8.4 Research output 3

Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders

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8.4.1 Abstract

The absence of patient-reported outcome measures (PROMs) for a specific construct or target population suggests a need for such measures to be developed. A case in point is the domain of falls efficacy; a PROM for balance recovery confidence was proposed to improve older persons 'agency to arrest a fall. Appropriate participation in its development by relevant stakeholders was identified as essential to maximise the utility of the PROM and its potential to enhance patient care. There is a gap in the practice development literature in terms of PROMs for older persons. This article aims to encourage researchers to use the principles of practice development to address this gap by involving relevant stakeholders to gain greater insight.

The nominal group technique and the Delphi technique were used to generate and refine the content of the measure, and content analysis was applied to assess and summarise the data. Unique themes emerged, such as 'agency of older people in the prevention of falls 'from the community-dwelling older adults in Singapore, and 'clinical specificity 'from an international panel of healthcare professionals. Common themes including 'relevance to the target population', 'comprehensibility 'and 'cultural and contextual sensitivity 'were found in both groups. A collaborative, inclusive and participatory approach involving different stakeholders, underpinned by practice development methodology, can offer rich insights for PROM developers.

8.4.2 Introduction

Patient-reported outcome measures (PROMs) are questionnaire-type instruments completed by the patient (FDA, 2009). These instruments can provide information about the patient's perceptions of their well-being, functioning, symptoms, and treatment experiences (Rothrock et al., 2011). PROMs will improve patient-clinician interactions through better communication and patient engagement (Greenhalgh et al., 2014). Employing PROMs in clinical practice emancipates individuals, allowing healthcare teams to develop their knowledge and skills, transforming culture and context of care (McCormack & Garbett, 2003; van Dulmen et al., 2017). Overall, PROMs facilitate patient empowerment and support shared decision-making among all stakeholders (Kyte et al., 2015). PROMs play a vital role in patient-centred practice and are increasingly used by clinicians (Van der Wees et al., 2014). In this article focusing on person-centred practice, patients are viewed as persons interchangeably.

When no adequate measurement instrument is available to measure a specific construct, a suitable PROM needs to be developed appropriately (De Vet et al., 2011). The improper use of PROMs, e.g., for other purposes that they are validated for, can risk clinicians making inadequate clinical decisions, leading to patients not receiving the care that they need. Given that person-centred care needs a proper understanding of patient’s needs, then accurate information is required to inform clinicians (de Leeuw et al., 2008; Streiner et al., 2015).

The development of a PROM could imbue the principles of practice development. Practice development relates to a continuous process and encouragement of person-centred cultures that allow transformations of individual and team practices towards person-centredness care (McCormack et al., 2013). In the context of PROM development, the principles of collaboration, inclusion and participation encourage person-centred PROM developers to engage all stakeholders to construct a set of appropriate content for the PROM that measures the construct for the persons of interest.

When developing a PROM for older people, multiple stakeholders including healthcare professionals involved in the older person’s care and the older people should participate. Different stakeholders’ participation augments the construction of the PROM based on the authentic contexts of older people's experiences in the real world and the clinicians’ interaction with older persons. Clinicians would contribute inputs from their clinical expertise and experience, while patient involvement would validate the relevance of outcomes and the

PROM's comprehensibility (Terwee et al., 2018). Ultimately, PROMs are meant to reflect the patient's perspective and can therefore complement person-centred approaches to practice.

In the field of falls management in older people, PROMs have been used to study falls-related self-efficacy or falls efficacy (Moore & Ellis, 2008). Falls efficacy centres on the self-efficacy mechanisms (Tinetti et al., 1990). Bandura (1981) defined self-efficacy as an individual's perception of their capabilities to complete specific tasks or perform in a particular situation successfully. The self-efficacy in tackling falls relates to an older person's agency in managing the threat of a fall (Payette et al., 2016; Tinetti et al., 1990). The perceived fall-efficacy may be understood as a falls efficacy continuum model categorised across four different domains: Pre-fall, Near-fall, Fall landing, and Completed fall (See Figure 8.4.1). Pre-fall relates to individuals performing daily activities without losing balance. Near-fall focuses on individuals recovering their balance when experiencing different forms of perturbations. Fall landing and completed falls are two phases in which individuals need to feel confident to fall safely and get help after falling.

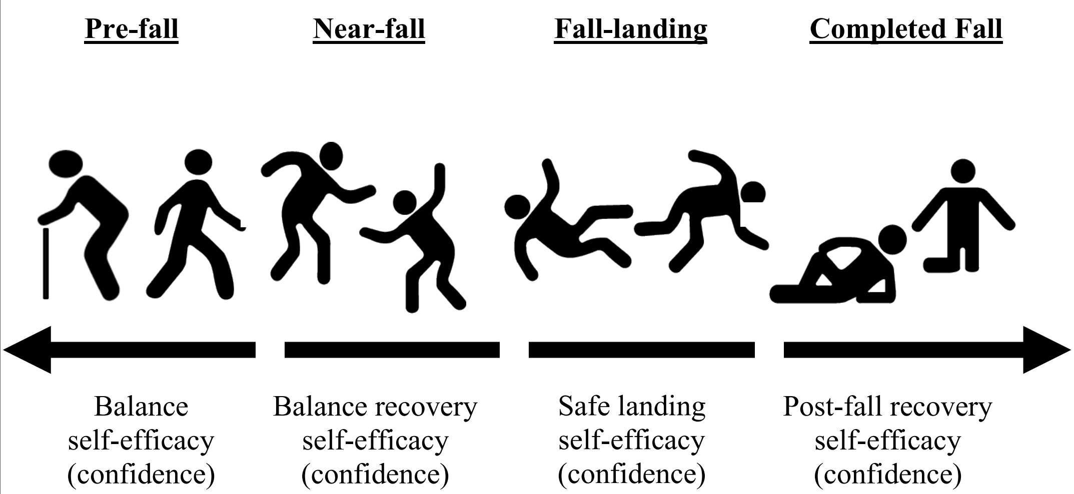

Figure 8.4.1 Falls Efficacy Continuum Model (Soh et al., 2021).

Older people accept that falls and falling as part of life (Gustavsson et al., 2018). In dealing with falls, older people have articulated their desire to be empowered, safeguard their integrity and promote their well-being (Clancy et al., 2015). Therefore, adopting a practice development approach is appropriate to the development of this PROM. Practice development aims to emancipate persons by inviting them to contribute to advancing healthcare processes and systems so that health services reflect their beliefs, values and expectations.

A recent conducted systematic review highlighted two key issues surrounding existing PROMs for falls-efficacy (Soh, Lane, et al., 2021). First, many PROMs had been developed without sufficiently involving representatives from the population of older persons or healthcare professionals from relevant clinical disciplines who provide care for older persons (Soh, Lane, et al., 2021). Inadequate participation of different stakeholders makes the PROM questionable on its relevance, comprehensiveness and comprehensibility (Prinsen et al., 2018). Second, numerous PROMs were found focused on the balance confidence construct, i.e., confidence of older people performing activities of daily living without losing balance (Soh, Lane, et al., 2021). When research uses these PROMs of balance confidence to study the effectiveness of perturbation-based interventions in older people, potential misinterpretation of falls efficacy in older people may arise. For example, Kurz et al. (2016) reported that there were no significant changes in falls efficacy in community-dwelling older adults based on the Falls Efficacy Scale (Tinetti et al., 1990) when compared between treadmill walking with perturbation and treadmill walking with no perturbation, despite improvement in their balance recovery performance. Based on the falls efficacy continuum model, this domain of falls efficacy reported focuses on the confidence of performing activities without losing balance under “pre-fall” domain. The understanding of balance recovery confidence or the perceived self-efficacy to recover balance from perturbations, i.e., a slip or a trip has yet to be understood.

There are no adequate PROMs to measure balance recovery confidence, i.e., perceived self-efficacy to recover their balance from different slip, trip or loss of balance scenarios in older people (Soh, Lane, et al., 2021). A purposeful PROM would be suitably employed by clinicians to understand the perceived self-efficacy in older people to recover their balance in a real-world context (near-fall domain). More than half of older people (53%) were found to experience near-falls over a three-week period during regular functioning (Soh, Tan, et al., 2021). Given the accumulated effects of age and comorbidities, a greater mismatched understanding of the perceived and actual abilities to recover balance, associated with risk-taking behaviours, can increase the older person’s probability of falls and falling (Delbaere et al., 2010).

A new PROM of balance recovery confidence in community-dwelling older adults was developed using two consensus-based methods, the Nominal Group Technique (NGT) and the

Delphi Technique. The NGT was used to generate a preliminary list of PROM questions (items). Items are questions listed in the PROM to measure the particular construct of interest (De Vet et al., 2011). The Delphi Technique was used to refine the items and complete the content development process. Both methods have been widely used and can underpin a practice development approach towards developing a new PROM (McMillan et al., 2016).

This article will present our process of developing the BRC scale by involving different stakeholders to contribute, and then we will share the content themes arising from the opinions given by the two groups of stakeholders: the older people and the healthcare professionals. The aims are to illustrate the value of applying practice development principles in constructing a PROM to be used in clinical practice for older people. Our findings of the themes that emerged from the Delphi study will be presented. The themes are constructed from the opinions of the Singaporean older adults living in the community and an international panel of healthcare professionals comprising physiotherapists, occupational therapists, nurses, podiatrists and medical doctors evaluating the content validity of the newly-developed PROM. The findings will be discussed based on: “What content themes are obtained from different stakeholders representing community-dwelling older adults and healthcare professionals when developing a PROM that measures balance recovery confidence for older people living in the community?"

8.4.3 Methods

Preliminary list of items generated

The NGT was selected as the first stage of generating a list of items for the PROM. This technique had shown to be a useful method for decision-making processes to generate an exhaustive list of important items through consensus (McMillan et al., 2016; Potter et al., 2004). In this stage, twelve eligible community-dwelling older adults were invited as our experts. Thirty-two items were generated and would be presented for the next stage. The process to generate content for the PROM of balance recovery confidence has been described in another study (Soh et al., 2020).

Refining and finalising the content

The Delphi Technique was adopted as the next stage to refine and finalise the content that meets an acceptable level of content validity. Delphi is a widely-used decision-making method to achieve a general agreement or convergence of opinion around a particular topic (McMillan et al., 2016). A two-stage modified online survey Delphi procedure was used. Two groups of experts: a new group of eligible Singaporean community-dwelling older adults and an international panel of healthcare professionals were invited to evaluate the content (PROM name, instructions, response options and items) for appropriateness (Fitch et al., 2001). Each item had a short text descriptor with an illustration. Each expert accessed the online survey through the link given via email. In both rounds, they rated the content using the Rand appropriateness scale; a 9-point Likert scale ranged from 1 (inappropriate) to 9 (appropriate) and gave any necessary comments in a free-text box (Fitch et al., 2001).

The appropriateness of the item to be included in the PROM was defined as having the clarity, importance and relevance for evaluating the construct of balance recovery self-efficacy. The consensus was operationalised based on the criteria established by the RAND guidelines (Table 8.4.1) (Fitch et al., 2001). Ethical approvals were obtained from two institutions: Queen Margaret University and Singapore Institute of Technology.

Table 8.4.1 Criteria to establish appropriateness and agreement (Fitch et al., 2001).

Level of appropriateness	**Definition**
Appropriate (A)	Panel median of 7-9, without disagreement
Uncertain (U)	Panel median of 4-6 OR any median with disagreement
Inappropriate (I)	Panel median of 1-3, without disagreement
Level of agreement	**Definition**
Agreement (+)	No more than 20% of panellists who had rated the indication outside the 3-point region (1-3; 4-6; 7-9) containing the median
Disagreement (-)	At least a third of the panellists who had rated the indication in the 1-3 region and at least three panellists rate it in the 7-9 region
Indeterminate (?)	Not meeting the above two-level of agreement

Participants

The eligibility criteria for experts participating in the Delphi are presented in Table 8.4.2. The Delphi was conducted with an expert panel formed by a group of community-dwelling older adults and a group of healthcare professionals representing physiotherapy, occupational therapy, nursing, medicine and podiatry. Representatives of the community-dwelling older adults were recruited through recommendations from participants of the earlier study (Soh, Tan, et al., 2021). The healthcare professionals were identified through professional colleagues, related professional associations, fall prevention related conferences, seminars and activities. All potential participants were invited through email with an attached cover letter and a link to the study information and consent form using an internet-based survey platform (JISC Online Surveys 2020). Consent to participate was obtained before the experts accessed the survey. All participants were allocated unique study codes for the purposes of anonymity during data analysis and to reduce the risk of bias.

Table 8.4.2 Participants eligibility criteria.

Inclusion criteria for community-dwelling older adults	
Inclusion criteria	**Exclusion criteria**
65-year-old or above	Requiring any physical assistance from another person to walk within home
Have an adequate understanding of the English language	Presenting with clinical observable severe cognitive impairment
Living independently in the community with or without the use of a walking aid	Unable to provide written consent to participate in the study
Inclusion criteria for healthcare experts	
• Representing one of the following professions: physiotherapy, occupational therapy, podiatry, nursing and geriatric medicine.	
• Have at least 3-year experience in geriatric clinical work or related-research studies.	

Pilot testing Delphi Round 1

The first round of Delphi was sent out in June 2020 to 50 potential participants, of whom 40 were healthcare professionals, and ten were community-dwelling older adults. The round involved a series of questions asking participants to rate, in their opinion, the level of appropriateness of the content using the Rand appropriateness scale. The content included the instrument's name, instructions, response options, recall period, and items. Participants were given two weeks to complete Round 1 survey. A reminder was sent to non-responders after one week after the date of the email sent.

Pilot testing Delphi Round 2

The second round of Delphi was sent out in August 2020 to those who responded in Round 1. Participants were provided revised items that were identified as appropriate and met the level of consensus agreement achieved by both panels of community-dwelling older adults and healthcare professionals. Both the ratings and summary of comments obtained in Round 1 were provided as the rationale of the updated item. Participants re-rated the updated item using the Rand appropriateness scale and offered their opinions in a free-text box. Participants were asked to complete Round 2 survey within two weeks. A reminder was sent to non-responders after one week after the date of the email sent.

A rubric (Table 8.4.3) was developed to recommend the actions taken for the reviewed content given the level of the agreement provided by both groups of experts. The preference of item selection was weighted to the community-dwelling older adults based on the utility of a PROM. One researcher (SS) independently organised all the quantitative and qualitative data. The data was verified with two other team members (JL; CW) to finalise the refined content of the PROM. Content analysis of the opinions was then done to determine the themes arising from the two groups of experts (Erlingsson & Brysiewicz, 2017). The raw data of the opinions were reviewed, condensed, coded and categorised into meaningful themes (Table 8.4.4) to reflect the views given by different groups of stakeholders on developing a PROM of balance recovery confidence for older people.

Table 8.4.3 Actions to be taken on the item given the level of the agreement provided by the two groups of experts.

Evaluation matrix		**Healthcare professionals**		
		Agree (+)	**Indeterminate (?)**	**Disagree (-)**
Community-dwelling older adults	**Agree (+)**	Include (Amend)	Likely include (Amend)	Likely include (Amend)
	Indeterminate (?)	Likely exclude (or Amend)	Likely exclude (or Amend)	Exclude
	Disagree (-)	Likely exclude (or Amend)	Exclude	Exclude

Agree (+) is determined by calculating no more than 20% of panelists rating the item outside the three-point region (1-3; 4-6; 7-9) containing the median

Indeterminate (?) is determined by calculating at least a third of the panelists rating the item in the 1-3 region and at least three rating it 7-9

Disagree (-) is determined by identifying where an item's appropriateness did not meet the above two levels of agreement

All amendments are made according to the feedback provided by both the community-dwelling older adults and healthcare professionals

Table 8.4.4 Glossary of terms used for the content analysis (Erlingsson and Brysiewicz, 2017).

Process	Description
Meaning unit	The text extracted from the raw data.
Condensation	A process of shortening the text while still preserving the core meaning.
Code	A name that describe the particular condensed meaning unit.
Category	A process of grouping together those codes that are related to each other through their content or context.
Theme	To express an underlying meaning.

8.4.4 Results

Table 8.4.5 reports the response rate and withdrawals. Ten community-dwelling older adults and twenty-two experts in healthcare of older people completed the two rounds of Delphi. The demographic characteristics of participants who completed at least one round (n=38) are presented in Table 8.4.6. From a preliminary list of thirty-two items, nineteen achieved respective consensus using Delphi.

Five themes emerged from the two groups of stakeholders (the community-dwelling older adults and the healthcare professionals including medical doctors, physiotherapists, occupational therapists, nurses, podiatrists): (1) "Relevance to the target population", (2) "Comprehensibility", (3) "Cultural and contextual sensitivity", (4) "Clinical specificity" and (5) "Agency of older people towards the prevention of falls". The first three themes were common among both groups of stakeholders. Clinical specificity was determined from the group of healthcare professionals, whereas the agency towards preventing falls was obtained from the group of older people. The themes that emerged from developing a PROM of balance recovery confidence for older people using practice development principles are reflected by a pictorial representation (Figure 8.4.2).

Table 8.4.5 Response rate and withdrawal for Delphi.

	Response rate (responded/consented (proportion)		
	Community-dwelling older adults	**Healthcare professionals**	**Overall**
Round 1	10/10 (100%)	28/40 (70%)	38/50 (76%)
Round 2	10/10 (100%)	22/28 (79%)	32/38 (84%)

Table 8.4.6 Demographic characteristics of the Delphi panel.

Characteristics of community-dwelling older adults	N (%)	Characteristics of healthcare professionals	N (%)
Age range		**Age range**	
65 to 69	7 (70)	25 to 34	7 (25)
70 to 74	2 (20)	35 to 44	15 (53.6)
75 to 79	1 (10)	45 to 54	5 (17.9)
		55 to 64	1 (3.6)
Gender		**Gender**	
Female (%)	5 (50)	Female (%)	21 (75)
Male (%)	5 (50)	Male (%)	7 (25)
Educational level		**Occupation**	
Secondary (%)	6 (60)	Medical doctor	3 (10.7)
College/ University (%)	4 (40)	Physiotherapy	6 (21.4)
Housing type		Occupational Therapist	9 (32.1)
3-room	1 (10)	Nurse	8 (28.6)
4-room	1 (10)	Podiatrist	1 (3.6)
5-room or executive flat	5 (50)	Researcher	1 (3.6)
Condominium or Landed property	1 (20)		
Personal mobility – not using a walking aid	10 (100)	**Length of work experience**	
Experience no fall in the past year	8 (80)	3 to 5 years	2 (7.1)
Experience 1 or more falls in the past year	2 (20)	6 to 10 years	4 (14.3)
		More than 10 years	22 (78.6)
History of near-falls in past year		**Location**	
Never or rarely	9 (90)	Singapore	23 (82.1)
Occasional or frequently	1 (10)	UK	1 (3.6)
		US	1 (3.6)
		Malaysia	1 (3.6)
		Australia	1 (3.6)
		Hong Kong	1 (3.6)

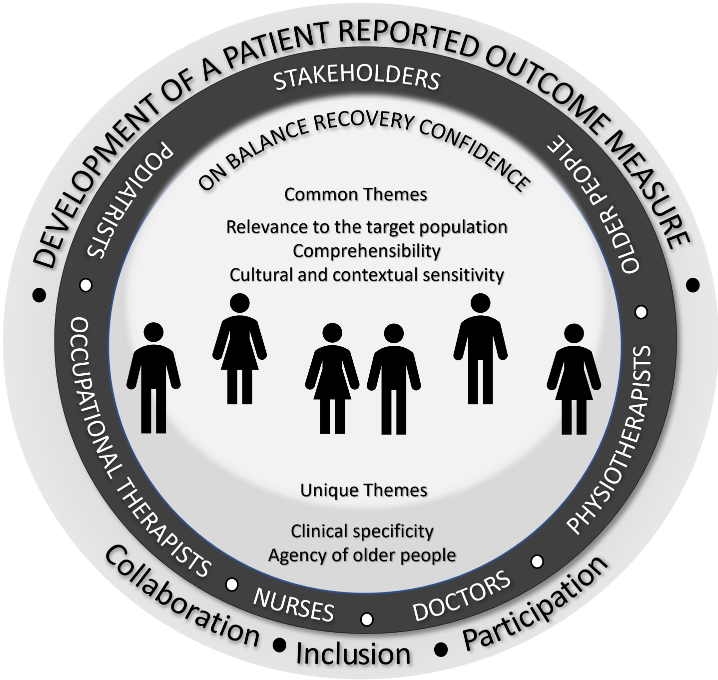

Figure 8.4.2 Developing a PROM for older people with practice development principles.

Theme (1): Relevance to the target population

Both groups of stakeholders viewed that the activities presented to the older people needs to be relevant and be appropriate for the construct of balance recovery confidence. This meant that the proposed items should be relatable to the older person. The scenarios described should allow older people to appreciate the need to recover balance when faced with different forms of perturbations, or likely to be unrealistic scenarios when older people take precautions to avoid a loss of balance (Box 8.4.1).

Theme (2): Comprehensibility

Both groups expressed that comprehensibility of the content was important, not only to the target population but also to the healthcare professionals. The list of opinions expressed encompasses that content should be understood by older people as intended and facilitate the ease of administration in practice (Box 8.4.2).

Box 8.4.1: Examples to develop the theme: Relevance to the target population

Meaning unit: “Normally one tends to hold on to the railings as we walk up hold on the railing” – CDA 6; “Hold on the railing” – CDA 9

Condensation: Holding railing on stairways use

Code: Use of rails on climbing stairs

Category: Approach towards stairs climbing

Meaning unit: "Have never experienced it (bending over to pick up an object) myself and have never heard of any friends losing balance this way." – CDA 8

Condensation: Unlikely to lose balance on bending to pick up an object

Code: Steadiness when bending to pick up an object

Category: In-balance on picking up activity

Meaning unit: “Rarely seen this (trip while approaching a bus) happening.” – CDA 8

Condensation: Unlikely to experience a trip while approach a bus

Code: Steadiness when walking towards a bus

Category: In-balance walking towards a bus

Meaning unit: “Very unlikely (to trip against a table leg) as one tends to stand up a walk slowly as the table leg is not obstructing” - CDA 6

Condensation: Unlikely to trip against a table leg

Code: Unlikely trip caused by table

Category: Perturbation type

Meaning unit: “(Slip on a puddle of water) at home while mopping the floor, or wet bathroom floor.” - CDA 1

Condensation: Likely slip while mopping or in bathroom

Code: Slip on wet floor

Category: Type of perturbation

Meaning unit: "Suggest using activities that are common to culture and daily tasks that are applicable to every older adult." – HCP 9.

Condensation: Use activities common to culture and daily task of older adults

Code: Older adults’ regular activities

Category: Relatable activities

Meaning unit: "I think the pictures really help and it's also localised." – HCP 17.

Condensation: Helpful and localised pictures

Code: Older adults’ regular activities

Category: Relatable activities

Meaning unit: “Senior is showering while standing and he does not have any hand rails to hold on to.” – HCP 28

Condensation: Showering

Code: Older adults’ regular activities

Category: Relatable activities

Box 8.4.2: Examples to develop the theme: Comprehensibility

Meaning unit: "Sounds very academic and long. Let it be simple for the layman to understand." - CDA 8; "Rephrase the question/statement please. - CDA 1"; "Not the most easy to understand." – HCP 15; "The instructions, I feel may be too profound for the majority of the OA to understand. Perhaps, simpler English might help." – HCP 1; "Instruction should be easy to understand and apply" – HCP26; "It may be hard for administrator to explain to participants too." – HCP 23

Condensation: Content language

Code: Understanding of content

Category: Comprehension

Box 8.4.3: Examples to develop the theme: Cultural and contextual sensitivity

Meaning unit: "Less chance as not everyone rears a dog" – CDA 6; "Do not own a pet" - CDA 2

Condensation: Not owning a pet

Code: Personal choice

Category: Lifestyle

Meaning unit: "will some cultures not have had the experience of walking a dog?" – HCP 4

Condensation: Owning different sizes of a pet

Code: Personal choice

Category: Lifestyle

Meaning unit: "The bathtub situation will be applicable to most participants overseas, but in Singapore, shower without a bathtub will be better?" – HCP 17; "Majority of us do not have bathtub at home. A bathtub definitely increases your chance, especially an OA to fall." – HCP 3

Condensation: Use of bathtub

Code: Toilet

Category: Indoor environment

Meaning unit: "I don't think the use of alighting is as common overseas amongst general population as it is here in Singapore. The picture makes it very obvious though." – HCP 24

Condensation: Use of alighting

Code: Transportation

Category: Outdoor environment

Meaning unit: "Most drains are covered." – CDA 8

Condensation: Covered drains

Code: Public infrastructure

Category: Outdoor environment

Theme (3): Cultural and contextual sensitivity

Older people and healthcare professionals had experienced views relating to cultural and contextual sensitivity issues. These issues are wide-ranging, encompassing social lifestyles and environmental infrastructure. Some of these views presented by the different stakeholders are illustrated (Box 8.4.3).

Theme (4): Clinical specificity

Healthcare professionals opined improvements of PROM content from their clinical expertise when reviewing the content of the PROM. Some of these views are illustrated to demonstrate their views for PROM developers to refine the content to fit into the objective of the PROM (Box 8.4.4).

Box 8.4.4: Examples to develop the theme: Clinical specificity
Meaning unit: "This scale is not commonly used in hospital setting. Most hospitals at inpatient setting use Morse scale." – HCP 2
Condensations: Where this instrument will be used
Codes: Clinical use
Categories: Context of setting
Meaning unit: "I think reactive balance is a more specific term to unanticipated losses of balance, and it aligns with the terms used in motor control & biomechanic" – HCP 4
Condensation: Reactive balance for unanticipated losses of balance
Code: Clinical use
Category: Clinical knowledge
Meaning unit: "Though the picture is quite self-explanatory, might want to consider the position, i.e., loses balance in standing or sitting when bus starts to move or accelerate." – HCP 16
Condensation: Consideration in the specificity of position
Code: Types of perturbation
Category: Clinical specificity

Theme (5): Agency of older people towards the prevention of falls

The opinions provided by community-dwelling older adults revealed the sense of personal responsibilities that older people should take to manage a fall threat. Some views expressed by the older participants reiterated that older people need to take precautions for avoiding precarious situations risking a fall (Box 8.4.5).

Box 8.4.5: Examples to develop the theme: Agency of older people towards the prevention of falls
Meaning unit: "Seniors should look out for themselves and not depend on drivers to drive off only when everyone is seated." – CDA 1
Condensation: Seniors should look out for themselves
Code: Cognitive awareness
Category: Mindfulness
Meaning unit: "Normally one tends to hold on to the railings as we walk up hold on the railing." – CDA 6
Condensation: Hold on to the railings
Code: Ways to avoid falls
Category: Falls avoidance strategy
Meaning unit: " will switch on light." – CDA 9
Condensation: Switch on light
Code: Ways to avoid falls
Category: Falls avoidance strategy

8.4.5 Discussion

The presented themes provided empirical evidence that having all stakeholders participating in a PROM development would encourage the transformation of understanding towards person-centredness and create a shared vision (McCance et al., 2013). Having all relevant voices involved in the care of the older people would contribute towards the development of the PROM of balance recovery confidence that can support older persons' agency to manage falls.

The four themes: (1) "Relevance to the target population"; (2) "Comprehensibility"; (3) "Cultural and contextual sensitivity"; and (4) "Clinical specificity" obtained were consistent with the guidelines for development and selection of PROMs described by De Vet et al. (2011) and the "Consensus-based Standards for the selection of health Measurement INstruments (COSMIN)" (Prinsen et al., 2018). The fifth theme, "Agency of older people towards the prevention of falls", is distinctive for older people in the context of falls management. This theme is unsurprising, given that older people have expressed their desire to preserve their identity and independence when dealing with falls (Clancy et al., 2015). Self-efficacy is a closely related concept to person-centred care (Wilberforce et al., 2016). Given that person-centred theory view persons as self-determining, self-efficacy is concerned with persons beliefs around having the power to realise their intentions and affect change (B. McCormack

& T. McCance, 2017). PROM developers need to recognise the importance of knowing patients as persons and engaging the person as an active partner to enable them to be self-determining and empower them to influence issues affecting them (Fors, 2015).

Theme 1: Relevance to the target population

PROM content needs to be relevant for the construct of interest within a specific population and the context of use (Terwee et al., 2018). Healthcare professionals representing different clinical disciplines through their lens of clinical experts reviewed items based on the potential clinical utility of the PROM. In contrast, community-dwelling older adults reviewed the content as layperson experts. They gave opinions on how they or their peers would perceive the information. The diversity of views provided by different stakeholders allowed PROM developers to understand the meaning of content from various stakeholders fully.

Theme 2: Comprehensibility

Determining comprehensibility is best determined by the target population since the target population would be completing the PROM themselves (Wiering et al., 2017). The group of older people articulated the need of ensuring that the language used should be made easy for the general older people population’s understanding. In this study, healthcare professionals opined that comprehensibility would also be needed for PROM administrators, e.g., administrators needing to explain the PROM to the older people. The standpoint of healthcare providers expects that barriers, e.g., administering time should be overcome to encourage the use of PROMs in clinical practice (Fleischmann & Vaughan, 2018). Some healthcare professionals had critiqued the PROM from another perspective, i.e., how their patients would perceive, based on their underpinning assumptions. Clinical experts, taking on a perspective of their patients, may be attributed to clinicians believing that patients have limited health literacy, low education, or that older adults do not want to participate in treatment decisions and prefer clinician-led care models (Politi, 2013).

It is essential for clinicians to respect patients' perspectives: for their values, preferences, and expressed needs. To realise person-centredness, it is essential for clinicians to challenge their assumptions regarding older adults’ desires to contribute. Moreover, the clinician should provide adequate support that enables patients to contribute to practice developments in a meaningful way, if they so wish (B. McCormack & T. McCance, 2017). Given that COSMIN (Terwee et al., 2018) has recommended that the target population assess comprehensibility, we weighted our content evaluation criteria for revising items more towards the opinions provided by the community-dwelling older adults than the healthcare professionals.

Theme 3: Cultural and contextual sensitivity

The theme of cultural and contextual sensitivity has been given little attention in PROM content development literature. The relative weight of opinions contributed by patients and healthcare professionals have been widely debated based on emic and etic viewpoints (Triandis, 1994; Magasi et al., 2012). There is no clear consensus on whose perspective should be prioritised. Emic explanations are based on insiders' views and understandings of how things work. Etic reasons are based on outsiders' perspectives and interpretations. Both emic and etic approaches have produced distinct explanations with their purposes but have often been viewed as complementary.

The opinions shared by both community-dwelling older adults and healthcare professionals encompasses different social contexts, realism, ethnicity, societal infrastructure. The occasional conflicting views were attributed to the diverse cultural and contextual community of experts from six countries (Singapore, UK, US, Malaysia, Australia and Hong Kong Special Administrative Region of the People's Republic of China). The participation of international stakeholders provided a rich level of consideration of complex issues. The meanings of local culture and context encourage developers to acknowledge that PROMs should remain suited to the community-dwelling older adults as a person, not just a patient.

Theme 4: Clinical specificity

The theme, “Clinical specificity”, derived from healthcare professionals, presents the value of having representatives from different healthcare disciplines participating in the development of a PROM. Concerns raised on issues ranging from clinical applications to clinical domain knowledge allowed PROM developers to consider varying concerns of the PROM to be used for their patients in clinical practice. The feedback also reflected a potential "buy-in" from healthcare practitioners attending to older people on falls-related issues. The consensus of the content received for the PROM of balance recovery confidence for older people strengthen PROM developers’ and healthcare professionals’ confidence that the PROM could be purposefully used in clinical practice.

Theme 5: Agency of older people towards the prevention of falls

The theme, "Agency of older people towards the prevention of falls" was determined based on the views presented by a group of older people. Older people validated the content based on what they or their perspectives of older people would encounter in their regular day-to-day activities. They suggested ways on how older people should overcome the potential risks of falls. Older people critiquing each item were based on their personal experiences. Personal strategies were cited on what older people should do in specific scenarios, e.g., holding on a handrail during stairs climbing or switching on the room light. These views displayed a high sense of perceived self-efficacy towards managing falls and supported Bandura's self-efficacy conceptual framework (Bandura, 1977).

Various self-efficacy sources include personal experiences, vicarious experience, verbal persuasions, and emotional arousal, can influence self-efficacy and alter their performance level (Bandura, 1977). Figure 3 illustrates the conceptual framework of balance recovery confidence, which adapted the Bandura (1977) self-efficacy framework with other relevant concepts of near-falls (Maidan et al., 2014), balance recovery mechanisms (Maki & McIlroy, 1997), and PROMs on falls efficacy (Soh, Lane, et al., 2021).

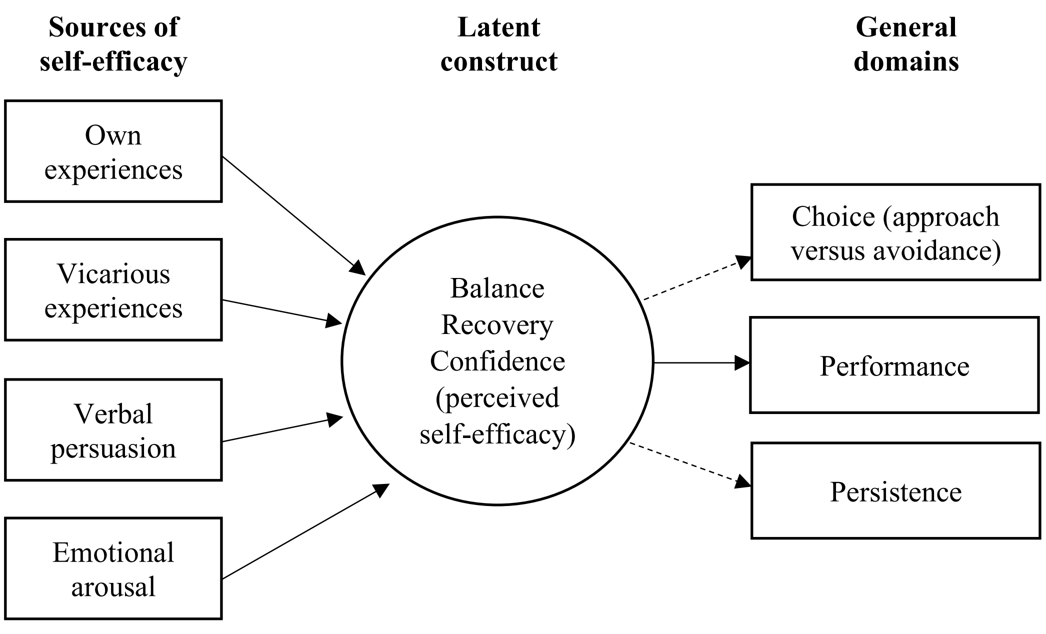

Figure 3 The conceptual framework of the Balance Recovery Confidence (BRC) scale. The BRC scale's conceptual framework has been developed and refined based on the literature from Bandura's self-efficacy concept, Maki's change-in-support paradigm, the definition of a near-fall and the systematic review conducted (Albert Bandura, 1977; Maidan et al., 2014; Maki & McIlroy, 1997; Soh et al., 2020).

8.4.6 Practice development approach for constructing PROMs

Practice development is a continuous process of improvement towards increased effectiveness in patient-centred care (McCormack & Garbett, 2003). From this perspective, patient-centred PROM developers need to empower, engage and emancipate all stakeholders when constructing the content of a PROM with the persons of interest in mind. By adopting principles of collaboration, inclusion and participation (CIP) in PROM development, new perspectives were acquired by all individuals involved in the process, cascading toward the potential transformation of person-centred care of older people in falls management practices.

This knowledge translation is evident with content revision across the different stages of the consensus methods used to develop the PROM. Rycroft-Malone et al. (2013) described that knowledge translation relies on facilitating and enabling contexts and cultures. The participation of all stakeholders centring on the care of the older person participating in the development of a PROM of balance recovery confidence for older person showcased the values of practice development. The use of creative imagination of employing collaboration, inclusion and participation (CIP) principles are encouraged for PROM development, enabling creating an authentic instrument used by the persons of interest. PROM developers should be cognizant of the abundant knowledge that all stakeholders involved in the care of persons can provide during PROM development (De Vet et al., 2011; Navarro, 2020).

8.4.7 Limitation

There were some limitations given the nature of the consensus methods chosen to develop a PROM. Delphi technique requires all participants to be literate and technologically capable to complete the online surveys. Therefore, those not meeting the eligibility criteria could not participate, restricting the participation of certain groups of older people. The Delphi Technique also limited the interactions between both panels of experts and the PROM developers. To improve knowledge translation, we provided the findings from Round 1 to all participants to make an informed decision in the second round.

8.4.8 Conclusion

Themes that emerged from the opinions given by all stakeholders provide more significant meaning to the content of PROMs created in person-centred practice. All stakeholders involved in the care of persons would aid in creating an authentic PROM. Collaboration, inclusion and participation, the principles of practice development, are fundamental in the early stages of PROM development. The opinions given by various stakeholders should be deliberated when crafting the PROM content. It is of hope that PROMs would serve their fullest potential in practice.

8.5 Concluding remarks

Three publications have been embedded into the thesis to illustrate the efforts of using the work of developing a BRC scale to potentially influence falls practice, research practice and PROM development. Within falls practice, falls efficacy has often been viewed either as fear of falling or balance confidence. This may potentially limit clinicians and researchers considering other forms of self-efficacy for older adults to prevent and manage falls. The extended interpretation of falls efficacy as the perceived ability to prevent and manage falls allows researchers and clinicians to use appropriate PROMs to evaluate different constructs of interest, for example, balance confidence, balance recovery confidence, safe landing confidence, and post-fall recovery confidence.

Other aspects of research practice and PROM development addressed relate to reflexivity and practice development. A developed PROM is ultimately used by the target population to give a personal perspective on their health status without interpretation by anyone else. A personal ontological position of pragmatism was presented to critically reflect on the role of ‘researcher as instrument’ when constructing a PROM. This endeavour attempted to emphasise the role of reflexivity in research. In the context of developing a PROM that is useful for the target population, a practical concern was to construct one that is relevant and relatable. A PROM that is constructed using grand theory risks lacking practicality and applicability. Researchers are encouraged to re-examine their own beliefs, judgements and practice during the research process and how these may influence the research. For PROMs, the key practice development principles of collaboration, inclusion, and participation encourage the work to be person-centred (McCormack & Garbett, 2003). Engagement of all stakeholders to construct a PROM can result in rich insights, which can boost impact. PROM developers are encouraged to engage different stakeholders from relevant disciplines and make the whole PROM development process meaningful and rewarding.

Chapter 9

General discussion

“New Ways

Here new ways go.

Quietly let us fare.

Come, let us seek

a new flower, and fair.

Throw away what we possess!

Everything attained, complete

lifelessly oppresses us,

not worthy of dream, song and deed.

Life is that which awaits,

what one cannot know of, or speak...

Come, let us forget!

New things and fair let us seek!”

– Karin Boye (Trans: David McDuff).

“The emphasis is on *being with* another rather than the doing to or doing for.”

– Jan Dewing.

9.1 Introduction

Chapter 9 serves as a general discussion of the different studies conducted in the thesis. First, the main findings of the different studies will be presented. Then, the contribution of the findings to the current literature of falls-related self-efficacy PROMs will be discussed. Next, insights will be presented on why specific steps are imperative for PROM development with a focus on three aspects: the need to conduct a systematic review of measurement instruments, the importance of involving the target population and healthcare professionals for content development; and the use of two measurement theories to develop and evaluate the PROM. Finally, the chapter will conclude with recommendations for future directions regarding developing and evaluating falls-related self-efficacy PROMs.

9.2 Main findings

In Chapter 1, four studies were proposed to meet the overall aim to develop the BRC scale for community-dwelling older adults. The main findings are as follows:

Study 1: To conduct a systematic review of the measurement properties of existing PROMs on falls-related self-efficacy used for community-dwelling older adults (Chapter 3).

Chapter 3 reported the first study evaluating 18 PROMs from 35 published studies. These studies were retrieved from five electronic databases searched between January 1990 and May 2019 using COSMIN guidelines. The identified PROMs were categorised as those measuring falls efficacy (11 PROMs), balance confidence (4 PROMs), and fear of falling (3 PROMs). Their respective studies on content validity and structural validity were evaluated for their methodological quality.

The review identified that many falls-related self-efficacy PROMs lacked high-quality studies on content development and content validity. The various critical aspects of relevance, comprehensiveness and comprehensibility - quality standards expressed by COSMIN (2021) - were not thoroughly investigated. Many PROMs were developed without involving the target population and were, therefore, rated with lowered quality scores. The systematic review posited that the three PROMs constructed to measure fear of falling need to be differentiated from PROMs measuring falls-related self-efficacy. While PROMs for fear of falling were given names relating to self-efficacy, they were conceptualised to measure an emotional construct, namely the concerns about falling or fear of falling. Fear relates to the judgement of personal inefficacy to cope with potential threats and the level of aggregate consequences (Bandura, 1986). While closely related, fear is distinguishable from self-efficacy.

Self-efficacy relates to the perceived efficacy to cope with potential adverse events is a cognitive construct (Bandura, 1977). Many falls efficacy PROMs were conceptualised to measure the perceived ability to perform activities of daily living without falling or losing balance, except for two PROMs: the "Perceived Ability to Manage Risk of Falls or Actual Falls" (PAMF) scale (Tennstedt et al., 1998) and the "Perceived Ability to Prevent and Manage Fall Risks" (PAPMFR) scale (Yoshikawa & Smith, 2019). Both PAMF and PAPMFR scales were constructed to measure a range of falls-related self-efficacy in respect of the perceived ability of older adults to prevent and manage falls.

For structural validity, the review showed that many existing falls efficacy PROMs had good methodological quality studies demonstrating their unidimensionality. However, a PROM that is unidimensional may not measure the construct of interest thoroughly. The findings of different PROMs' content suggested that falls efficacy should not be interpreted as synonymously with balance confidence. Falls efficacy was viewed to encompass many aspects of falls-related self-efficacy: balance confidence; balance recovery confidence; safe landing confidence; and post-fall recovery confidence. Since many PROMs did not involve the target population to construct or validate the content, it is plausible to consider that many existing PROMs might be inadequate to measure the different aspects of falls efficacy accurately in the target population.

Based on the systematic review, existing PROMs were identified not to be constructed purposefully for measuring balance recovery confidence. This study justified the need to develop a new PROM of balance recovery confidence with an emphasis on using a proper PROM development methodology.

Study 2: To assess the feasibility of studying near-falls and the use of balance recovery manoeuvres in community-dwelling older adults (Chapter 4).

Given that the balance recovery confidence is a novel concept, there was a need to investigate whether the construct is relatable and relevant to the target population. Chapter 4 presented a feasibility study conducted with a sample group of 30 community-dwelling older adults for this purpose.

The second study showed that community-dwelling older adults were able to identify concepts of near-falls and balance recovery. They had no issues distinguishing between falls and near-falls and if a near-fall occurred, they were able to identify the types of balance recovery manoeuvres used to arrest the falls. The preliminary results also showed that slightly over half of the target population experienced at least one near-falls during the 21-day study period. This number was higher than a previous study reporting 35% of older adults experiencing a near-fall within a similar study period (Ryan et al., 1993).

The study added new knowledge to the current literature by reporting the balance recovery manoeuvres employed to arrest falls. The most common strategy was the lower limb stepping strategy (52.8%), followed by the reach-to-grasp strategy (36%), then use of other body parts, e.g., hip and trunk (11.2%). This observation fitted the definition of near-falls as a stumble event or loss of balance that would result in a fall if sufficient recovery mechanisms were not activated (Maidan et al., 2014). More studies would be required to illuminate the roles and the impact of employing different perceived balance recovery manoeuvres to arrest falls. Overall, the feasibility study rationalised that balance recovery confidence was relevant and relatable to community-dwelling older adults.

Study 3: To develop and validate the content of a new PROM of balance recovery confidence in community-dwelling older adults (Chapter 5).

Chapter 5 detailed the content development and validation of a new PROM constructed to measure balance recovery confidence in community-dwelling older adults. The third study had a list of 99 items generated by 12 community-dwelling older adults using two focus group sessions that employed the Nominal Group Technique (McMillan et al., 2016). Thirty-two items were then identified from the list as important for measuring the construct of interest in the target population. The items were also congruent with the conceptual self-efficacy framework of balance recovery performance.

The preliminary version of the PROM, which included the suggested name for the scale, instructions, response option, recall period and the list of 32 items, were reviewed by two panels of experts, 28 healthcare professionals and 10 community-dwelling adults aged 65 years and older. After two-round of reviews, the list of 32 items was reduced to 19 items. All aspects of the PROM were finalised with the panels' consensus. The final version of the PROM was named as the Balance Recovery Confidence (BRC) scale. The instruction for the respondents was for them to rate "How certain you are, now, that you can recover your balance and arrest a fall in each of the following scenarios." A 11-point rating options was used for the 19 items. The scale achieved acceptable face validity.

Study 4: To assess the psychometric properties of a newly developed PROM of balance recovery confidence (Chapters 6 and 7).

Chapter 6 presented a study protocol that detailed the field test evaluating the psychometric properties of the PROM of balance recovery confidence for community-dwelling older adults. Chapter 7 reported the field test of the BRC scale and illuminated its psychometric properties. This study showed that the BRC scale was accepted by a sample of 84 community-dwelling older adults. The scale measured a single factor and showed good internal consistency and test-retest reliability. Moderate and positive correlations were reported between the BRC scale, ABC Scale, LLFDI and the Mini BESTest. The BRC scale had a moderate and negative correlation with the FES-I scale. Compared against the ABC, LLFDI, and FES-I scales, the BRC scale had a greater congruence with the reactive postural control section of the Mini-BESTest. There were weak and positive correlations between the BRC scale, the handgrip strength dynamometer and the 30-second chair stand test.

The internal structure of the BRC was good. All items used the full range of response options except for three items (Item 3: Recover from a loss of balance while walking to the toilet, Item 10: Recover from a loss of balance while doing light exercises and Item 11: Recover from falling forwards while walking down a gentle slope). These items used response options ranging between 2 (Low certainty can do) and 10 (High certainty can do). There were no missing scores, which implied that all items were comprehensible and suitably administered. There was no floor effect for any of the items. However, nine of the 19 items had a ceiling effect. The field test results showed that most items were suitably constructed, in other words, neither extremely difficult nor extremely easy for healthy and independent community-dwelling older adults.

9.3 Insights of PROM development

The development of the BRC scale posited three important responsibilities of its developers: (1) To perform the due diligence by ensuring that no similar PROMs exist in the literature, (2) To adopt a robust methodology to construct a PROM, if a new one is needed (3) To be committed to elucidating the psychometric properties of the new PROM, once constructed. These responsibilities are crucial to curtailing the practice of constructing unnecessary PROMs in a field with abundant instruments. Developers must recognise that introducing new PROMs could create risks, such as confusion among researchers trying to select an appropriate instrument or difficulties with results interpretation when conducting meta-analysis studies. In the event that the PROM was found to be poorly or insufficiently validated, then it would be neglected at best or, at worse, compromise the results of interventions. Both outcomes lead to a waste of resources, and this is unethical.

The reiteration of these critical responsibilities is essential to encourage responsible practices among PROM developers. Key steps must be undertaken to develop a PROM adequately. The following sections will discuss the use of a systematic review, the involvement of different stakeholders for content development, and the application of two measurement theories to develop and evaluate PROM.

The use of a systematic review

The first responsibility of performing due diligence is addressed by conducting a systematic review of the literature. The purpose of the review would be to identify if there are any suitable instruments relevant for the construct of interest and to assess the quality of their measurement properties. For the context of developing a falls efficacy-related PROM, the review had three functions. First, there was an imperative need to clarify the literature of PROMs on measuring common falls-related psychological concerns. Previous systematic reviews (Jorstad et al., 2005; Moore & Ellis, 2008) highlighted the confusion in the literature over the use of different PROMs. Second, the review would provide ideas to developers on what a new PROM should and should not look like. This would help the design of the new PROM, address previous limitations, and attend to critical errors to avoid similar failures. Third, the review would identify whether a new PROM should be constructed from scratch; a PROM adapted from existing instruments would save time and effort. If no PROM is suitable, then a new PROM should be developed using a proper methodology to ensure its high quality.

The first function of providing greater clarity was achieved through illuminating the historical development of different PROMs. There were some factors contributing to the confusion in the literature. First, there was incongruence between the PROMs purported for falls efficacy. The original conceptualisation of the Falls Efficacy Scale was related to the perceived ability of older adults to perform activities of daily living without falling (Tinetti et al., 1990). However, the seminal Falls Efficacy Scale (FES) was posited as a measure of fear of falling. This fear was determined based on a total greater than 70 out of a possible 100 on the FES with higher scores denoting less confidence (Tinetti et al., 1990). A subsequent study countered their own work by reporting that individuals could have high falls efficacy and were afraid of falling (Tinetti et al., 1994). Second, the (dis)similarity of conceptualising the measures of falls efficacy and balance confidence. The ABC Scale (Powell & Myers, 1995) was developed using a similar construct question applied for the development of the FES. This led to views that scales of balance confidence and the scale of falls efficacy were inevitably measuring similar constructs (Hadjistavropoulos et al., 2011). However, other PROMs for falls efficacy, for example the Perceived Ability to Manage Risk of Falls or Actual Falls scale (Tennstedt et al., 1998) and the Perceived Ability to Prevent and Manage Fall Risk scale (Yoshikawa & Smith, 2019) were designed to assess the different self-efficacy to cope with the various aspects of managing falls. This suggested that falls efficacy was conceptualised with a broader framework extending beyond balance confidence. Third, some PROMs that conceptualised to measure fear of falling were named with the term, “falls efficacy”. Some examples included the FES-I (Yardley et al., 2005) and the Icon-FES (Delbaere et al., 2011). According to Yardley et al. (2005), the term “falls efficacy” was retained in the naming of the FES-I to acknowledge the historical development of the scale. It is, therefore, important for researchers and clinicians to be able to distinguish the different PROMs to be used to measure the specific construct of interest.

The review’s second function was achieved by identifying what the new PROM should and should not look like. This showed that various aspects of the PROM’s content development needed serious deliberation: PROM’s name, instructions, response options, recall period, the number of items and how the items were constructed. The process of PROM naming is little mentioned in the literature. However, inappropriate naming can lead to confusion in selecting suitable falls efficacy PROMs. Instructions, response options, and recall period listed in the PROM should be unambiguous and well understood by the target population. The content of previous PROMs could be used as a reference for developing the new PROM. For example, existing instruments suggest the number of items listed in a PROM should fall within the range of four to 30, although the majority fall between 10 and 16. An excessive number of items places an unnecessary burden upon respondents and risks having missing data (Diamantopoulos et al., 2012). Another consideration is the format of response options. Some PROMs had options of 1 to 3, while others had 11-point options of 0 to 100. To be consistent with Bandura’s (2006) guide to constructing a self-efficacy scale, a single unit interval response format should range from 0 to 10, where “0” will denote “cannot do at all”, “ 5” will represent “moderately certain can do”, and “10” will reflect “highly certain can do”. A suitably formatted response scale allows respondents to rate the strength of their belief in their ability to execute the performance. Scherpenzeel (2002) argued that an 11-point scale from 0 to 10 could minimise the categorisation effects seen in scales with fewer points by providing more discriminating options for respondents. She also said such a scale could improve data analysis by allowing clearer interpretation of reference points and reduce measurement error because offering more response options lessens the likelihood of a random selection.

The third function was accomplished by establishing that existing PROMs were unsuitable for measuring balance recovery confidence. PROMs for balance confidence centre on individual's perceived ability of proactive balance control. Proactive balance control is different from reactive balance control (Huxham et al., 2001). Adapting these PROMs for measuring balance recovery confidence would be inappropriate. Other PROMs for falls efficacy did not have items that suitably measure perceived reactive balance recovery abilities. For example, the three items, "Steadiness on their feet", "Balance while walking" and "Ability to prevent falls" in the Perceived Ability to Prevent and Manage Fall Risks scale (Yoshikawa & Smith, 2019) are not specific for the construct of interest. Therefore, in order to measure perceived reactive balance recovery control, the development of a new PROM for balance recovery confidence was justified.

Conducting the systematic review using the COSMIN guidelines had its challenges. First, the process of evaluating the risk of bias is laborious. Bias relates to transparency and whether the research outcomes had been influenced by predetermined ideas or prejudiced in a particular direction (McKenna & Heaney, 2021). To evaluate the risk of bias of content validity and structural validity in all studies, 70 indicators of standards were rated using a 4-point rating scale (very good, adequate, doubtful, or inadequate). Thirty-five studies were included for the systematic review of falls-related self-efficacy PROMs. This meant that a total of 2,450 indicators (70 indicators x 35 studies) was evaluated. The results were then qualitatively summarised to determine whether the overall rating for each PROM's content validity was sufficient considering the evidence of its overall relevance, comprehensiveness and comprehensibility. The overall rating had to be accompanied by a grading given for the quality of the evidence using a modified GRADE approach to reflect how trustworthy the overall ratings were (Prinsen et al., 2018).

Another challenge faced related to the risk of bias in the opinion-based rating method. The general rules recommended when conducting the rating evaluation (Terwee et al., 2018) were:

- A standard is rated as very good when there is evidence that the quality aspect of the study to which the standard is referring is adequate.

- A standard is rated as adequate when relevant information is not reported in an article, but it can be assumed that the quality aspect is adequate.
- A standard is rated as doubtful if it is doubtful whether the quality aspect is adequate.
- A standard is rated as inadequate when evidence is provided that the quality aspect is not adequate.
- The overall rating is obtained by taking the lowest rating of any standards based on the "worst score counts" method.

Many studies of content validity on falls-related self-efficacy PROMs lacked sufficient information about whether key aspects such as relevance, comprehensibility or comprehensiveness were adequately investigated. For example, the anglicised version of the FES (Parry et al., 2001) reported achieving face validity, acceptability and relevance for older adults without offering any supportive details. Another PROM, the Modified FES – Serbian (Aleksic et al., 2018) reported the involvement of a sample of 10 older women aged to evaluate the simplicity, clarity and relevance of the PROM. No additional information of the methodology was provided. In the review, the final judgement of the quality of many PROMs had to be based on extensive discussions between the reviewers.

Involvement of target population and clinical experts for PROM's content development and validation

The second responsibility required of PROM developers as part of a robust methodology is the early involvement of the target population. For the BRC scale, content was generated by a sample group from the target population of community-dwelling older adults and subsequently validated by a second sample group alongside clinical experts. The contribution of the older adults concerned the level of symptoms, functioning and perceived health. Healthcare professionals provided inputs based on their clinical expertise and extensive experience from treating the target population.

Content development was accomplished through two focus group sessions conducted with 12 community-dwelling adults aged 65 years and older, as presented in Chapter 5. The older adults generated items that they viewed essential to measure balance recovery confidence in the groups they represented. Two questions were posed to the participants: (1) "What common and everyday activities that older people participate in (at home or outside the home) when a near-fall can occur?" and (2) "How can older people avoid a fall in these near-fall events?" These questions were constructed to be conceptually differently from those previously used to develop a list of items for balance confidence or falls efficacy, such as “Name the 10 most important activities essential to independent living, that while requiring some position change or walking, would be safe and nonhazardous to most elderly persons” (Powell & Myers, 1995; Tinetti et al., 1990). Applying properly worded questions based on construct theory for the target population can generate meaningful and interpretable items (McKenna et al., 2019).

Conducting focus group sessions with the target population is a good method of generating a comprehensive list of items (De Vet et al., 2011). However, it is important to be aware that respondents may not discuss topics that the developers want to discuss, and so the information that emerges may not be useful for the PROM (McKenna et al., 2019). Therefore, it is imperative for PROM developers to be explicit about the construct to be measured and the conceptual framework (De Vet et al., 2011). The BRC scale was detailed and conceptualised using the Bandura’s (2006) self-efficacy framework as described in Chapter 2. The proposed items offered by the sampled target population were put into three categories:

- Choice: Items recommending avoidance of situations carrying the threat of a fall, such as walking on a wet floor, or the use of a safer approach such as holding a rail while on a staircase.
- Performance: Items that reflected performance to arrest falls in different scenarios using different recovery manoeuvres.
- Persistence: Items focusing on efforts to overcome the threat of falls, such as exercising to stay fit and agile.

Content validation of the BRC scale employed a pragmatic approach of using the internet-based Delphi Technique to reach out to a wider group of healthcare professionals with the participation of a new group of community-dwelling older adults. The Delphi Technique facilitated a group of experts to come together, address posed questions, and reconcile various inputs towards a common ground (Donohoe et al., 2012). This study, reported in Chapter 5, involved the participation of 28 healthcare professional representing physiotherapy, occupational therapy, nursing and podiatry, with nurses from countries including Singapore, the UK, the US, Malaysia, Australia and Hong Kong, alongside 10 community-dwelling older adults from Singapore.

The diversity of opinions from healthcare professionals and community-dwelling older adults provided rich information for PROM developers. However, there were some challenges to refine items to achieve a consensus on the PROM's relevance, comprehensiveness and comprehensibility. PROM developers had to appreciate the philosophical paradigms of different experts and a pragmatic epistemology was applied to amend items accordingly. Pragmatic epistemology rejects the demands for a scientific or objective basis of criticism grounded in a grand theory, in favour of participants' own knowledge and self-understandings (Bohman, 2021). The feedback from clinical experts included issues such as the mechanics of perturbations and directions of fall. In contrast, feedback from layperson experts centred on issues such as personal agency and applicability. These multi-faceted concerns had to be grappled with to construct a final list of content as an adequate reflection of the construct to be measured by the PROM. Overall, the validation of the BRC scale's content was based on epistemic and practical principles.

Another concern was whether participants were able to clearly understand the content as required for the validation process through the Delphi Technique. Clarification methods, such as, "think aloud" and probing" could not be adequately applied using the email-based Delphi Technique, unlike face-to-face meetings. To mitigate this limitation, a two-round evaluation was used. Each round provided the participants with information and set out the objectives to be achieved. The inputs given in the second round meant a third round would not be required, and also reflected that the experts were clear about PROM's content. Face validity was achieved. Other methodological limitations with the use of Delphi Technique such as the lack of engagement with those unable to use electronic communication, were accepted as trade-offs inherent in this choice of consensus method (McMillan et al., 2016).

Using two measurement theories to develop and evaluate the PROM

The third responsibility in relation to the psychometric properties of the newly developed PROM surrounds the use of suitable measurement theories. A measurement theory concerns the rules on how the scores generated by items represent the construct to be measured (Edwards & Bagozzi, 2000). PROMs for unobservable constructs require a measurement theory to provide objectivity in describing the statistical relationships between the items and the construct (De Vet et al., 2011).

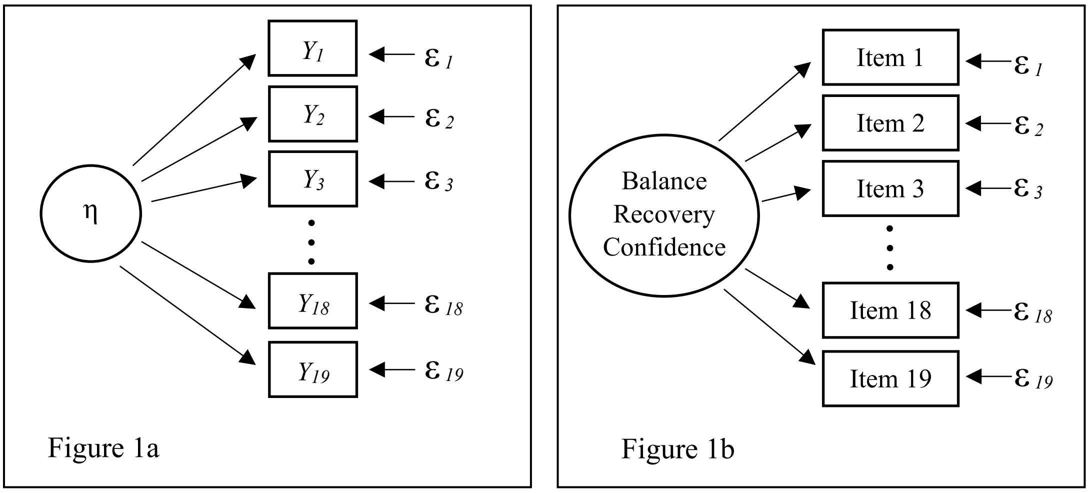

Figure 9.1a Classical Test Theory's statistical relationship between items and the construct where η represents the unobservable construct, Y_i represents a specific observable item, and ε represent an error which will accompany each *Y*. The figure is adapted from Figure 2.4 Chapter 2 Concepts, theories and models, and types of measurements (De Vet et al., 2011). **Figure 9.1b** Reflective conceptual framework of the BRC scale.

The validation of the BRC scale employed two measurement theories, the Classical Test Theory (CTT) and the Rasch Measurement Theory (RMT). Each theory with its advantages and disadvantages will be discussed to understand the psychometric properties of the BRC scale. However, prior to discussing the importance of using different measurement theories to develop and evaluate a PROM, the conceptual framework of the PROM should be made explicit. This framework describes the relationships of the items and the construct (Fayers & Hand, 1997). This could either be a reflective model or a formative model (De Vet et al., 2011). A reflective model refers to the intimate relationship between items and construct whereby all items will change when the construct changes. In contrast, when a change in the construct does not affect all items, then the underlying model is formative. The conceptualised reflective framework of the BRC scale (Figure 9.1) was made explicit in Chapter 5 when items were selected based on Bandura's self-efficacy concept.

Employing two measurement theories provides a comprehensive understanding of the PROM based on its data-model relationship (Nijsten et al., 2006). CTT is a descriptive approach that assesses item performance using the basic formula is $Y_i = \eta + \varepsilon_i$. Y_i is the observed score of the item i, η is the 'true' score of the construct to be measured and ε_i is the error term for item I (Lord & Novick, 2008). The formula expresses that an individual's item score (the observed score Y_i) is the sum of the score of the unobservable construct (η) plus the associated unobservable measurement error (ε_i). Using CTT, the statistical relationship between the items and construct of the BRC scale is shown in Figure 9.1b. Some features of the items' performance evaluated using CTT in Chapter 7 were response distribution, item difficulty, test-retest reliability, item complexity and internal consistency (Table 9.1). However, CTT was not able to fully glean other information on the BRC scale items' performance, for example, item difficulty level. Conceptual limitations of the CTT include that the theory cannot assess an explicit, ordered continuum of items that represent a unidimensional construct, or consider the lack of additive structure of an ordinal rating scale measure (McKenna & Heaney, 2021). It would not be possible to determine whether items of the BRC scale were performing meaningfully for the ability of the sampled population. Nevertheless, CTT posited that the items in the BRC scale had been adequately used by the target population to determine the underlying construct.

Table 9.1 Item performance features assessed by Classical Test Theory

Performance feature	Definition	BRC scale items performance
Response distribution	Proportion of responses for each item was determined. An item was described as having a poor distribution if >70% of responses were found in one response option.	Proportion of responses were within the range of 0% and 27.38%. This reflected that all items had a good level of response distribution.
Item difficulty	Proportion of missing scores. Item difficulty was considered high if 10% or more of scores were missing.	There was no missing score, reflecting no item was too difficult. A recognition that participants could handle a reasonable level of difficulty.
Test-retest reliability	Intra-class coefficient (two-way agreement) was calculated. Suboptimal reliability was defined as < 0.2.	The intra-class coefficient (two-way agreement) was 0.944 with a 95% confidence interval between 0.89 and 0.97. This reflected that test-retest relatability was excellent.

Item complexity	Factor loading was calculated. Suboptimal complexity existed if loading was < 0.4	Factor loading was between 0.727 and 0.921. This reflected that items were adequately measuring the common construct.
Internal consistency	Cronbach's α was calculated. Internal consistency was considered suboptimal if α was < 0.7.	Cronbach's α was 0.975. This reflected that there was high internal consistency.

Rasch Measurement Theory (RMT) is a prescriptive approach to investigating whether data conform to a probabilistic model (Duncan, 1984). In contrast to CTT, RMT transform ordinal data into interval data rather than summing raw scores or reporting percent correct. RMT accounts the importance of an ordered continuum to represent a measurement construct (Bond & Fox, 2015). Items would be ordered along a scale of varying difficulty level and individuals' performance is expected to be consistent with the order of difficulty of the item scale based on their ability trait. If item patterns are reasonably consistent with the item order, then an aggregate score is likely to serve as a useful estimate of the degree of the construct. Some features of the items' performance evaluated using RMT in Chapter 7 are highlighted in Table 9.2. The information provided by RMT complemented that obtained by CTT. Overall, RMT posited that the BRC scale was performing well taking into account the ability of the sampled population.

Table 9.2 Item performance features assessed by Rasch Measurement Theory

Item performance feature	**Definition**	**BRC scale items performance**
Model fit	Refers to the ability of a model to reproduce the data. The fit index used: Standardised root mean square residual (SRMR). A good fit was represented by SRMR < 0.08.	The SRMR was 0.057. This reflected that there was a good model fit.
Item fit	Refers to items reflective of the latent traits to be measured. The infit and outfit mean	The means of the infit and outfit MNSQ were 1.03 and 1.01. This reflected that

	square standardised residuals (MNSQ) statistics were represented by a range of 0.5 to 1.5 that supports productive measurement.	items were harmonious with Rach-modelled optimal performance of 1.0.
Consistency of items	A person-item map (Wright map) displays the difficulty of the items on the same latent dimension as the ability of the individuals.	The Wright map reflected that the mean items difficulty level was slightly lower than the average ability of the sampled population. The ability traits of the older adults were between moderately high to moderately low. The items were centred around average difficulty level. There were redundant questions that were of similar difficulty level, which that may potentially be removed.
Reliability	Similar to internal consistency. An equivalence to Cronbach's α. Reliability is referred to as the ability of the scale to discriminate amongst persons with different levels of the trait. A person separation index of > 0.7 is considered acceptable.	The person separation index was 0.93. This reflected excellent reliability, i.e., high level of reliability that individuals responded to the questions based on their ability level and ability to distinguish the different ability levels among the sample.

9.4 Comparison of findings with existing literature

The role of the BRC scale alongside other falls-related self-efficacy PROMs

Falls remains a significant issue among older people. Despite concerted efforts, total deaths and disability-adjusted life years due to falls have increased steadily over the past three decades, with global deaths almost doubling between 1990 and 2017 (James et al., 2020). There have been multifaceted approaches taken towards tacking the complex phenomenon of falls. Ultimately, there must be adequate consideration of the multidimensional issues that older adults face when managing falls risk, and the influence these factors have on their behaviours (Robson et al., 2018). Literature has pointed towards older adults not fully appreciating or taking proper actions in managing their actual falls risk (Gardiner et al., 2017; Mihaljcic et al., 2017). An awareness of falls risk factors does not necessarily equate to older adults having a realistic appraisal of the relevance of these risk factors to their own lives (Robson et al., 2018). Some may underestimate the risks by thinking that the issues do not apply to them; others may overestimate the risks and impose restrictions on physical activities. Such actions potentially lead to physical decline and increase their risk of falls.

PROMs are useful measurement instruments to determine individuals' perspectives. In the context of falls, there are various PROMs used to measure falls efficacy, balance confidence, and fear of falling. Over the last three decades, there has been confusion in the literature between these three constructs. Falls efficacy has been posited as a measure of fear of falling (Tinetti et al., 1990) or synonymous with balance confidence (Hadjistavropoulos et al., 2011). Chapter 3 proposed that falls efficacy should have been posited as a perceived ability to prevent and manage falls. Falls efficacy was distinguished from fear of falling. Balance confidence is one of four domains that surround the perceived self-efficacy to tackle the potential threat of falls. The others are balance recovery confidence, safe-landing confidence and post-fall recovery confidence.

The construct measured by the BRC scale is posited to be distinct from commonly understood falls-related psychological concerns, namely, balance confidence and fear of falling. The BRC scale was conceptualised to measure the perceived ability to recover balance in response to perturbation. The scale aims to complement existing PROMs that purportedly measure different falls-related psychological constructs, such as, falls efficacy, balance confidence, falls efficacy and perceived ability of functioning. The findings in Chapter 7 - field testing of the BRC scale - supported this claim. There was varying consistency found between different measures (Figure 9.2). A priori hypotheses between the BRC scale and other PROMs were consistently found they were moderately congruent. This suggested the BRC scale can provide additional information towards understanding older adults' perspectives on their ability to manage falls. Inconsistencies were found in the postulated relationships made between the BRC scale, handgrip strength test, lower limb strength test, and balance performance test. The BRC scale was hypothesised to have a strong and positive correlation with tests of handgrip strength, lower limb strength, and balance performance; however, the preliminary results showed a weak, positive correlation for the first two of these and moderate, positive correlation for the third. These hypotheses were made based on the literature covering strength, balance control and balance self-efficacy, which suggested that older adults with higher upper and lower limb strength and balance performance exhibited higher balance confidence (Fong et al., 2014; Nor et al., 2021).

One explanation of the inconsistent relationship offers an alternative view on muscle strength and balance recovery confidence. A recent paper by Strandkvist et al. (2021) reported that handgrip strength is strongly associated with lower limb strength but has a weak association with postural control in community-dwelling older adults. The authors recommended that obtaining strength measurements as a substitute for measuring postural control would be insufficient and that specific balance tests are critical. Another explanation of the inconsistency could be the different measurement approaches' use of subjective and objective assessment. Subjective measures rely on a person's perception whereas objective measures employ the assessment of a trained observer (Reuben et al., 2004). Both modes of assessment have been posited to provide separate information and should be conducted together for a global evaluation of the individual (Onodera et al., 2020). This finding supported emerging literature suggesting that self-reported measurement instruments and performance-based measurement instruments are measuring different constructs, and therefore should be complementarily used to obtain a fuller understanding of individuals' perceived and actual abilities (Dayton et al., 2016). The relationships between different modes of assessments need to be further investigated. Based on the preliminary findings, the performance measures used (hand-held dynamometer, 30-second sit to stand test and Mini-BESTest) are inadequate proxies to provide a measurement of self-efficacy in older adults to recover balance and arrest a fall. This supports the utility of the BRC scale.

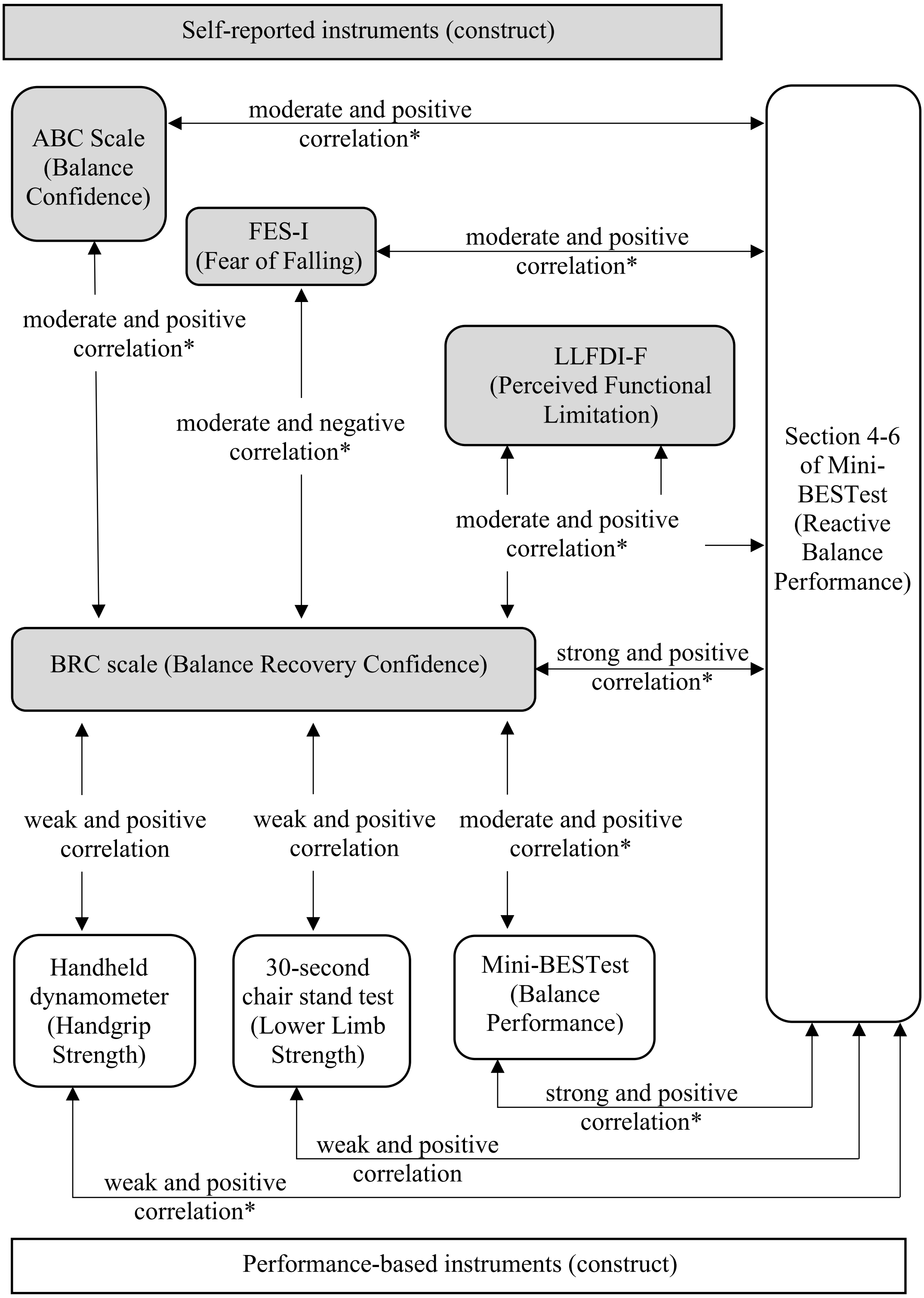

Figure 9.2 Schematic diagram of the correlations between different constructs studied in the field test. Asterisk (*) denotes meeting p-value of 0.05 significance level. Shaded boxes denote self-reported instruments and the constructs of interest measured.

The field test has distinguished the role of the BRC scale among other existing PROMs measuring different falls-related psychological concerns (such as the FES-I and ABC scales) or those measuring perceived ability of physical function (such as the LLFDI-F scale). The BRC scale focuses on perceived ability to react to different perturbations and arrest a fall, hence centring around reactive balance recovery control of executing change-in-support reactions, such as stepping or reach-to-grasp recovery strategies in situations where falling is a risk. In contrast, other PROMs focus on other aspects, such as the concerns of older adults about the possibility of falling, confidence in doing an activity without losing balance or becoming unsteady, or perceived physical functioning ability. The perceived abilities for the sampled community-dwelling older adults in Singapore are presented in Figure 9.3. More studies are needed to fully understand the clinical utility of the BRC scale.

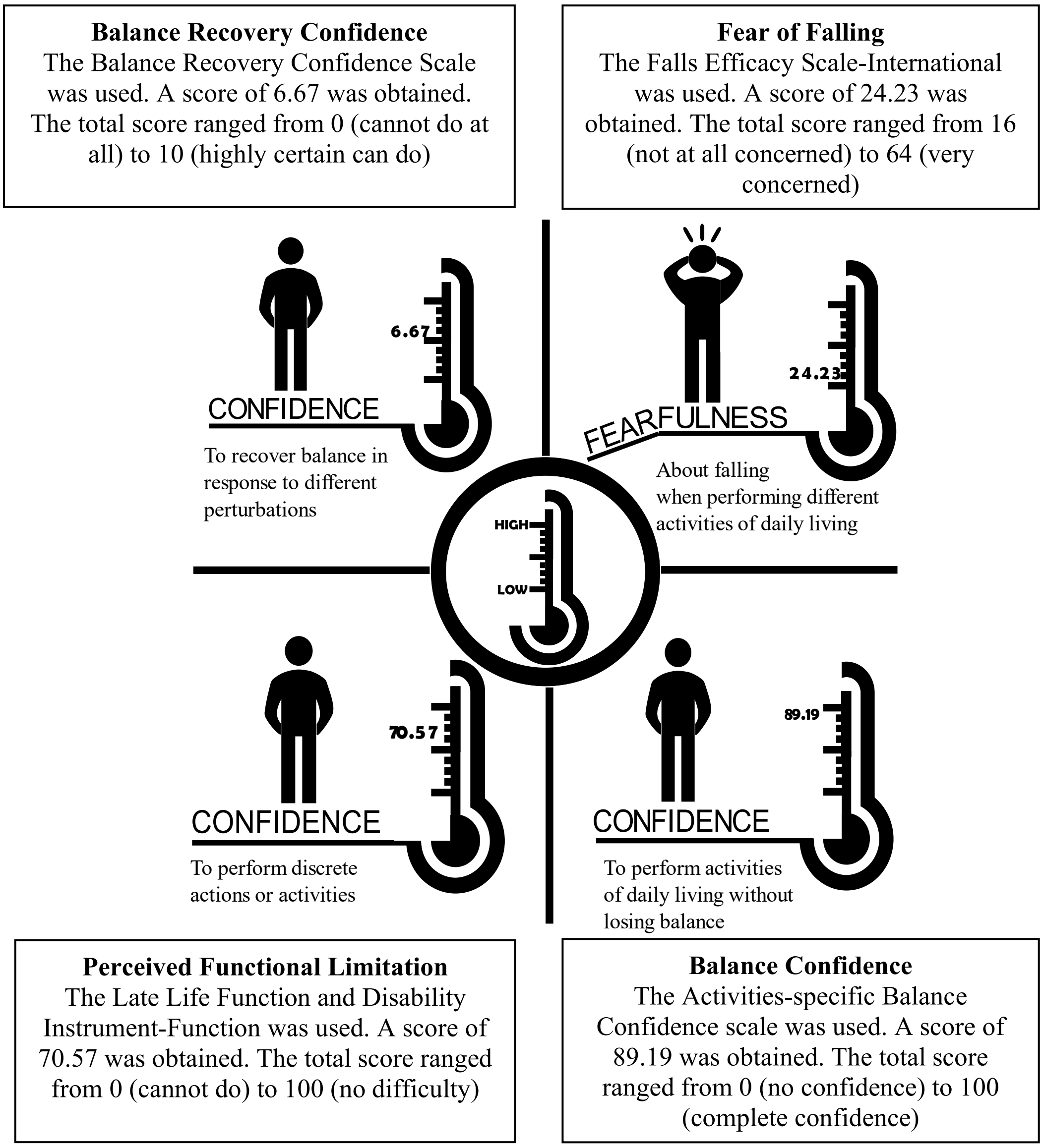

Figure 9.3 Pictorial presentation of the different constructs measured by various instruments and the scores obtained in the sample of community-dwelling older adults.

Development of the BRC scale compared with other related PROMs' development

A pragmatic approach was taken to developing the BRC scale. The limitations of previous development of falls-related self-efficacy PROMs were considered and efforts were taken to adequately address them. The methodology adopted both qualitative and quantitative methods: qualitative techniques for data collection offer a rich understanding of studying the lived experiences, whereas quantitative techniques driven by hypothesis-driven empiricism are considered "the scientific method" (Ring et al., 2010). The mixed method applied in pragmatism is justified for whatever rigorous approach works to gain useful insights (Johnson et al., 2007).

The new PROM of balance recovery confidence presented in this thesis would be the first of its kind; there is no such PROM in the literature. The construction of the PROM content for the BRC scale and other widely used falls-related self-efficacy PROMs is presented in Table 9.3. The explicit purpose and the method of constructing the BRC scale is distinct from others. The construct to be measured focuses on perceived self-efficacy in reactive balance recovery abilities. The involvement of the target population in the development of the PROM items highlights that a person-centred approach was prioritised. At the level of symptoms, functioning and perceived health, members of the target population are considered the key experts (De Vet et al., 2011). The validation of the content was achieved through healthcare professionals, a new group from the target population, and the literature.

The BRC scale was constructed based on the guidance provided by De Vet et al. (2011) and Bandura (2006). A set of robust and rigorous methods, displayed in Chapter 5, was used to construct and validate its content. A sequential method using the Nominal Group Technique (NGT) and the modified Delphi Technique (MDT) was employed to engage the target population and healthcare professionals. The NGT sessions involved 12 Singapore community-dwelling older adults. The MDT sessions involved a new group of 10 Singapore community-dwelling older adults and 28 healthcare professionals representing physiotherapy, occupational therapy, nursing, podiatry and medicine. The inputs from the older adults provided authenticity by helping to construct a measurement instrument to be relevant and comprehensible to the target audience. The contribution of healthcare professionals from six different countries (Singapore, the UK, the US, Malaysia, Australia and Hong Kong) added contextual relevance and clinical acuity. A consensus was obtained from both groups that the list of items was appropriate to measure the balance recovery confidence, meeting the COSMIN standards (Prinsen et al., 2018). The 19-item BRC scale was eventually constructed through robust methodology (See Figure 9.4). The performance of the items for the Singapore community-dwelling older adults was good, as shown in Chapter 7. However, the degree to which the performance of items for older adults in other countries, such as the UK or the US, is unknown. Further studies on cross-cultural validity and measurement invariance are warranted.

Table 9.3 Construction of content during PROM development

PROM aspects	FES	ABC scale	FESI	BRC scale
Explicit construct measured by the PROM	To determine fear of falling identified as low perceived self-efficacy or confidence at avoiding falls	To assess balance confidence during the performance of activities of daily living.	To assess fear of falling and its impact in older adults	To assess perceived ability to recover balance in response to perturbations in older adults. A focus towards self-efficacy in reactive balance recovery abilities
Theory	Bandura's self-efficacy theory	Bandura's self-efficacy theory	Unknown	Bandura's self-efficacy theory
Invited experts to construct content	10 physical therapists, occupational therapists, rehabilitation nurses and physicians	15 physical and occupational therapists and 12 older adults aged over 65 years	Members of the Prevention of Falls Network Europe (ProFaNE)	12 community-dwelling older adults aged 65 and over
Question(s) given to experts for item construction	"Name the 10 most important activities essential to independent living, that while requiring some position change or walking, would be safe and nonhazardous to most elderly persons"	"Name the 10 most important activities essential to independent living, that while requiring some position change or walking, would be safe and nonhazardous to most elderly persons". An additional question to older adults: "Are you afraid of falling during any normal daily activities, and if so, which ones?"	Discussion based. To identify any potential difficulties that might pose translation or applicability issues to cultural context, and to assess more difficult and social activities	"What common and everyday activities that older people participate in (at home or outside the home) when a near-fall can occur?" and "How can older people avoid a fall in these near-fall events?"
Invited experts to validate content	10 therapists and nurses	Unknown	Unknown	One panel of 38 healthcare professionals representing physiotherapy, occupational therapy, nursing, podiatry and medicine. Another panel of 10 community-dwelling adults aged 65 and older

Table 9.3 Construction of content during the PROM development

PROM aspects	FES	ABC scale	FES-I	BRC scale
Number of items constructed	10	16	16	19
Instruction	On a scale from 1 to 10, with 1 being very confident and 10 being not confident at all, how confident are you that you can do the following activities without falling?	For each of the following activities, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady choosing one of the percentage points on the scale from 0% to 100% If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports.	Now we would like to ask some questions about how concerned you are about the possibility of falling. Please reply thinking about how you usually do the activity. If you currently don't do the activity (e.g., if someone does your shopping for you), please answer to show whether you think you would be concerned about falling IF you did the activity. For each of the following activities, please tick the box which is closest to your own opinion to show how concerned you are that you might fall if you did this activity.	Please rate how certain you are, now, that you can recover your balance to arrest a fall in each of the following scenarios. Answer all questions to show whether you think you can recovery from a loss of balance, trip or slip if the situation occurs.
Response options	10-point continuum (1-10) with a higher score equivalent to lower confidence.	0%-100% continuum with a higher score equivalent to higher confidence.	4-point scale with a higher score equivalent to higher concerns.	11-point continuum (0-10) with a higher score equivalent to higher confidence
Recall period	Indeterminate	Current status	Current status	Current status
Possible total score	10-100	Average score of 0-100% is obtained	16-64	0-190

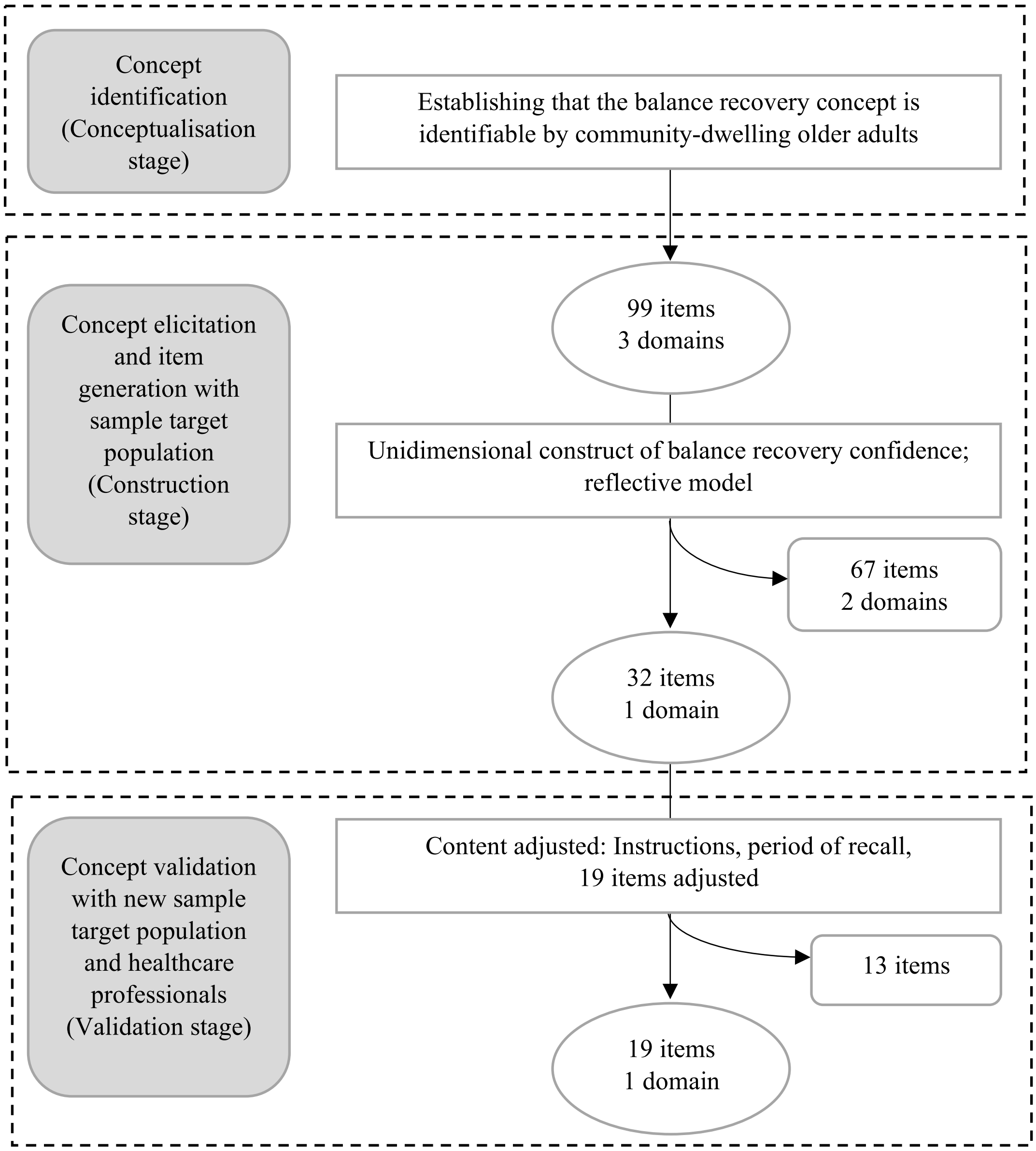

Figure 9.4 Flow chart of the BRC scale content development process involving the conceptualisation, construction and validation stages.

9.5 Challenges faced when developing the BRC scale

Before this work, there had been no PROM to measure balance recovery confidence. The new BRC scale developed for community-dwelling older adults is the first of its kind in the falls literature. There were some challenges that arose during the development of this new scale.

Challenge 1: Establishing whether falls efficacy-type PROMs were truly measuring the construct they purported to measure.

Validity relates to the degree to which an instrument is truly measuring the construct(s) it was purportedly developed to measure (COSMIN, 2021). However, it is challenging to determine this validity among PROMs claiming to measure falls efficacy since it is a latent construct. Three types of validity could be applied: content validity, criterion validity and construct validity, of which construct validity is the one that has been most often applied in the literature to understand fall efficacy. Chapter 2 detailed that falls efficacy has still not been adequately understood over the last three decades. Some PROMs that were conceptualised using the self-efficacy theory were posited to be measuring fear of falling. Other that were conceptualised to measure fear of falling were given names relating to falls efficacy. Whether the different PROMs had been suitably developed to accurately measure the specific construct or whether they were interchangeably used to study the construct of interest were among the issues that surfaced during the review of literature.

COSMIN methodology for assessing the content validity of PROMs was useful to navigate this challenge. This methodology details a systematic procedure for evaluating studies on the content validity of PROMs (Terwee et al., 2018). Chapter 3 employed this methodology for a review of different falls efficacy-related instruments. The content validity of different PROMs, based on a summary of all available evidence on their development and additional content validity studies, provided the needed insights into various falls efficacy-type PROMs and the construct that each purported to measure.

Challenge 2 Explaining the role of the BRC scale in falls practice.

The construct of balance recovery confidence is novel and the role that the BRC scale could play in falls practice needs to be understood. More studies are needed to establish its role in falls prevention and management. Perceived reactive balance recovery control has been given little attention in the literature. Therefore, it has been a challenge to explain to peers the role of the BRC scale in falls practice with community-dwelling older adults.

Existing falls efficacy-type PROMs have been concentrated on interventions targeting falls prevention (avoidance) in older adults. The introduction of the BRC scale extends the conventional paradigm by targeting perceived personal ability to cope in near-fall scenarios. The BRC scale is the first measurement instrument that has included different adverse fall situations to determine the perceived (in)ability of the individual to arrest the fall, which amounts to a judgement of their reactive ability to recover balance. This information provides a more complete understanding for older adults to deal with falls given the probability of age-related physiological decline, and the complexity of human behavioural response to imperfect environments and performances. Evidence points towards a rising global incidence of falls, and falls interventions need to focus beyond prevention and help older adults cope with the potential threat of falls. Older adults have reportedly recognised that their response should involve more than just risk avoidance (Gustavsson et al., 2018). While falls-prevention strategies are imperative, older adults identify that falling and falls are possibilities and therefore they would benefit from falls-management strategies. Emerging work on reactive balance from various research institutions, such as KITE Research Institute (Canada) and NeuRA (Australia) is increasingly demonstrating the importance of this approach. The BRC scale will play a vital role to support these endeavours.

9.6 Limitations

This work has some limitations. First, the samples of target population recruited to develop and validate the BRC scale were high functioning community-dwelling older adults. The scenarios generated and evaluated by this population segment may not be relevant to other populations, such as frail older adults, those with stroke, or Parkinson’s. Second, the steps taken to develop the BRC scale deviated slightly from De Vet et al.’s (2011) recommended steps to develop and evaluate a measurement instrument. Pilot testing of the BRC scale was incorporated within the content validation and field-testing phases. During content validation, the aspect of comprehensibility and relevance were sought out. Acceptability and feasibility of completing the BRC scale was determined through field-testing. Third, the sample size of 200 targeted for the BRC scale’s validation study was not achieved because of the COVID-19 pandemic. As large samples are generally considered necessary to obtain more robust items parameters estimates, the Rasch analysis of the BRC scale should be used for exploratory purpose and that the interpretation should be made with caution.

9.7 Future directions

This thesis has demonstrated the robust development of the BRC scale and its initial psychometric properties among community-dwelling older adults. The scale has excellent reliability and validity. Work is still needed to fully understand its psychometric properties as well as its clinical utility. The work to develop the BRC scale is ongoing. De Vet et al. (2001, p. 31) stated, “Developing a measurement instrument is not something to be done on a rainy Sunday afternoon. If it is done properly, it may take years.”

Recommended future directions for developing and deploying the BRC scale in falls practice are set out below:

Further evaluation of the measurement properties of the BRC scale

1. A more complete evaluation of the BRC scale’s psychometric properties using the Rasch Measurement Theory should be undertaken. The RMT is best applied by using several hundred participants to construct a stable model for evaluation (De Vet et al., 2011).

2. Translation and adaption of the BRC scale for older adults living in different cultural communities or built environments should be explored. Some items in a questionnaire may not be relevant. For example, the use of escalators may not be common for those living in areas with low-rise buildings. Cross-cultural validation studies are needed.

3. A short version of the BRC scale could be constructed using appropriate methodology. Such a version would make studying balance recovery confidence more appealing by needing less time to administer. The BRC scale should be used as criterion when developing a shorter version for the community-dwelling older adults to improve its utility.

4. The BRC scale needs to be evaluated among other clinical groups, such as those living with stroke, Parkinson’s or orthopaedic conditions. If the scale would be adapted for other clinical populations, then more information about the differences between adapted scales would be needed for a better understanding and interpretation of balance recovery confidence between different target populations.

5. The responsiveness of the BRC scale needs to be assessed to provide confidence of its evaluative purpose or application to detect changes of balance recovery confidence over time. Responsiveness is defined by the COSMIN panel as ‘the ability of an instrument to detect change over time in the construct to be measured’ and refers to the validity of a change score (De Vet et al., 2011). Interventions for studies measuring BRC scale’s responsiveness could consider perturbation-based training, agility training, Tai chi, Yoga, and therapeutic exercises focusing on strength, balance, and flexibility. These interventions have been commonly studied in falls prevention clinical trials. The impact of these interventions on balance recovery confidence should be investigated alongside when determining the responsiveness of the BRC scale.

6. Studies on other measurement properties, such as minimal important change, measurement invariance, construct validity compared against other measurement instruments beyond those used in field testing, are needed.

Contribution towards a greater understanding of the role of the BRC scale in fall practice

Field-testing of the BRC scale has presented greater insights of the different types of psychological concerns of the sampled community-dwelling older adults. The older adults were functioning well with their activities of daily living. A high level of balance confidence (89.19 out of 100) was accompanied by a low level of fear of falling (24.23 out of 64). The mean scores were identified to fit within the normative data of healthy and independent community-dwelling older adults established by previous studies (Table 9.4). Their level of balance recovery confidence (6.67 out of 10) suggested a moderate level of perceived self-efficacy to recover balance in response to perturbation.

Table 9.4 Baseline presentation of scores from the sample community-dwelling older adults.

Type	Mean score (SD)	Total range	Normative data
Balance confidence	89.19 (12.5)	0-100	79.89 (20.59) (Huang & Wang, 2009)
Balance recovery confidence	6.67 (2.05)	0-10	Nil
Fear of falling	24.23 (7.07)	16-64	29.6 (10.7) (Hauer et al., 2011)
Perceived difficulty of performing activities of daily living	70.57 (12.31)	0-100	75.6 (11.0) (Haley et al., 2002)

According to the Goldilocks principle, this may reflect that certain self-efficacy should be at an appropriate level – not too high or too low, suggesting that independent living should be balanced by a respect for the potential falls risk. The Goldilocks principle has not been discussed much in falls literature but was first mentioned by Bowman and Graham-Bowman (2015) in the context of appropriate flooring – neither having to be excessively slip resistant nor too slippery. The threat of falls was viewed by those authors as a wicked problem and that mechanisms relating to slips, trips and falls need to be adequately addressed. In the context of balance recovery, slips, trips and falls can be viewed as the "big bad wolf". Empowerment strategies should encompass understanding the individual's reactive ability to deal with the wolf, and not only about what can be done to avoid it. This provides a more comprehensive approach towards dealing with the wickedness of potential falls.

The BRC scale will play a valuable role to complement different measurement instruments and assist to recalibrate mismatched awareness. Recalibrating disparities in perceived and actual balance abilities has been shown to help give older adults a realistic appraisal of falls risk and encourage them to undertake tailored exercises to improve their physical performance (Ellmers et al., 2018). Such disparity in older adults is not uncommon and should warrant attention. A third of older adults have been reported to underestimate or overestimate their risk of falling (Delbaere et al., 2010). Falls are known to be closely related to hazardous or risk-taking behaviours (Reubenstein, 2006). The gradual decline of performance capacities due to ageing or comorbidities could put unsuspecting older adults at higher risk. A healthy and realistic degree of perceived balance recovery abilities could nudge individuals towards making appropriate behavioural and lifestyle changes or adaptations to deal with the potential threat of falls.

This work has also presented a new perspective on falls efficacy by including a range of self-efficacies, namely balance confidence, balance recovery confidence, safe landing confidence and post-fall recovery confidence. As a conceptual model, further investigation on its impact on improving older adults' fall agency is needed. Research on such a complex phenomenon needs methodological rigour and sophistication that calls towards revisiting traditional research concepts. Further exploration of interventions for the different perceived falls-related self-efficacy constructs would be helpful; an extended interpretation of falls efficacy would mean interventions could be better evaluated to determine their efficacy in helping older adult in specific domains to be more falls-resilient (Figure 9.5).

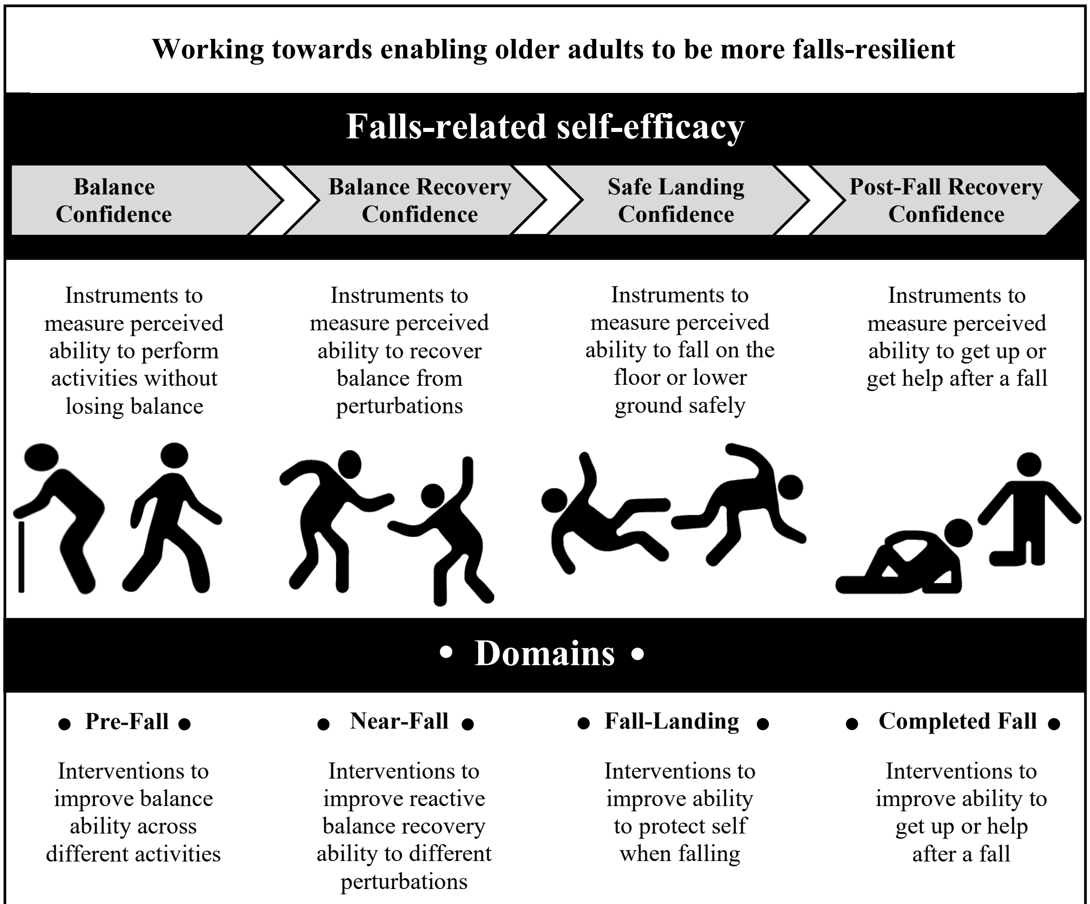

Figure 9.5 Conceptual model of falls efficacy for a falls-resilient older adult

9.7 Conclusion

All studies were planned with best efforts to adhere to the steps recommended by De Vet et al. (2011) to develop and evaluate a measurement instrument. Each of the included studies' findings informed the next through justification and rationalisation of what would be most usefully applied to construct the BRC scale. The approach is grounded in pragmatism. Several insights into the use of key steps for developing a PROM have been presented alongside with the methodological challenges. Given that the BRC scale is still in its infancy, future studies are needed to realise its full potential.

9.8 Summary

The thesis has presented the development of a PROM of balance recovery confidence for community-dwelling older adults. Balance recovery confidence refers to the perceived ability to recover balance in response to destabilising perturbations that can occur in common, everyday activities. It is an important construct to be studied, given that falls are major concerns among older adults. A scale of balance recovery confidence would allow older adults to identify their perceived self-efficacy to arrest a fall. To manage a broad range of falls-related concerns, the PROM complements other falls-related PROMs to play a significant role for the agency of older adults to tackle potential falls. Four specific objectives were proposed and met in this thesis:

The first objective was to identify whether there had been an existing falls efficacy-related PROM of sufficient quality to measure this construct of interest in community-dwelling older adults. A systematic review evaluating the methodological quality of content validity and structural validity in falls-related self-efficacy PROM studies was employed. If no PROM of sufficient quality was available to measure balance recovery confidence, then the review justified the need to develop a new PROM.

The second objective was to determine whether the concepts of balance recovery were relatable and relevant to community-dwelling older adults. A feasibility study was conducted with a sample of community-dwelling adults aged 65 years or older. The longitudinal study invited 30 older adults to report any incidence of near-falls or falls over a three-week period and to identify the type of balance recovery manoeuvres used to arrest a fall, if a near-fall occurred. The study also established whether older adults were able to distinguish between near-falls and falls. If they were able to identify near-falls and the type of recovery manoeuvres used, then the concepts of balance recovery could be said to be relatable and relevant to the target population.

The third objective was to develop and validate the content of a new PROM of balance confidence scale for community-dwelling older adults. The content was constructed with a sample of community-dwelling adults aged 65 years or older. Content validation was done with a new sample from that population as well as a panel of healthcare professionals representing physiotherapy, occupational therapy, nursing, podiatry and medicine. The two processes were conducted by using Nominal Group Technique and Delphi Technique respectively to construct a set of content items that were relevant, comprehensible and comprehensive to measure the construct of interest in the target population. The instructions, recall period, response options and the scale's name were also constructed with the experts' consensus.

The fourth objective was to assess the psychometric properties of the new PROM. It was field-tested to evaluate its acceptability among the target population. The initial evaluation of its key measurement properties informed the internal structure: factor structure, internal consistency, reliability and validity. Measurement instruments were used to provide information on the construct validity, including other PROMs such as the ABC, FES-I and LLFDI-F scales, and performance-based measures such as handgrip strength, dynamometer, the 30-second chair stand test and the Mini-BESTest.

Summaries of the chapters of this thesis are provided below.

Chapter One provided the background to the thesis, with an outline of its structure and research objectives. Various assumptions and limitations of the research with the different operational definitions were presented in the chapter. An introduction to the subsequent chapters was also given to provide clarity and coherence in meeting the overall aim of developing the BRC scale for community-dwelling older adults.

Chapter Two detailed a literature review of pertinent theories and existing knowledge that would support the development of the PROM of balance recovery confidence. Bandura's self-efficacy theory was presented to provide a theoretical understanding of self-efficacy. Three common types of falls-related psychological concerns and the associated PROMs used to measure the different constructs were described. As balance recovery confidence has not been much mentioned in the literature, the role of balance recovery control was considered. Finally, the steps to develop a PROM were presented to explain the need to employ a proper methodology so that a quality PROM of balance recovery confidence could be constructed.

Chapter Three presented a systematic review to summarise the evidence regarding the methodological quality of studies on content development, content validity and structural validity of falls efficacy related PROMs for community-dwelling older adults. Eighteen PROMs were identified in the literature of which 15 measured falls efficacy or balance confidence. The remaining three measured fear of falling and were reportedly constructed to measure an emotive construct, rather than a cognitive construct of self-efficacy. For the 15

PROMs, the results showed a lack of quality evidence that their content had been sufficiently validated for relevance, comprehensiveness and comprehensibility. Many PROMs did not involve the target population during their development or conduct content validation before the PROM was used in community-dwelling older adults. Only four PROMS had been underpinned by partial relevant evidence. Two PROMs (Perceived Ability to Manage Risk of Falls or Actual Falls scale and Perceived Ability to Prevent and Manage Fall Risks scale) were conceptualised to measure the perceived ability to prevent and manage falls, extending the understanding of falls efficacy beyond balance confidence. None of the identified PROMs was constructed with the intention of measuring balance recovery confidence.

Chapter Four showed the feasibility of studying the concepts of balance recovery in community-dwelling older adults, 30 of whom were recruited to determine whether a sample of the target population would be able to identify a near-fall and report the type of balance recovery manoeuvres used to arrest the fall. The results showed that community-dwelling older adults were able to relate to the concept of near-falls and distinguish the different types of balance recovery manoeuvres used to stop a fall following perturbations. Studying the concept of balance recovery was relevant for the community-dwelling older adults given that the sample population reported a high incidence of near-falls; half of the sampled population reported experiencing one or more during a three-week period.

Chapter Five described the development of the new PROM. Twelve older adults who participated in the feasibility study were invited to generate a comprehensive list of items aiming to measure balance recovery confidence in the target population. The Nominal Group Technique was employed. Two focus groups sessions were conducted and facilitated by two researchers. From an initial list of 99 generated items, a final list of 32 items that fitted the performance domain within Bandura's self-efficacy conceptual framework were selected. From the list of 32 items, 19 items achieved consensus of appropriateness as well as for the name of the PROM, instructions, response options, recall period in the Delphi study. The PROM achieved face validity during this development stage.

Chapter Six presented the study protocol describing the prioritised measurement properties to be studied during field testing. Two measurement theories, the Classical Test Theory and Rasch Measurement Theory would be employed. The acceptability of the BRC scale among the sample target population would be evaluated. The field test would assess the BRC scale's unidimensionality, internal structure, reliability and validity. Various measures would be applied during the field testing which include self-reported instruments (BRC, ABC, FES-I and LLFDI-F scales) and performance measures (Hand strength dynamometer, 30-second Chair Stand Test and Mini BESTest). A priori hypotheses were made for the construct validity of the BRC scale.

Chapter Seven reported the findings of the BRC scale's psychometric properties obtained from the field test conducted with a sampled target population in Singapore. Eight-four community-dwelling older adults aged 65 and older participated in the study. Results showed that the BRC scale is unidimensional and has excellent internal consistency (α = .975) and good test-retest reliability (ICC = 0.944). It was shown to have moderate correlations with the ABC scale (.54), FES-I scale (.57), LLFDI-F scale (.41) and Mini BESTest (.51). There was negligible to weak correlation with handgrip strength (0.18), and 30-second chair stand test (0.09). The BRC scale (.62) has a slightly stronger correlation with reactive postural control performance than ABC scale (.57), FES-I scale (.54), and LLFDI-F scale (0.50). The BRC scale was shown to be a distinctive PROM used to assess balance recovery confidence across various perturbation-type scenarios.

Chapter Eight presented the research impact of the work conducted to develop the BRC scale. A significant number of research outputs have been generated alongside the development. This research offers significant new perspective on falls efficacy that could benefit and influence research in falls practice and the development of PROMs.

Chapter Nine provided a general discussion of findings obtained from the different studies. The key issues to consider when developing a PROM were critically reflected, namely the need for a systematic review of existing PROMs, involvement of different stakeholders, and the application of traditional and modern measurement theories to evaluate the PROM. Various challenges were presented alongside strategies adopted to manage these challenges. Future directions for the B RC scale were proposed.

An infographic poster that succinctly summarises the thesis is presented in Figure 9.6.

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Development of a Balance Recovery Confidence (BRC) scale for Community-Dwelling Older Adults

Chapter 1 General introduction	Falls present a major problem for older people. Patient-reported outcome measures (PROMs) are useful measurement instruments to obtain individuals' perspectives. Balance recovery confidence refers to the perceived ability to recovery balance in response to different perturbations.
Chapter 2 Review of the literature	Self-efficacy is an important concept in human agency. Falls efficacy empowers older adults to prevent and manage falls. Balance recovery control and balance control appears to be conflated. A systematic review of different falls efficacy-types PROMs will justify whether a new PROM is needed. If one is required, then a proper methodology should be used to construct a high-quality PROM.
Theoretical frameworks	- Self-efficacy theory - Balance recovery concepts - Development of a measurement instrument concepts

Chapter 3 Systematic review

Eighteen falls efficacy-related PROMs were identified from five electronic databases. The quality evidence of content validity in many widely used PROMs were shown to be of low to very-low quality. An absence of a PROM to measure balance recovery confidence was identified. The review justified for a new PROM of balance recovery confidence to be developed.

Chapter 4 Feasibility study

Thirty community-dwelling older adults were able to relate to the concept of balance recovery. 53.3% experienced near-falls within a 21-day period. Balance recovery manoeuvres were the reach-to-grasp strategy (36%), compensatory stepping (52.8%) and other body regions (11.2%) were used to arrest the falls. Near-falls were noted to be more common than falls in older adults.

Chapter 5 Content development and validation of the BRC scale

The content of the BRC scale was generated by 12 community-dwelling adults aged 65 and older. The content was then reviewed by a new group of 10 older adults and 28 healthcare professionals. The instrument's name, instructions, recall period, response options and 19 items obtained the consensus for appropriateness - relevance, comprehensiveness and comprehensibility – to measure balance recovery confidence in the target population.

Chapter 6 and 7 Psychometric properties of the BRC scale

The BRC scale was completed by a sample of 84 community-dwelling adults aged 65 and older. The scale was shown to be unidimensional. Its internal structure and test-retest reliability were good. The scale had moderate correlations with the ABC, FES-I and LLFDI scales. The BRC scale was shown to have a slightly stronger congruence with reactive balance performance control in comparison to other falls efficacy-related scales.

Chapter 8 Research dissemination & Chapter 9 General discussion

Falls efficacy relates to the perceived ability to prevent and manage falls. The participation of multiple stakeholders provides greater insights towards the development and validation of a newly constructed PROM development. The objectives set out in the beginning have been met. A new scale for use to measure balance recovery confidence in community-dwelling older adults has been developed. The BRC scale is distinct from other PROMs for falls efficacy, balance confidence and fear of falling. The BRC scale is still in infancy. Future studies are needed to realise its fullest potential.

Figure 9.6 Infographic poster summarising this thesis.

"Cogito, ergo sum"

– René Descartes

"…that the world will be different only if we live differently"

– Maturana and Varela

9.9 About the author

Shawn Leng-Hsien Soh was born on 26 December 1976 in Singapore. He received a bursary award to study for the Diploma in Physiotherapy at Nanyang Polytechnic, Singapore, from 1997 to 2000. Upon completion, Shawn worked at the National University Hospital, Singapore, from 2001 to 2005. During this time, he obtained the Bachelor of Health Sciences (Physiotherapy), University of Sydney, Australia, from a part-time coursework at the Singapore Institute of Management (SIM), Singapore, in 2001. He also had completed a one-year full-time course in Brisbane, Australia, in 2004 to be awarded a Master of Physiotherapy (Manipulative Physiotherapy), University of Queensland, Australia. In 2018, Shawn was awarded a scholarship to study for a PhD. He decided to pursue the programme with Queen Margaret University, Scotland, to gain a broader understanding of the different philosophical paradigms within physiotherapy practice and to conduct person-centred research.

Shawn has gained an immensely rich work experience since 2000. After working as a physiotherapist at the National University Hospital, Singapore, he took on a managerial position with a private rehabilitation company overseeing turnkey clinical rehabilitation services at nursing homes and hospice centres from 2005 to 2007. From 2007 to 2013, Shawn undertook different roles supervising clinical and administrative departments within restructured hospitals and voluntary welfare organisations. In February 2013, he joined Nanyang Polytechnic, Singapore, as an Assistant Manager for the Physiotherapy programme and was promoted to Deputy Manager in October 2017. Through his teaching at his alma mater, Shawn wanted to inspire young minds by highlighting the importance of physiotherapy within the multidisciplinary team-based healthcare approach. He was involved in notable projects, including the "NYP Physiotherapy Standardised Patient Programme" (2014-2016) (est. SGD 200,000) and the Nanyang Polytechnic-National University Singapore research collaboration, "Creating a collaborative healthcare workforce: Designing and evaluating a virtual hospital for collaborative practice across higher education institutions in Singapore", which was awarded SGD 551,759 under Singapore Millennium Foundation 5th grant (2016-2019). Since July 2018, Shawn has continued his teaching and research in physiotherapy at the Singapore Institute of Technology as a Senior Lecturer.

Shawn has contributed to the profession in numerous ways. He served in Singapore Physiotherapy Association (SPA) as a Chairperson, Education Committee from 2006 to 2008 and Chairperson, Corporate Communication Committee from 2014 to 2016. He has been a member of SPA since 2000. Shawn has also played a role as a global member through the Singapore International Foundation (SIF). Being a Singapore Volunteer Overseas (SVO) Specialist Team member (Physiotherapy), he helped upgraded the skills of Cambodian physiotherapists at the Kien Khleang rehabilitation centre, Phnom Penh, Cambodia (2006). He has also conducted physiotherapy-related training programmes in Kuala Lumpur, Malaysia (2006), Gujurat, India (2007), and Jiangsu, China (2016).

9.10 PhD Portfolio

PhD candidate: Shawn Leng-Hsien Soh	**PhD period:** September 2018 to January 2022
Division/Centre: Division of Physiotherapy / Centre for Health, Activity and Rehabilitation Research	**Supervisors:** Dr Judith Lane and Dr Chee-Wee Tan **Advisor:** Professor Nigel Gleeson
Graduate School: School of Health Sciences	

TRAINING ACTIVITIES

Title	Organiser/ Location/ Year	Role
A practical guide to patient & public Involvement	Wellcome Trust Clinical Research Facility, Edinburgh, 28 February 2019	Participant
Breaking the flight of a fall	Doctoral Candidates Association Annual Conference 2019, Queen Margaret University, Edinburgh, 2 May 2019	Presenter
WCPT congress 2019	WCPT, Geneva, Switzerland, 10-13 May 2019	Participant
Fundamentals of the Personal Data Protection Act - facilitating compliance with legislative and regulatory requirements.	Personal Data Protection Commission of Singapore and NTUC Learning Hub Pte Ltd, Singapore, 10-11 July 2019,	Participant
Symposium on elder person rehabilitation – an update.	Singapore Institute of Technology, Singapore, 7 October 2019	Participant
7th Edinburgh clinical research methodology course	John McIntyre Centre, Edinburgh, 11-12 November 2019.	Participant
Falls efficacy related instruments for community-dwelling older adults: a COSMIN-based systematic review on development and content validity	1st World Congress on Falls and Postural Stability, Kuala Lumpur Convention Centre, Malaysia, 4-7 December 2019	Presenter
Clinimetrics: assessing measurement properties of health measurement instruments.	VU University Medical Center, Driebergen, Netherlands, 20-22 January 2020	Participant
Item response theory	VU University Medical Center, Amsterdam, Netherlands, 23, 24, 27 January 2020	Participant
UKRIO research integrity webinar: Consent	UK Research Integrity Office, Zoom, 9 September 2020	Participant
Attracting funding: writing & applying for postdoctoral fellowships	Edinburgh CRF, Zoom, 9 September 2020	Participant
Creative and imaginative practices: exploring reflexive writing as a qualitative or mixed researcher	Scottish Graduate School of Social Sciences, Zoom, 22 September 2020	Participant
Becoming doctoral	Doctoral Candidate study weeks, Queen Margaret University, Zoom, 5 October 2020	Presenter
UKRIO research integrity webinar: clinical trials	UK Research Integrity Office, Zoom, 14 October 2020	Participant
SIT Research integrity-IRB-IACUC Awareness Day	SIT, Zoom, 21 October 2020	Participant

PhD candidate:	PhD period:
Shawn Leng-Hsien Soh	September 2018 to January 2022
Division/Centre:	**Supervisors:**
Division of Physiotherapy / Centre for Health, Activity and Rehabilitation Research	Dr Judith Lane and Dr Chee-Wee Tan
Graduate School:	**Advisor:**
School of Health Sciences	Professor Nigel Gleeson

TRAINING ACTIVITIES

Title	Organiser/ Location/ Year	Role
Asian Confederation for physical therapy congress 2020. Macau hybrid edition	WCPT, Zoom, 24-25 October 2020	Participant
6th PROMIS international conference. Toward patient-centred care: PROMIS implementations and advances	PROMIS, Zoom, 25-27 October 2020	Participant
World Ageing Festival 2020	Team Ageing Asia, Zoom, 10 November 2020	Participant
Decolonising the curriculum. Lightning talk event	Queen Margaret University, Zoom, 30th November 2020	Presenter
A realistic introduction to R	WTCRF Education, Zoom, 9 November 2020	Participant
Stats for the terrified: an introduction to medical statistics	WTCRF Education, Zoom, 18 November 2020	Participant
Data management planning	WTCRF Education, Zoom, 19 November 2020	Participant
Development of a Balance Recovery Confidence scale for community-dwelling older adults	CHEARR, Queen Margaret University, Zoom, 24 June 2021	Presenter
Person-centred rehabilitation care	Singapore International Physiotherapy Congress, Zoom, 3 July 2021	Presenter
Development of a Balance Recovery Confidence scale for community-dwelling older adults	SIT Health and Social Sciences Research Cluster Retreat, Zoom, 21 October 2021	Presenter

PUBLICATIONS

Title	Location / DOI / Year	Role
Falls efficacy instruments for community-dwelling older adults: a COSMIN-based systematic review	BMC Geriatrics 10.1186/s12877-020-01960-7 2021	First author
Near-falls in Singapore community-dwelling older adults: a feasibility study	Pilot and Feasibility Studies 10.1186/s40814-020-00748-1 2021	First author
Researcher as instrument: a critical reflection using nominal group technique for content development of a new patient-reported outcome measure	International Practice Development Journal 10.19043/ipdj.102.010 2020	First author
Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders	International Practice Development Journal 10.19043/ipdj.111.009 2021	First author
Validation of a new patient-reported outcome measure of balance recovery confidence (BRC) for community-dwelling older adults: a study protocol	Physical Therapy Reviews 10.1080/10833196.2021.1938867 2021	First author

PhD candidate:	PhD period:
Shawn Leng-Hsien Soh	September 2018 to January 2022
Division/Centre:	**Supervisors:**
Division of Physiotherapy / Centre for Health, Activity and Rehabilitation Research	Dr Judith Lane and Dr Chee-Wee Tan
	Advisor:
Graduate School:	Professor Nigel Gleeson
School of Health Sciences	

PUBLICATIONS

Title	Location / Year	Role
Falls efficacy: extending the understanding of self-efficacy in older adults towards managing falls	Journal of Frailty, Sarcopenia and Falls. 10.22540/JFSF-06-131	First author
A systematic review on falls efficacy instruments for community-dwelling older adults	Singapore Physiotherapy Association Newsletter “Engage” July 2021	Invited contributor

OTHER ROLES

Journal	Year	Role
Physiotherapy Theory and Practice	2021	Invited peer reviewer

COMMITTEES

Title	Location / Year	Role
The Resilient Learning Communities Research Institutional Team	Queen Margaret University, 2021	Member
Concordat for Researcher Development Working Group (CRDWG)	Queen Margaret University, 2020	Member

GRANTS AND AWARDS

Title	For
Training and development fund 2021 (£224)	Publication
Training and development fund 2020 (£1,000)	Publication
SIT seed grant award 2019 (SGD$5,000)	Study 2 and 3
Training and development fund 2019 (£1,000)	Training

CERTIFICATION

Title	Year
Researcher Enhancement & Development- Doctoral Certificate (60 credits)	2021

References

Abedalaziz, N., & Chin, H. L. (2011). The relationship between CTT and IRT approaches in analyzing item characteristics. *The Malaysian Online Journal of Educational Science*, 1(1), 52-58.

Abyad, A., & Hammami, S. O. (2017). Fear of falling in the elderly - an emerging syndrome. *Middle East Journal of Age and Ageing*, 14(3), 16-25.

Adams, J. M. G., & Tyson, S. (2000). The effectiveness of physiotherapy to enable an elderly person to get up from the floor. *Physiotherapy*, 86(4), 185-189.

Addae-Dapaah, K., & Wong, G. K. M. (2001). Housing and the elderly in Singapore – financial and quality of life implications of ageing in place. *Journal of Housing and the Built Environment*, 16, 153-178.

Aleksic, J., Zvekic-Svorcan, J., Stupar, N. V., Jeremic, I., & Grgurevic, A. (2018). Cross-cultural validation of the modified falls efficacy scale in Serbian community-dwelling women at risk for osteoporotic fracture. *Menopause*, 25(4), 444-450.

Ang, G. C., Low, S. L., & How, C. H. (2020). Approach to falls among the elderly in the community. *Singapore Medical Journal*, 61(3), 116-121.

Arai, T., Obuchi, S., Inaba, Y., Nagasawa, H., Shiba, Y., Watanabe, S., . . . Kojima, M. (2007). The effects of short-term exercise intervention on falls self-efficacy and the relationship between changes in physical function and falls self-efficacy in Japanese older people - A randomized controlled trial. *American Journal of Physical Medicine & Rehabilitation*, 86(2), 133-141.

Arfken, C. L., Lach, H. W., Birge, S. J., & Miller, J. P. (1994). The prevalence and correlates of fear of falling in elderly persons living in the community. *American Journal of Public Health*, 84(4), 565-570.

Arnadottir, S. A., Lundin-Olsson, L., Gunnarsdottir, E. D., & Fisher, A. G. (2010). Application of Rasch analysis to examine psychometric aspects of the Activities-specific Balance Confidence scale when used in a new cultural context. *Archives of Physical Medicine and Rehabilitation*, 91(1), 156-163.

Arnold, C. M., & Faulkner, R. A. (2007). The history of falls and the association of the timed up and go test to falls and near-falls in older adults with hip osteoarthritis. *BMC Geriatrics*, 7, 17.

Avin, K. G., Hanke, T. A., Kirk-Sanchez, N., McDonough, C. M., Shubert, T. E., Hardage, J., . . . Academy of Geriatric Physical Therapy of the American Physical Therapy Association. (2015). Management of falls in community-dwelling older adults: clinical guidance statement from the Academy of Geriatric Physical Therapy of the American Physical Therapy Association. *Physical Therapy*, 95(6), 815-834.

Avril Mansfield, J. S. W., Jessica Bryce, Svetlana Knorr, Kara K. Patterson. (2015). Does perturbation-based balance training prevent falls? Systematic review and meta-analysis of preliminary randomized controlled trials. *Physical Therapy*, 95(5).

Ayhan, Ç., Büyükturan, Ö., Kirdi, N., Yakut, Y., & Güler, Ç. (2014). The Turkish version of the Activities specific Balance Confidence (ABC) scale: its cultural adaptation, validation and reliability in older adults. *Turkish Journal of Geriatrics*, 17(2), 157-163.

Babinski, J. (1899) De l'asynergie cerebelleuse. *Revista de Neurología*, 7, 806-816.

Bandura, A. (1971). *Social Learning Theory*. New York. General Learning Press.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191-215.

Bandura, A. (1981). *Self-referent thought: A developmental analysis of self-efficacy*. Cambridge University Press.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37(2), 122-147.

Bandura, A. (1986). Fearful expectations and avoidant actions as coeffects of perceived self-inefficacy. *American Psychologist*, 41(12), 1389–1391.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44, 1175-1184.

Bandura, A. (1990). Perceived self-efficacy in the exercise of control over AIDS infection. *Evaluation and Program Planning*, 13, 9-17.

Bandura, A. (1994). *Self-efficacy*. In V. S. Ramachaudran (Ed.), Encyclopedia of Human Behavior (Vol. 4, pp. 71-81). Academic Press. (Reprinted from H. Friedman [Ed.], Encyclopedia of mental health. San Diego: Academic Press, 1998)

Bandura, A. (1996). *Social cognitive theory of human development*. In T. Husen & T. N. Postlethwaite (Eds.), International Encyclopedia of Education (pp. 5513-5518). Pergamon Press.

Bandura, A. (1997). *Self-efficacy: the exercise of control*. Worth Publishers.

Bandura, A. (1999). Social cognitive theory: an agentic perspective. *Asian Journal of Social Psychology*, 2, 21-41.

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science*, 9, 75-78.

Bandura, A. (2009). *Social cognitive theory of mass communications*. In J. Bryant & D. Zillman (Eds.), Media effects: Advances in theory and research (pp. 121-153). Lawrence Erlbaum.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior*, 31(2), 143-164.

Bandura, A. (2006). *Guide for constructing self-efficacy scales*. Information Age Publishing.

Bandura, A. (2007). Much ado over a faulty conception of perceived self-efficacy grounded in faulty experimentation. *Journal of Social and Clinical Psychology*, 26(6), 641-658.

Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of Management*, 38(1), 9-44.

Bandura, A. (2018). Toward a psychology of human agency: pathways and reflections. *Perspectives on Psychological Science*, 13(2), 130-136.

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, 41, 586-598.

Bardecki, M. J. Participants' response to the Delphi method: an attitudinal perspective. *Technological Forecasting and Social Change*. 1984, 25(3), 281–92.

Barry, M. J., & Edgman-Levitan, S. (2012). Shared decision making—pinnacle of patient centered care. *The New England Journal of Medicine*, 366(9), 780-781.

Basler, G. V., O'Connell, K. A., & Bundy, K. (2017). Near-falls in elderly community-dwelling blacks from two out-patient clinics in Harlem. *Nursing Research*, 66(1), 49-53.

Bergquist, R., Weber, M., Schwenk, M., Ulseth, S., Helbostad, J. L., Vereijken, B., & Taraldsen, K. (2019). Performance-based clinical tests of balance and muscle strength used in young seniors: a systematic literature review. *BMC Geriatrics*, 19(1), 1-9.

Bhala, R. P., O'Donnell, J., & Thoppil, E. (1982). Ptophobia. Phobic fear of falling and its clinical management. *Physical Therapy*, 62(2), 187-190.

Billingham, S., Whitehead, A., & Julious, S. (2013). An audit of sample sizes for pilot and feasibility trials being undertaken in the United Kingdom registered in the United Kingdom Clinical Research Network database. *BMC Medical Research Methodology*, 13(104), 1-6.

Bjerk, M., Brovold, T., Skelton, D. A., & Bergland, A. (2017). A falls prevention programme to improve quality of life, physical function and falls efficacy in older people receiving home help services: study protocol for a randomised controlled trial. *BMC Health Services Research*, 17(1-9), 559.

Blake, A. J., Morgan, K., Bendall, M. J., Dallosso, H., Ebrahim, S. B. J., Arie, T. H. D., Fentem, P. H., & Bassey, E.J. (1988). Falls by elderly people at home: Prevalence and associated factors. *Age and Aging*, 17(6), 35-372.

Bloch, F. (2017). To recognize fall related psychological concern should not lead to neglect other psychomotor consequences of falls. *Geriatrics & Gerontology International*, 17(4), 666-667.

Bohman, J. (2021). *Critical Theory*. In E. N. Zalta (Eds.), The Stanford Encyclopedia of Philosophy (Spring 2021 Edition). https://plato.stanford.edu/archives/spr2021/entries/critical-theory.

Bond, T. G., & Fox, C. M. (2015). *Applying the Rasch model: Fundamental measurement in the human sciences* (3rd ed.). Routledge.

Bower, E. S., Wetherell, J. L., Merz, C. C., Petkus, A. J., Malcarne, V. L., & Lenze, E. J. (2015). A new measure of fear of falling: psychometric properties of the fear of falling questionnaire revised (FFQ-R). *International Psychogeriatrics*, 27(7), 1121-1133.

Brach, J. S., Perera, S., Studenski, S., & Newman, A.B. (2008). The reliability and validity of measures of gait variability in community-dwelling older adults. *Archives of Physical Medicine and Rehabilitation*, 89(12), 2293-2296.

Bradburn, N., Sudman, S., & Wansink, B. (2004). *Asking questions: The definitive guide to questionnaire design - for market research, political polls, and social and health questionnaires*. Jossey-Bass.

Brooke, P., & Bullock, R. (1999). Validation of a 6-item cognitive impairment test with a view to primary care usage. *International Journal of Geriatric Psychiatry*, 14(11), 936-940.

Buchner. (1993). Development of the common database for the FICSIT trials. *Journal of the American Geriatrics Society*, 41(3), 297-308.

Cameron, I. D., Stafford, B., Cumming, R. G., Birks, C., Kurrle, S. E., Lockwood, K., . . . Salkeld, G. (2000). Hip protectors improve falls self-efficacy. *Age and Ageing*, 29(1), 57-62.

Cappelleri, J. C., Lundy, J. J., & Hays, R. D. (2014). Overview of classical test theory and item response theory for the quantitative assessment of items in developing patient-reported outcomes measures. *Clinical Therapeutics*, 36(5), 648-662.

Carty, C. P., Mills, P. & Barrett, R. (2011) Recovery from forward loss of balance in young and older adults using the stepping strategy. *Gait Posture*, 33(2), 261-7.

Cella, D., Gershon, R., Lai, J. S. and Choi, S. (2007). The future of outcome measurement: item banking, tailored short-forms, and computerized adaptive testing. *Quality of Life Research*, 16 (Suppl 1), 133–41.

Centers for Disease Control and Prevention. (2017, April 10). *30-second chair stand assessment*. In. USA: U.S. Department of Health & Human Services. https://www.cdc.gov/steadi/pdf/STEADI-Assessment-30Sec-508.pdf

Centers for Disease Control and Prevention. (2017). *Timed Up and Go (TUG)*. In. USA: U.S. Department of Health & Human Services. https://www.cdc.gov/steadi/pdf/TUG_test-print.pdf

Centre for Clinical Practice. (2013, August 29). *Falls: Assessment and prevention of falls in older people*. London: National Institute for Health and Care Excellence (UK). https://pubmed.ncbi.nlm.nih.gov/25506960/

Cheng, K. B. & Yeh, C. K. (2015) A unified approach for revealing multiple balance recovery strategies. *Human Movement Science*, 44, 307-16.

Clancy, A., Balteskard, B., Perander, B., & Mahler, M. (2015). Older persons' narrations on falls and falling-stories of courage and endurance. *International Journal of Qualitative Studies on Health and Well-being*, 10(26123), 1-10.

Clemson, L., Cumming, R. G., Kendig, H., Swann, M., Heard, R., & Taylor, K. (2004). The effectiveness of a community-based program for reducing the incidence of falls in the elderly: a randomized trial. *Journal of the American Geriatrics Society*, 52(9), 1487-1494.

Commodari, E., & Guarnera, M. (2008). Attention and aging. *Aging Clinical and Experimental Research*, 20(6), 578-584.

COSMIN (2021, August 29). *COSMIN helps you select the most suitable outcome measurement instruments*. https://www.cosmin.nl/.

Creswell, J. W. (2013). *Qualitative inquiry and research design*. Sage Publications.

Crotty, M. (2005). *Foundations of social research: Meaning and perspective in the research process*. Sage Publications.

CSP. (2014, April 10). *Outcome and experience measures. Chartered Society of Physiotherapy*. https://www.csp.org.uk/professional-clinical/research-evaluation/outcome-experience-measures

Cumming, S., Nevitt, M., & Kidd, S. (1988). Forgetting falls. The limited accuracy of recall of falls in the elderly. *Journal of the American Geriatrics Society*, 36, 613-616.

Dayton, M. R., Judd, D. L., Hogan, C. A., & Stevens-Lapsley, J. E. (2016). Performance-based versus self-reported outcomes using the hip disability and osteoarthritis outcome score after total hip arthroplasty. *American Journal of Physical Medicine & Rehabilitation*, 95(2), 132-138.

de Jong, L. D., Lavender, A. P., Wortham, C., Skelton, D. A., Haines, T. P., & Hill, A. M. (2019). Exploring purpose-designed audio-visual falls prevention messages on older people's capability and motivation to prevent falls. *Health & Social Care in the Community*, 27(4), e471-e482.

de Leeuw, E. D., Hox, J. J., & Dillman, D. A. (2008). *International handbook of survey methodology*. Psychology Press.

De Vet, E., de Nooijer, J., de Vries, N. K., Brug, J., de Vet, E., de Nooijer, J., . . . Brug, J. (2005). Determinants of forward stage transition from precontemplation and contemplation for fruit consumption. *American Journal of Health Promotion*, 19(4), 278-285.

De Vet, H. C. W., Terwee, C. B., Mokkink, L. B., & Knol, D. L. (2011). *Measurement in medicine: A practical guide.* Cambridge University Press.

Delbaere, K., Close, J. C., Brodaty, H., Sachdev, P., & Lord, S. R. (2010). Determinants of disparities between perceived and physiological risk of falling among elderly people: cohort study. BMJ, 341, c4165.

Delbaere, K., Kochan, N. A., Close, J. C. T., Menant, J. C., Sturnieks, D. L., Brodaty, H., . . . Lord, S. R. (2012). Mild cognitive impairment as a predictor of falls in community-dwelling older people. *American Journal of Geriatric Psychiatry*, 20(10), 845-853.

Delbaere, K., Smith, S. T., & Lord, S. R. (2011). Development and initial validation of the Iconographical Falls Efficacy Scale using Item Response Theory Rasch model. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 66(6), 674-680.

Dennett, D. (1991). *Consciousness explained*. Little, Brown & Co.

Department of Statistic Singapore. (2019, October 30). *Census of population 2019*. https://www.singstat.gov.sg/

Deshpande, A. M., Shiffman, R. N., Nadkarni, P. M. (2005). Meta-drive Delphi rating the internet. *Computer Methods and Programs in Biomedicine*, 77: 49-56.

DeVon, H. A., Block, M. E., Moyle-Wright, P., Ernst, D. M., Hayden, S. J., Lazzara, D. J., . . . Kostas-Polston, E. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship*, 39(2), 155-164.

Diamantopoulos, A., Sarstedt, M., Fuchs, C. (2012). Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. Journal of the Academy of Marketing Science. 40: 434-449.

Dickinson A, Horton K, Machen I, Bunn F, Cove J, Jain D, & Maddex, T. (2011). The role of health professionals in promoting the uptake of fall prevention interventions: a qualitative study of older people's views. *Age and Ageing*, 40(6), 724-730.

Di Giulio, I., Baltzopoulos, V., Maganaris, C. N. & LKoram, I. D. (2013) Human standing: does the control strategy preprogram a rigid knee? *Journal of Applied Physiology*, 114, 1717-1729.

Dinh, A., Shi, Y., Teng, D., Ralhan, A., Chen, L., Dal Bello-Haas, V., . . . McCrowsky, C. (2009). A fall and near-fall assessment and evaluation system. *The Open Biomedical Engineering Journal*, 3, 1-7.

DiStefano, L. J., Clark, M. A., & Padua, D. A. (2009). Evidence supporting balance training in healthy individuals: a systematic review. *The Journal of Strength and Conditioning Research*, 23(9), 2718-2731.

Dite, W., Temple, V.A. (2002). A clinical test of stepping and change of direction to identify multiple falling older adults. *Archives of Physical Medicine and Rehabilitation,* 83, 1566-1571.

Donohoe, H. M., Stellefson, M. L., & Tennant, B. (2012). Advantages and limitation of the e-Delphi technique. *American Journal of Health Education*, 43(1), 38-46.

Duncan, O. D. (1984). *Rasch measurement: Further examples and discussion* (Vol. 2). Russell Sage Foundation.

Durkin, K. (2014, April 10). *Procedure for measuring hand grip strength using the Jamar dynamometer*. NHS. https://www.uhs.nhs.uk/Media/Southampton-Clinical-Research/Procedures/BRCProcedures/Procedure-for-measuring-gripstrength-using-the-JAMAR-dynamometer.pdf

Economic and Social Research Council (2021, January 21) Defining Impact. https://www.ukri.org/councils/esrc/impact-toolkit-for-economic-and-social-sciences/

Edwards, J. R., & Bagozzi, R. P. (2000). On the nature and direction of relationships between constructs and measures. *Psychological Reviews*, 5, 155-174.

Edwards, N., & Lockett, D. (2008). Development and validation of a modified falls-efficacy scale. *Disability & Rehabilitation: Assistive Technology*, 3(4), 193-200.

Elboim-Gabyzon, M., Agmon, M., Azaiza, F. (2019). Psychometric properties of the Arabic version of the Activities-specifc Balance Confidence (ABC) scale in ambulatory, community-dwelling, elderly people. *Clinical Interventions in Ageing*. 14, 1075-1084.

Eldridge, S. M., Chan, C. L., Campbell, M. J., Bond, C. M., Hopewell, S., & Thabane, L. (2016). CONSORT 2010 statement: extension to randomised pilot and feasibility trials. *BMJ*, 355(i5239), 1-29.

Ellmers, T. J., Paraskevopoulos, I. T., Williams, A. M. & Young, W. R. (2018). Recalibrating disparities in perceived and actual balance abilities in older adults: a mixed-methods evaluation of a novel exergaming intervention. *Journal of Neuroengineering and Rehabilitation*, 15(26), 1-12.

Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*, 7(3), 93-99.

Fadavi-Ghaffari, M., Azad, A., Meimandi, M., Arani-Kashani, Z., & Ghorbanpoor, H. (2019). The psychometric properties of falls efficacy scale in the elderly Iranian residents of nursing homes. *Iranian Rehabilitation Journal*. 17(3), 197-206.

Fahn, S., Elton, R., & UPDRS program members. (1987). *Unified Parkinson's disease rating scale* (Vol. 2). Macmillan Healthcare Information.

Fayers, P. M., & Hand, D. J. (1997). Factor analysis, causal indicators, and quality of life. *Quality of Life Research*, 6, 139-150.

FDA. (2009, April 10). *Guidance for industry patient-reported outcome measures: Use in medical product development to support labeling claims*. Rockville: Office of Communication, Education, and Radiation Programs U.S. Food & Drug Administration. http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Guidance

Filiatrault, J., Gauvin, L., Fournier, M., Parisien, M., Robitaille, Y., Laforest, S., . . . Richard, L. (2007). Evidence of the psychometric qualities of a simplified version of the Activities-specific Balance Confidence scale for community-dwelling seniors. *Archives Of Physical Medicine And Rehabilitation*, 88(5), 664-672.

Fitch, K., Bernstein, S. J., Aguilar, M. D., Burnand, B., Lacalle, J. R., Lazaro, P., . . . Kahan, J. P. (2001). *The RAND/UCLA Appropriateness Method User's Manual.* RAND.

Fixsen, D., Scott, V., Blase, K., Naoom, S., & Wagar, L. (2011). When evidence is not enough: the challenge of implementing fall prevention strategies. *Journal Of Safety Research*, 42(6), 419-422.

Fleischmann, M., & Vaughan, B. (2018). The challenges and opportunities of using patient reported outcome measures (PROMs) in clinical practice. *International Journal of Osteopathic Medicine*, 28, 56-61.

Fleming, J., Matthews, F. E., Brayne, C., & the Cambridge City over-75s Cohort study collaboration. (2008). Falls in advanced old age: recalled falls and prospective follow-up of over-90-year-olds in the Cambridge City over-75s Cohort study. *BMC Geriatrics*, 8(6), 1-11.

Fong, S. S., Ng, S. S., Liu, K. P., Pang, M. Y., Lee, H. W., Chung, J. W., . . . Guo, X. (2014). Musculoskeletal strength, balance performance, and self-efficacy in elderly Ving

Tsun chinese martial art practitioners: implications for fall prevention. *Evidence-Based Complementary and Alternative Medicine*, 402314.

Fors, A. (2015). Person-centred care and self-efficacy - Experiences, measures and effects after an event of acute coronary syndrome. University of Gothenburg. Sweden.

Franchignoni, F., Horak, F., Godi, M., Nardone, A., & Giordano, A. (2010). Using psychometric techniques to improve the Balance Evaluation Systems Test: the mini-BESTest. *Journal of Rehabilitation Medicine*, 42(4), 323-331.

Gallagher, M., Hares, T., Spencer, J., Bradshaw, C., & Webb, I. (1993). The nominal group technique: a research tool for general practice? *Family Practice*, 10(1), 76-81.

Gardiner, S., Glogowska, M., Stoddart, C., Pendlebury, S., Lasserson, D., & Jackson, D. (2017). Older people's experiences of falling and perceived risk of falls in the community: A narrative synthesis of qualitative research. *International Journal of Older People Nursing*, 12(4).

Gazibara, T., Kisic Tepavcevic, D., Svetel, M., Tomic, A., Stankovic, I., Kostic, V. S., & Pekmezovic, T. (2017). Near-falls in people with Parkinson's disease: Circumstances, contributing factors and association with falling. *Clinical Neurology and Neurosurgery*, 161, 51-55.

GBD 2017 DALYs and HALE Collaborators. (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the global burden of disease study 2017. *The Lancet*, 392, 1859–1922.

Gerards, M. H. G., McCrum, C., Mansfield, A., & Meijer, K. (2017). Perturbation-based balance training for falls reduction among older adults: Current evidence and implications for clinical practice. *Geriatrics & Gerontology International*, 17(12), 2294-2303.

Gillespie, L. D., Robertson, M. C., Gillespie, W. J., Sherrington, C., Gates, S., Clemson, L. M., & Lamb, S. E. (2012). Interventions for preventing falls in older people living in the community (Review). *Cochrane Database of Systematic Review*, 9(CD007146), 1-370.

Glaser, E. M. (1980). Using behavioural science strategies for defining the state-of-the-art. *Journal of Applied and Behavioural Science*, 16(1), 79-92.

Gorecki, C., Brown, J. M., Cano, S., Lamping, D. L., Briggs, M., Coleman, S., . . . Nixon, J. (2013). Development and validation of a new patient-reported outcome measure for patients with pressure ulcers: the PU-QOL instrument. *Health and Quality of Life Outcomes*, 11(95), 1-12.

Graham, D. F., Carty, C. P., Lloyd, D. G. & Barrett, R. S. (2015) Biomechanical predictors of maximal balance recovery performance amongst community-dwelling older adults. *Experimental Gerontology*, 66, 39-46.

Granacher, U., Muehlbauer, T., Zahner, L., Gollhofer, A., & Kressig, R. W. (2011). Comparison of traditional and recent approaches in the promotion of balance and strength in older adults. *Sports Medicine*, 41(5), 377-400.

Greenhalgh, J. (2009). The applications of PROs in clinical practice: what are they, do they work, and why? *Quality of Life Research*, 18(1), 115-123.

Greenhalgh, J., Pawson, R., Wright, J., Black, N., Valderas, J. M., Meads, D., . . . Dalkin, S. (2014). Functionality and feedback: a protocol for a realist synthesis of the collation, interpretation and utilisation of PROMs data to improve patient care. *BMJ Open*, 4(e005601), 1-7.

Gschwind, Y. J., Kressig, R. W., Lacroix, A., Muehlbauer, T., Pfenninger, B., & Granacher, U. (2013). A best practice fall prevention exercise program to improve balance, strength / power, and psychosocial health in older adults: study protocol for a randomized controlled trial. *BMC Geriatrics*, 13(1), 1-13.

Guan, Q., Han, H. J., Li, Y. X., Zhao, L. J., Jin, L. J., & Zhan, Q. (2012). Activities-specific Balance Confidence (ABC) scale adapted for the mainland population of China. *Clinical Rehabilitation*, 26(7), 648-655.

Gustavsson, J., Jernbro, C., & Nilson, F. (2018). There is more to life than risk avoidance - elderly people's experiences of falls, fall-injuries and compliant flooring. *International Journal of Qualitative Studies on Health and Well-being*, 13(1), 1-9.

Hackney, M.E., & Earhard, G.M. (2010). Backward walking in Parkinson Disease. *Movement Disorders*. 24(2), 218-223.

Hadjistavropoulos, T., Delbaere, K., & Fitzgerald, T. D. (2011). Reconceptualizing the role of fear of falling and balance confidence in fall risk. *Journal of Aging and Health*, 23(1), 3-23.

Hadjistavropoulos, T., Martin, R. R., Sharpe, D., Lints-Martindale, A. C., McCreary, D. R., & Asmundson, G. J. G. (2007). A longitudinal investigation of fear of falling, fear of pain, and activity avoidance in community dwelling older adults. *Journal of Aging and Health*, 19, 965-984.

Halaweh, H., Willen, C., Grimby-Ekman, A., & Svantesson, U. (2016). Physical functioning and fall-related efficacy among community-dwelling elderly people. *European Journal of Physiotherapy*, 18(1), 11-17.

Haley, S. M., Jette, A. M., Coster, W. J., Kooyoomjian, J. T., Levenson, S., Heeren, T., & Ashba, J. (2002). Late Life Function and Disability Instrument: II. Development and evaluation of the function component. *Journal of Gerontology: Biological Sciences*, 57A, M217-M222.

Hallam, R. S., & Hinchcliffe, R. (1991). Emotional stability: its relationship to confidence in maintaining balance. *Journal of Psychosomatic Research*, 35, 421-430.

Halvarsson, A., Franzén, E., & Ståhle, A. (2015). Balance training with multi-task exercises improves fall-related self-efficacy, gait, balance performance and physical function in older adults with osteoporosis: a randomized controlled trial. *Clinical Rehabilitation*, 29(4), 365-375.

Hammersley, M., & Atkinson, P. (1995). *Ethnography: Principles in Practice*. Routledge.

Harter, S. (1990). *Causes, correlates, and the functional role of global self-worth: A life-span perspective*. In R. J. Sternberg & J.Kolligian (Eds.), Competence considered (pp. 67-97). New Haven, CT: Yale University Press.

Hartholt, K. A., van Beeck, E. F., & van der Cammen, T. J. M. (2018). Mortality from falls in dutch adults 80 years and older, 2000-2016. *JAMA*, 319(13), 1380-1382.

Hauer, K. A., Kempen, G. I., Schwenk, M., Yardley, L., Beyer, N., Todd, C., . . . Zijlstra, G. A. (2011). Validity and sensitivity to change of the falls efficacy scales international to assess fear of falling in older adults with and without cognitive impairment. *Gerontology*, 57(5), 462-472.

Hauer, K., Lamb, S. E., Jorstad, E. C., Todd, C., Becker, C., & Group, P. (2006). Systematic review of definitions and methods of measuring falls in randomised controlled fall prevention trials. *Age and Ageing*, 35(1), 5-10.

Higgs, J., Jones, M. A., Loftus, S., & Christensen, N. (2008). *Clinical reasoning in the health professions* (3rd ed.). Elsevier.

Hill, K. D., Schwarz, J. A., Kalogeropoulos, A. J., & Gibson, S. J. (1996). Fear of falling revisited. *Archives of Physical Medicine & Rehabilitation*, 77(10), 1025-1029.

Hilliard, M. J., Martinez, K. M., Janssen, I., Edwards, B., Mille, M., Zhang, Y. & Rogers, M. W. (2008) Lateral balance factors predict future falls in community-living older adults. *Archives of Physical Medicine & Rehabilitation*, 89(9), 1708-1713.

Hofmeyer, M.R., Alexander, N.B., Nyquist, L.V., Medell, J.L., Koreishi, A. (2002). Floor-rise strategy training in older adults. *Journal of the American Geriatrics Society*, 50, 1702-1706.

Horak, F. B. (2006). Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Age and Ageing*, 35 Suppl 2, ii7-ii11.

Horak, F. B., & Nashner, L. M. (1986). Central programming of postural movements: adaptation to altered support-surface configurations. *Journal of Neurophysiology*, 55(6), 1-13.

Horak, F. B., Wrisley, D. M., & Frank, J. (2009). The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. *Physical Therapy*, 89(5), 484-498.

Horkheimer, M. & Adorno, T. W. (1972). *Dialectic of Enlightenment*. New York: Seabury.

Hotchkiss, A., Fisher, A., Robertson, R., Ruttencutter, A., Schuffert, J., & Barker, D. B. (2004). Convergent and predictive validity of three scales related to falls in the elderly. *American Journal of Occupational Therapy*, 58(1), 100-103.

Howland, J., Lachman, M. E., Peterson, E. W., Cote, J., Kasten, L., & Jette, A. (1998). Covariates of fear of falling and associated activity curtailment. *Gerontologist*, 38(5), 549-555.

Howland, J., Peterson, L., Levin, W., Fried, L., Pordon, D., & Bak, S. (1993). Fear of falling among the community-dwelling elderly. *Journal of Aging and Health*, 5, 229-243.

Huang, T. T. (2006). Geriatric fear of falling measure: development and psychometric testing. *International Journal of Nursing Studies*, 43(3), 357-365.

Hughes, C. C., Kneebone, I. I., Jones, F., & Brady, B. (2015). A theoretical and empirical review of psychological factors associated with fall-related psychological concerns in community-dwelling older people. *International Psychogeriatrics*, 27(7), 1071-1087.

Huxham, F. E., Goldie, P. A., & Patla, A. E. (2001). Theoretical considerations in balance assessment. *Australian Journal of Physiotherapy*, 47(2), 89-100.

Ioannidis, J. P., Greenland, S., Hlatky, M. A., Khoury, M. J., Macleod, M. R., Moher, D., . . . Tibshirani, R. (2014). Increasing value and reducing waste in research design, conduct, and analysis. *Lancet*, 383(9912), 166-175.

Jacobs, J. V., Horak, F. B., Van Tran, K., & Nutt, J. G. (2006). An alternative clinical postural stability test for patients with Parkinson's disease. *Journal Of Neurology*, 253(11), 1404-1413.

James, S. L., Lucchesi, L. R., Bisignano, C., Castle, C. D., Dingels, Z. V., Fox, J. T., . . . et al. (2020). The global burden of falls: global, regional and national estimates of morbidity and mortality from the Global Burden of Disease Study 2017. *Injury Prevention*, 26 (Supp 1), i3-i11.

JISC. (2021, July 26). *Online surveys*. JISC. https://www.onlinesurveys.ac.uk/

Johnson, D. H., & Johnson, F. P. (2013). *Joining Together: Group Theory and Group Skills*. Pearson.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1(2), 112-133.

Johnson, S. T. (2018). *Falls and fall prevention in community-dwelling older adults*. Uppsala University. Sweden.

Johnston, B. C., Patrick, D. L., Devji, T., Maxwell, L. J., Bingham III, C. O., Beaton, D. E., . . . Guyatt, G. H. (2018, May 29). Chapter 18: *Patient-reported outcomes. Cochrane Handbook for Systematic Reviews of Interventions version 6.0*. Cochrane. https://www.training.cochrane.org/handbook

Jones, C. J., Rikli, R. E., & Beam, W. C. (1999). A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Research Quarterly for Exercise and Sport*, 70(2), 113-119.

Jootun, D., McGhee, G., & Marland, G. R. (2009). Reflexivity: promoting rigour in qualitative research. *Nursing Standard*, 23(42-46).

Jöreskog, K. G. (1969). A general approach to confirmatory maximum likelihood factor analysis. *Psychometrika*, 34, 183-202.

Jørstad, E. C., Hauer, K., Becker, C., Lamb, S. E., & ProFaNE Group. (2005). Measuring the psychological outcomes of falling: a systematic review. *Journal of the American Geriatrics Society*, 53(3), 501-510.

Jung, D. (2008). Fear of falling in older adults: comprehensive review. *Asian Nursing Research*, 2(4), 214-222.

Kamper, S. J., Ostelo, R. W., Knol, D. J., Maher, C. G., De Vet, H., & Hancock, M. J. (2010). Global Perceived Effect scales provided reliable assessments of health transition in people with musculoskeletal disorders, but ratings are strongly influenced by current status. *Journal of Clinical Epidemiology*, 63(7), 760-766.

Karström, L., Yttergren, M., Borgblad, M., & Stenström, C. H. (2002). The Falls-Efficacy Scale. *Nordisk Fysioterapi*, 6(2), 66-73.

Katzman, R., Brown, T., & Fuld, P. (1983). Validation of a short orientation-memory-concentration test of cognitive impairment. *American Journal of Psychiatry*, 140, 734-739.

Kellogg International Work Group. (1987). The prevention of falls in later life. A report of the Kellogg International Work Group on the Prevention of Falls by the Elderly. *The Danish Medical Birth Registry*, 34(Suppl 4), 1-24.

Kline, P. (1994). *An easy guide to factor analysis*. Routledge.

Klingels, K., Mayhew, A. G., Mazzone, E. S., Duong, T., Decostre, V., Werlauff, U., . . . Upper Limb Clinical Outcome Group. (2016). Development of a patient‐reported outcome measure for upper limb function in Duchenne muscular dystrophy: DMD Upper Limb PROM. *Developmental Medicine and Child Neurology*, 59(2), 224-231.

Komisar, V., McIlroy, W. E., & Duncan, C. A. (2019). Individual, task, and environmental influences on balance recovery: a narrative review of the literature and implications for preventing occupational falls. *IISE Transactions on Occupational Ergonomics and Human Factors*, 7(2), 91-118.

Krueger, R. A., & Casey, M. A. (2014). *Focus groups: A practical guide for applied research* (5th ed.). Sage.

Kumar, A., Delbaere, K., Zijlstra, G. A. R., Carpenter, H., Iliffe, S., Masud, T., . . . Kendrick, D. (2016). Exercise for reducing fear of falling in older people living in the community: Cochrane systematic review and meta-analysis. *Age and Ageing*, 45(3), 345-352.

Kurz, I., Gimmon, Y., Shapiro, A., Debi, R., Snir, Y., & Melzer, I. (2016). Unexpected perturbations training improves balance control and voluntary stepping times in older adults - a double blind randomized control trial. *BMC Geriatrics*, 16, 1-11.

Kyte, D. G., Calvert, M., Van der Wees, P. J., ten Hove, R., Tolan, S., & Hill, J. C. (2015). An introduction to patient-reported outcome measures (PROMs) in physiotherapy. *Physiotherapy*, 101(2), 119-125.

Lach, H. W. (2006). Self-efficacy and fear of falling: in search of complete theory. *Journal of the American Geriatrics Society*, 54(2), 381-382.

Lachenbruch, P., Reinsch, S., MacRae, P., & Tobis, J. (1991). Adjusting for recall bias with proportional hazard model. *Methods of Information in Medicine*, 30, 108-110.

Lachman, M. E., Howland, J., Tennstedt, S., Jette, A., Assmann, S., & Peterson, E. W. (1998). Fear of falling and activity restriction: the survey of activities and fear of falling in the elderly (SAFE). *Journal of Gerontology: Psychological Sciences*, 53B(1), P43-P50.

Lacy, A., & Williams, S. (2018). *Measurement and Evaluation in Physical Education and Exercise Science* (8th ed.). Routledge.

Lamb, S. E., Jorstad-Stein, E. C., Hauer, K., Becker, C., Prevention of Falls Network Europe, & Outcomes Consensus Group. (2005). Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. *Journal of the American Geriatrics Society*, 53(9), 1618-1622.

Landers, M. R., Durand, C., Powell, D. S., Dibble, L. E., & Young, D. L. (2011). Development of a scale to assess avoidance behavior due to a fear of falling: the fear of falling avoidance behavior questionnaire. *Physical Therapy*, 91(8), 1253-1265.

Langeard, A., Torre, M. M., & Temprado, J. J. (2021). A dual-task paradigm using the oral trail making test while walking to study cognitive-motor interactions in older adults. *Frontier Ageing Neuroscience*, 13, 712463.

Lavedan, A., Viladrosa, M., Jurschik, P., Botigue, T., Nuin, C., Masot, O., & Lavedan, R. (2018). Fear of falling in community-dwelling older adults: A cause of falls, a consequence, or both? *PLoS One*, 13(3), e0194967.

Lee, S. K., Kwon, H. R., Cho, H., Kim, J., & Lee, D. (2016, October 30). *International Case studies of Smart Cities – Singapore, Republic of Singapore*. Inter-American Development Bank. https://publications.iadb.org/en/international-case-studies-smart-cities-singapore-republic-singapore

Legters, K. (2002). Fear of Falling. *Physical Therapy*, 82, 264-272.

Li, F., Fisher, K. J., Harmer, P., & McAuley, E. (2005). Falls self-efficacy as a mediator of fear of falling in an exercise intervention for older adults. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 60(1), P34-P40.

Li, F., McAuley, E., Fisher, K. J., Harmer, P., Chaumeton, N., & Wilson, N. L. (2002). Self-efficacy as a mediator between fear of falling and functional ability in the elderly. *Journal of Aging and Health*, 14(4), 452-466.

Linacre, J. M. (2021, June 11). *Winsteps®* (Version 4.8.2.0) [Computer Software]. Winsteps. https://www.winsteps.com

Linacre, M. (1994). Sample size and item calibration [or person measure] stability. *Rasch Measurement Transactions*, 7(4), 328.

Lord, F. M., & Novick, M. R. (2008). *Statistical theory of mental test scores*. Information Age Publishing Inc.

Lord, S. R., & Fitzpatrick, R. C. (2001). Choice stepping reaction time: A composite measure of falls risk in older people. *The Journals of Gerontology*. 56(10), M627-M632.

Lord, S. R., Sherrington, C., Menz, H. B., & Close , J. C. T. (2007). *Falls in older people: Risk factors and strategies for prevention* (2nd ed.). Cambridge University Press.

Lurie, J. D., Zagaria, A. B., Ellis, L., Pidgeon, D., Gill-Body, K. M., Burke, C., . . . McDonough, C. M. (2020). Surface perturbation training to prevent falls in older adults: a highly pragmatic, randomized controlled trial. *Physical Therapy*, 100, 1153-1162.

Lusardi, M. M., & Smith, J. E. V. (1997). Development of a scale to assess concern about falling and applications to treatment programs. *Journal of Outcome Measurement*, 1(1), 34-55.

Maidan, I., Freedman, T., Tzemah, R., Giladi, N., Mirelman, A., & Hausdorff, J. M. (2014). Introducing a new definition of a near fall: intra-rater and inter-rater reliability. *Gait Posture*, 39(1), 645-647.

Mak, M. K., Lau, A. L., Law, F. S., Cheung, C. C., & Wong, I. S. (2007). Validation of the chinese translated Activities-specific Balance Confidence scale. *Archives Of Physical Medicine And Rehabilitation*, 88(4), 496-503.

Maki, B. E., & McIlroy, W. E. (1996). Postural control in the older adult. *Clinics In Geriatric Medicine*, 12(4), 635-658.

Maki, B., & McIlroy, W. E. (1997). The role of limb movements in maintaining upright stance: the “change-in-support” strategy. *Physical Therapy*, 77(5), 488-507.

Maki, B. E., & McIlroy, W. E. (1999). Control of compensatory stepping reactions: age-related impairment and the potential for remedial intervention. *Physiotherapy Theory & Practice*, 15(2), 69-90.

Maki, B. E., & McIlroy, W. E. (2006). Control of rapid limb movements for balance recovery: age-related changes and implications for fall prevention. *Age and Ageing*, 35 Suppl 2, ii12-ii18.

Maki, B. E., Cheng, K. C., Mansfield, A., Scovil, C. Y., Perry, S. D., Peters, A. L., . . . McIlroy, W. E. (2008). Preventing falls in older adults: new interventions to promote more effective change-in-support balance reactions. *Journal of Electromyography and Kinesiology*, 18(2), 243-254.

Maki, B. E., McIlroy, W. E., & Fernie, G. R. (2003). Change-in-support reactions for balance recovery. *IEEE Engineering in Medicine and Biology Magazine*, 22(2), 20-26.

Maki, B. E., Perry, S. D., Scovil, C. Y., Peters, A. L., McKay, S. M., Lee, T. A., . . . McIlroy, W. E. (2008). Interventions to promote more effective balance-recovery reactions in industrial settings: new perspectives on footwear and handrails. *Industrial Health*, 46(1), 40-50.

Maki, B. E., Sibley, K. M., Jaglal, S. B., Bayley, M., Brooks, D., Fernie, G. R., . . . Zettel, J. L. (2011). Reducing fall risk by improving balance control: development, evaluation and knowledge-translation of new approaches. *Journal of Safety Research*, 42(6), 473-485.

Mancini, M., & Horak, F. (2010). The relevance of clinical balance assessment tool to differentiate balance deficits. *European Journal of Physical and Rehabilitation Medicine*, 46(2), 239-248.

Manley, K., & McCormack, B. (2003). Practice development: purpose, methodology, facilitation and evaluation. *Nursing in Critical Care*, 8, 22-29.

Mansfield, A., Peters, A. L., Liu, B. A., & Maki, B. E. (2010). Effect of a perturbation-based balance training program on compensatory stepping and grasping reactions in older adults: A randomized controlled trial. *Physical Therapy and Rehabilitation Journal*, 90(4), 476-491.

Mansfield, A., Wong, J. S., Bryce, J., Knorr, S., & Patterson, K. K. (2015). Does perturbation-based balance training prevent falls? Systematic review and meta-analysis of preliminary randomized controlled trials. *Physical Therapy*, 95(5), 700-709. https://doi.org/10.2522/ptj.20140090

Manton, K. J., Gauld, C. S., White, K. M., Griffin, P. M., & Elliott, S. L. (2018). Qualitative study investigating the underlying motivations of healthy participants in phase I clinical trials. *Public Health*, 9(e024224), 1-9.

Marinsek, M. & Cuk, I. (2010) Landing errors in the men's floor exercise are caused by flight characteristics. *Biology of Sport*, 27(2), 123-128.

Marks, I., & Bebbington, P. (1976). Space phobia: syndrome or agoraphobic variant? *BMJ*, 2, 345-347.

Marsh, H. W., Walker, & Debus, R. (1991). Subject-specific components of academic self-concept and self-efficacy. *Contemporary Educational Psychology*, 16, 331-345.

Massion, J. & Woollacott, M. H. (2004) *Posture and equilibrium* (3rd ed.). London: Arnold.

McAuley, E., Mihalko, S. L., & Rosengren, K. (1997). Self-efficacy and balance correlates of fear of falling in the elderly. *Journal of Aging & Physical Activity*, 5(4), 329-340.

McCance, T., Gribben, B., McCormack, B., & Laird, E. A. (2013). Promoting person-centred practice within acute care: the impact of culture and context on a facilitated practice development programme. *International Practice Development Journal*, 3(1), 1-17.

McCormack, B., & Garbett, R. (2003). *The meaning of practice development: evidence from the field*. Collegian, 10(3), 13-16.

McCormack, B., & McCance, T. (2017). *Person-Centred Practice in Nursing and Health Care: Theory and Practice*. Wiley Blackwell.

McCormack, B., Manley, K., & Titchen, A. (2013). *Introduction*. in McCormack, B., Manley, K., and Titchen, A. (Eds.) (2013) Practice Development in Nursing and Healthcare. Oxford, UK: Wiley-Blackwell.

McCrum, C. (2018). Falls among older people-are intervention duration and specificity the keys to making a difference? *BMJ*, 361, k2213.

McCrum, C., Gerards, M. H. G., Karamanidis, K., Zijlstra, W., & Meijer, K. (2017). A systematic review of gait perturbation paradigms for improving reactive stepping responses and falls risk among healthy older adults. *European Review Of Aging and Physical Activity*, 14(3), 1-11.

McIlroy, W. E. & Maki, B. E. (1995) Early activation of arm muscles follows external perturbation of upright stance. *Neuroscience Letters*, 184, 177-180.

McIver, J. P., & Carmines, E. G. (1981). *Unidimensional scaling (Quantitative applications in the social sciences).* Sage Publications.

McKenna, S. P., Heaney, A. (2021). Setting and maintaining standards for patient-reported outcome measures: can we rely on the COSMIN checklists? *Journal of Medical Economics*, 24(1): 502-511.

McKenna, S. P., Heaney, A., & Wilburn, J. (2019). Measurement of patient-reported outcomes. 2: Are current measures failing us? *Journal of Medical Economics*, 22(6), 523-530.

McKenna, S. P., Heaney, A., Wilburn, J., & Stenner, A. J. (2019). Measurement of patient-reported outcomes. 1: The search for the Holy Grail. *Journal of Medical Economics*, 22(6), 516-522.

McMillan, S. S., King, M., & Tully, M. P. (2016). How to use the nominal group and delphi techniques. *International Journal of Clinical Pharmacy*, 38(3), 655-662.

Melzer, I., Kurz, I., Shahar, D., Levi, M., & Oddsson, L. (2007). Application of the voluntary step execution test to identify elderly fallers. *Age and Ageing*, 36(5), 532-537.

Mihaljcic, T., Haines, T. P., Ponsford, J. L., & Stolwyk, R. J. (2017). Investigating the relationship between reduced self-awareness of falls risk, rehabilitation engagement and falls in older adults. *Archives of Gerontology and Geriatrics*, 69, 38-44.

Miyamoto, K., Takebayashi, H., Takimoto, K., Miyamoto, S., Morioka, S., & Yagi, F. (2008). A new simple performance test focused on agility in elderly people: The ten step test. *Gerontology*. 54, 365-372.

MOH. (2014, October 30). *Creating senior-friendly communities: Tips and tools from the city for all ages project*. Ministry of Health. https://www.moh.gov.sg/resources-statistics/educational-resources/cfaa-guidebook---creating-senior-friendly-communities.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*, 339(b2535), 1-8.

Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., . . . De Vet, H. C. (2010). The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Quality of Life Research*, 19(4), 539-549.

Mokkink, L. B., De Vet, H. C., Prinsen, C. A., et al. (2018) COSMIN risk of bias checklist for systematic reviews of patient-reported outcome measures. *Quality of Life Research*, 27(5): 1171–1179.

Moon, Y., & Sosnoff, J. J. (2017). Safe landing strategies during a fall: systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*, 98(4), 783-794.

Moore, D. S., & Ellis, R. (2008). Measurement of fall-related psychological constructs among independent-living older adults: a review of the research literature. *Aging and Mental Health*, 12(6), 684-699.

Montero-Odasso, M., Van Der Velde, N., Alexander, N. B., Becker, C., Blain, H., Camicioli, R., . . . on behalf of the Task Force on Global Guidelines for Falls in Older Adults. (2021). New horizons in falls prevention and management for older adults: a global initiative. *Age and Ageing*, 1-9.

Mourey, F., Manckoundia, P., Martin-Arveux, I., Tavernier-Vidal, B., & Pfitzenmeyer, P. (2004). Psychomotor disadaptation syndrome. A new clinical entity in geriatric patients. *Geriatrics*, 59, 20-24.

Murphy, J., & Isaacs, B. (1982). The post-fall syndrome. A study of 36 elderly patients. *Gerontology*, 28(4), 265-270.

Myers, A. M., Holliday, P. J., Harvey, K. A., & Hutchinson, K. S. (1993). Functional performance measures: are they superior to self-assessments? *The Journals of Gerontology*, 48, 196-206.

Nagai, K., Yamada, M., Komatsu, M., Tamaki, A., Kanai, M., Miyamoto, T., . . . Tsuboyama, T. (2017). Near falls predict substantial falls in older adults: A prospective cohort study. *Geriatrics & Gerontology International*, 17(10), 1477-1480.

Nanthapaiboon, K., Wannapakhe, J., Viriyatarakij, N., & Boonsinsukh, R. (2018). Assessment of internal consistency and convergent validity of the Activities-specific Balance Confidence (ABC) scale Thai version. *Thai Pharmaceutical and Health Science Journal*. 13(1), 1-7.

Nashner, L. M. (1979). Organization and programming of motor activity during posture control. *Progress in Brain Research*, 50, 177-184.

Navarro, M. D. (2020). Patients' empowerment and the role of patients' education. *Medical Research Archives*, 8(12), 1-7.

NICE. (2017, July 26). *Falls in older people*. National Institute for Health and Care Excellence. https://www.nice.org.uk/guidance/qs86

NIH. (2014, December 28). *Consensus document on frailty and falls prevention among the elderly*. Spain Retrieved from Inter-territorial Council of the National Health System. https://www.mscbs.gob.es/eu/profesionales/saludPublica/prevPromocion/Estrategia/docs/Fragilidad/Frailtyandfalls_Elderly.pdf

Nijsten, T., Unaeze, J., & Stern, R. S. (2006). Refinement and reduction of the impact of Psoriasis Questionnaire: classical test theory vs. Rasch analysis. *British Journal of Dermatology*, 154(4), 692-700.

Nor, R., Justine, M., Joanny, A., & Zolkafli, A. A. (2021). Effectiveness of a 3-month antifalling program in the mobility, balance confidence, and muscle performance of older adults. *Journal of Exercise Rehabilitation*, 17(4), 247-255.

Nyumba, T. O., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1).

Okubo, Y., Sturnieks, D. L., Brodie, M. A., Duran, L., & Lord, S. R. (2019). Effect of reactive balance training involving repeated slips and trips on balance recovery among older adults: a blinded randomized controlled trial. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, 74(9), 1489-1496.

Onodera, C. M. K., Coelho-Júnior, H. J., Sampaio, R. A. C., Lana, J. F. S. D., Teixeira, L. F. M., Uchuda, M. C., & Bizzacchi, M. A. A. (2020). The importance of objectively measuring functional tests in complement to self-report assessments in patients with knee osteoarthritis. *Gait and Posture*. 82: 33-37

Orr, R. (2010). Contribution of muscle weakness to postural instability in the elderly. A systematic review. *European Journal of Physical Rehabilitation Medicine*. 46: 183-220.

Pajares, F. (1997). *Current directions in self-efficacy research*. In M. Maehr & P. R. Pintrich (Ed.). Advances in Motivation and Achievement (pp. 1-49). Greenwich, CT: JAI Press.

Pajares, F. (2002, August 26). *Overview of social cognitive theory and self-efficacy*. http://www.emory.edu/EDUCATION/mfp/eff.html.

Pajares, F., Hartley, J., & Valiante, G. (2001). Response format in writing self-efficacy assessment: Greater discrimination increases prediction. *Measurement and Evaluation in Counseling and Development*, 33, 214-221.

Palmgren, A., Ståhle, A., Roaldsen, K. S., Dohrn, I. M., & Halvarsson, A. (2019). "Stay balanced" - effectiveness of evidence-based balance training for older adults transferred into a physical therapy primary care setting - a pilot study. *Disability and Rehabilitation*, 42(13), 1797-1802.

Papadimitriou, A., & Perry, P. (2017). A systematic review of the effects of perturbation training on preventing falls. *New Zealand Journal of Physiotherapy*, 45(1), 31-49.

Parker, C., Scott, S., & Geddes, A. (2019). Snowball sampling. *SAGE Research Methods Foundations*, 1-13.

Parry, S. W., Steen, N., Galloway, S. R., Kenny, R. A., & Bond, J. (2001). Falls and confidence related quality of life outcome measures in an older British cohort. *Postgraduate Medical Journal*, 77(904), 103-108.

Pater, M. L., Rosenblatt, N. J. & Grabiner, M. D. (2015) Expectation of an upcoming large postural perturbation influences the recovery stepping response and outcome. *Gait and Posture*, 41(1), 335-337.

Patti, A., Bianco, A., Sahin, N., Sekulic, D., Paoli, A., Iovane, A., Messina, G., Gagey, P. M. & Palma, A. (2018) Postural control and balance in a cohort of healthy people living in Europe: An observational study. *Medicine*, 97(52), e13835.

Patton, M. (1990). *Designing qualitative studies. Qualitative evaluation and research methods*. Sage Publications.

Pauelsen, M., Nyberg, L., Röijezon, U., & Vikman, I. (2018). Both psychological factors and physical performance are associated with fall-related concerns. *Aging Clinical and Experimental Research*, 30(9), 1079-1085.

Payette, M. C., Bélanger, C., Léveillé, V., & Grenier, S. (2016). Fall-related psychological concerns and anxiety among community-dwelling older adults: systematic review and meta-analysis. *PLoS One*, 11(4), 381-382.

Peel, N. M. (2011). Epidemiology of falls in older age. *Canadian Journal on Aging*, 30(1), 7-19.

Peretz, C., Herman, T., Hausdorff, J. M., & Giladi, N. (2006). Assessing fear of falling: Can a short version of the Activities-specific Balance Confidence scale be useful? *Movement Disorders Journal*, 21(12), 2101-2105.

Perrot, A., Castanier, C., Maillot, P., & Zitari, H. (2018). French validation of the modified-falls efficacy scale (M-FES Fr). *Archives of Gerontology & Geriatrics*, 78, 233-239. https://doi.org/10.1016/j.archger.2018.07.001

Patton, M. (1990). *Designing qualitative studies. Qualitative Evaluation and Research Methods*. Sage Publications.

Penfield, T., Baker, M. J., Scoble, R., & Wykes, M. C. (2014). Assessment, evaluations, and definitions of research impact: A review. *Research Evaluation*, 23(1), 21-32.

Pezalla, A. E., Pettigrew, J., & Miller-Day, M. (2012). Researching the researcher-as-instrument: an exercise in interviewer self-reflexivity. *Qualitative Research*, 12(2), 165-185.

Phelan, E. A., Rillamas-Sun, E., Johnson, L., LaMonte, M. J., Buchner, D. M., LaCroix, A. Z., & Anderson, G. L. (2020). Determinants, circumstances and consequences of injurious falls among older women living in the community. *Injury Prevention*, 27(1), 1-8.

Phu, S., Kirk, B., & Duque, G. (2020). Postural instability - balance, posture and gait. *Encyclopedia of Biomedical Gerontology*, 64-76.

Piantadosi, S. (2005). *Clinical trials: a methodologic perspective*. Wiley & Sons, Inc.

Pijnappels, M., Kingma, I., Wezenberg, D., Reurink, G., & van Dieën, J. H. (2010). Armed against falls: the contribution of arm movements to balance recovery after tripping. *Experimental Brain Research*, 201(4), 689-699.

Pijnappels, M., Reeves, N. D., Maganaris, C. N., & van Dieen, J. H. (2008). Tripping without falling; lower limb strength, a limitation for balance recovery and a target for training in the elderly. *Journal of Electromyography and Kinesiology*, 18(2), 188-196.

Podsiadlo, D., & Richardson, S. (1991). The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, 39(2), 142-148.

Politi, M. (2013). Importance of clarifying patients' desired role in shared decision making. *BMJ Case Reports*, 347, 18-19.

Potter, M., Gordon, S., & Hamer, P. (2004). The nominal group technique: a useful consensus methodology in physiotherapy research. *New Zealand Journal of Physiotherapy*, 32(3), 126-130.

Powell, L. E., & Myers, A. M. (1995). The Activities-specific Balance Confidence (ABC) scale. *Journal of Gerontology: Medical Sciences*, 50A(1), M28-M34.

Prinsen, C. A. C., Mokkink, L. B., Bouter, L. M., Alonso, J., Patrick, D. L., De Vet, H. C. W., & Terwee, C. B. (2018). COSMIN guideline for systematic reviews of patient-reported outcome measures. *Quality of Life Research*, 27(5), 1147-1157. https://doi.org/10.1007/s11136-018-1798-3

Pua, Y. H., Ong, P. H., Clark, R. A., Matcher, D. B., & Lim, E. C. W. (2017). Falls efficacy, postural balance, and risk for falls in older adults with fall-related emergency department visits: prospective cohort study. *BMC Geriatrics*, 17, 1-7.

R Core Team. (2020, June 11). *R: A language and environment for statistical computing*. The R Foundation. https://www.R-project.org

Raad, J., Moore, J., Hamby, J., Rivadelo, R. L., & Straube, D. (2013). A brief review of the Activities-specific Balance Confidence scale in older adults. *Archives of Physical Medicine and Rehabilitation*, 94, 1426-1427.

Rachman, S. J. (1978). Fear and courage: A psychological perspective. *Social Research*, 71(1), 149-176.

Reeve, J. (2009). *Understanding Motivation and Emotion*. John Wiley & Sons, Inc.

REF. (2021). *Research Excellence Framework*. UK Research and Innovation (UKRI). https://www.ref.ac.uk

Reuben, D.B., Seeman, T.E., Keeler, E., Hayes, R. P., Bowman, L., Sewall, A., … Guralnik, J. M. (2004). Refining the categorization of physical functional status: the added value of combining self-reported and performance-based measures. *Journal of Gerontology: Medical Sciences*. 59A(10): 1056-1061.

Rinaldi, N. M., Lim, J., Hamill, J., Van Emmerik, R., & Moraes, R. (2018). Walking combined with reach-to-grasp while crossing obstacles at different distances. *Gait Posture*, 65, 1-7.

Ring, L., Gross, C. R., & McColl, E. (2010). Putting the text back into context: toward increased use of mixed methods for quality of life research. *Quality of Life Research*, 19(5), 613-615.

Robson, K., Coyle, J., & Pope, R. (2018). Exploration of older people's perceptions of behavioural factors associated with falls. *Age and Ageing*, 47(5), 734-740.

Rochat, S., Bula, C., Martin, E., Ganea, R., Hoskovec, C., Ionescu, A., . . . Santos-Eggimann, B. (2008). Does falls efficacy predict gait performance in high-functioning older people? *Gerontologist*, 48, 536-536.

Rolfe, G., Freshwater, D., & Jasper, M. (2001). *Critical reflection in nursing and the helping professions: a user's guide*. Palgrave Macmillan.

Rosengren, K. S., McAuley, E., & Mihalko, S. L. (1998). Gait adjustments in older adults: activity and efficacy influences. *Psychology And Aging*, 13(3), 375-386.

Rothrock, N. E., Kaiser, K. A., & Cella, D. (2011). Developing a valid patient-reported outcome measure. *Clinical Pharmacology & Therapeutics*, 90(5), 737-742.

Rubenstein, L. Z. (2006). Falls in older people: epidemiology, risk factors and strategies for prevention. *Age and Ageing*, 35 Suppl 2, ii37-ii41.

Ryan, J. W., Dinkel, J. L. & Petrucci, K. (1993). Near fall incidents a study of older adults in the community. *Journal of Gerontological Nursing*, 19(12), 23-28.

Rycroft-Malone, J., Seers, K., Chandler, J., Hawkes, C. A., Crichton, N., Allen, C., . . . Strunin, L. (2013). The role of evidence, context, and facilitation in an implementation trial: implications for the development of the PARIHS framework. *Implementation Science*, 8(28), 1-13.

Said, C. M., Batchelor, F., Shaw, K., & Blennerhassett, J. (2016). Preparing patients at high risk of falls for discharge home after rehabilitation: Do we meet the guidelines? *Geriatric and Gerontology International*, 16, 570-576.

Scherpenzeel, A. (2002). Why use 11-point scales. *Swiss Household Panel*, 9, 2008.

Schoene, D., Heller, C., Aung, Y. N., Sieber, C. C., Kemmler, W., & Freiberger, E. (2019). A systematic review on the influence of fear of falling on quality of life in older people: is there a role for falls? *Clinical Interventions in Aging*, 14, 701-719.

Schön, D. A. (1983). *The reflective practitioner. How professionals think in action*. Basic Books.

Schott, N. (2008). German adaptation of the "Activities-specific Balance Confidence (ABC) scale" for the assessment of fall-related self-efficacy. *Zeitschrift Fur Gerontologie Und Geriatrie*, 41(6), 475-485.

Schott, N. (2014). Reliability and validity of the German short version of the Activities specific Balance Confidence (ABC-D6) scale in older adults. *Archives of Gerontology & Geriatrics*, 59(2), 272-279.

Sechrest, L., & Sidani, S. (1995). Quantitative and qualitative methods: is there an alternative? *Evaluation and Program Planning*, 18(1), 77-87.

Shalin, D. N. (1992). Introduction: Hebermas, Pragmatism, Interactionism. *Symbolic Interaction*, 15(3): 251-260.

Sherrington, C., Fairhall, N. J., Wallbank, G. K., Tiedemann, A., Michaleff, Z. A., Howard, K., . . . Lamb, S. E. (2019). Exercise for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews*, 1(1), CD012424.

Shumway-Cook, A., & Woollacott, M. H. (2017). *Motor control: translating research into clinical practice* (5th ed.). Wolters Kluwer.

Shumway-Cook, A., Gruber, W., Baldwin, M., & Liao, S. (1997). The effect of multidimensional exercises on balance, mobility, and fall risk in community-dwelling older adults. *Physical Therapy*, 77(1), 46-57.

Sibley, K. M., Inness, E. L., Straus, S. E., Salbach, N. M., & Jaglal, S. B. (2013). Clinical assessment of reactive postural control among physiotherapists in Ontario, Canada. *Gait Posture*, 38(4), 1026-1031.

Sibley, K. M., Straus, S. E., Inness, E. L., Salbach, N. M., & Jaglal, S. B. (2011). Balance assessment practices and use of standardized balance measures among Ontario physical therapists. *Physical Therapy*, 91(11), 1583-1591.

Silva, A. G., Queiros, A., Sa-Couto, P., & Rocha, N. P. (2015). Self-reported disability: association with lower extremity performance and other determinants in older adults attending primary care. *Physical Therapy*, 95(12), 1628-1637.

Silverman, R., & Kwiatkowski, T. (1998). Research fundamentals: III. Elements of a research protocol for clinical trials. Academic Emergency Medicine, 5(12), 1218-1223.

Sim, J., & Waterfield, J. (2019). Focus group methodology: some ethical challenges. *Quality and Quantity*, 53, 3003-3022.

Simpson, J. M., Worsfold, C., Fisher, K. D., & Valentine, J. D. (2009). The CONFbal scale: a measure of balance confidence -- a key outcome of rehabilitation. *Physiotherapy*, 95(2), 103-109.

Simpson, J., Worsfold, C., & Hawke, J. (1998). Balance confidence in elderly people - the CONFbal Scale. *Age and Ageing*, 27(suppl 2), 57-57.

Singapore Business Review. (2018, October 30). *4.83 million Singaporeans are now online*. https://sbr.com.sg/information-technology/news/483-million-singaporeans-are-now-online

Sloan, J. A., Aaronson, N., Cappelleri, J. C., Fairclough, D. L., Varricchio, C., & Clinical Significance Consensus Meeting Group. (2002). Assessing the clinical significance of single items relative to summated scores. *Mayo Clinic Proceedings*, 77(5), 479-487.

Smith, A. B., Rush, R., Fallowfield, L. J., Velikova, G., & Sharpe, M. (2008). Rasch fit statistics and sample size considerations for polytomous data. *BMC Medical Research Methodology*, 8(33), 1-11.

Smith, J. K., & Heshusius, L. (1986). Closing down the conversation: the end of the quantitative–qualitative debate among educational inquirers. *Educational Researcher*, 15(1), 4-13.

Smulders, E., Weerdesteyn, V., Groen, B. E., Duysens, J., Eijsbouts, A., Laan, R., & van Lankveld, W. (2010). Efficacy of a short multidisciplinary falls prevention program for elderly persons with osteoporosis and a fall history: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*, 91(11), 1705-1711.

Soh, S. L. H. (2021, July 14). *Validation of a new scale of balance recovery confidence for community-dwelling older adults*. NIH. https://clinicaltrials.gov/ct2/show/NCT04577365.

Soh, S. L. H., Gilmour, F., Lane, J., Asokan, S., Woan, K. L., & Tan, C. W. (2021). Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders. *International Practice Development Journal*, 11(1), 1-19.

Soh, S. L. H., Lane, J., & Tan, C. W. (2020). Researcher as instrument: a critical reflection using nominal group technique for content development of a new patient-reported outcome measure. *International Practice Development Journal*, 10(2), 1-9.

Soh, S. L. H., Lane, J., Gleeson, N., Xu, T., Rahman, F. B. A., Yeh, T. T., Soon, B., & Tan C. W. (2021). Validation of a new patient-reported outcome measure of balance recovery confidence (BRC) for community-dwelling older adults: a study protocol. *Physical Therapy Reviews*, https://doi.org/10.1080/10833196.2021.1938867.

Soh, S. L. H., Lane, J., Xu, T., Gleeson, N., & Tan, C. W. (2021). Falls efficacy instruments for community-dwelling older adults: a COSMIN-based systematic review. *BMC Geriatrics*, 21(21), 1-10.

Soh, S. L. H., Tan, C. W., Lane, J., Yeh, T. T., & Soon, B. (2021). Near falls in Singapore community-dwelling older adults: a feasibility study. *Pilot And Feasibility Studies*, 7(25), 1-10.

Soh, S. L. H., Tan, C. W., Thomas, J. I., Tan, G., Xu, T., Ng, Y. L., & Lane, J. (2021). Falls efficacy: extending the understanding of self-efficacy in older adults towards managing falls. *Journal of Frailty, Sarcopenia and Falls*, 6(3), 131-138.

Srygley, J. M., Herman, T., Giladi, N., & Hausdorff, J. M. (2009). Self-report of missteps in older adults: a valid proxy of fall risk? *Archives of Physical Medicine & Rehabilitation*, 90(5), 786-792.

Stasny, B. M., Newton, R. A., LoCascio, L. V., Bedio, N. B., Lauke, C., Conroy, M., … Polidoro, C. (2011). The ABC Scale and fall risk: a systematic review. *Physical and Occupational Therapy in Geriatrics*, 29(3), 233-242.

Stevens, J. A., Mahoney, J. E., & Ehrenreich, H. (2014). Circumstances and outcomes of falls among high risk community-dwelling older adults. *Injury Epidemiology*, 1(5), 1-9.

Stevens, J. A., Sleet, D. A., & Rubenstein, L. Z. (2018). The influence of older adults' beliefs and attitudes on adopting fall prevention behaviors. *American Journal of Lifestyle Medicine*, 12(4), 324-330.

Strandkvist, V., Larsson, A., Pauelsen, M., et al. (2021). Hand grip strength is strongly associated with lower limb strength but only weakly with postural control in community-dwelling older adults. *Archives of Gerontology and Geriatrics*. 94: 1-9.

Streiner, D. L., Norman, G. R., & Cairney, J. (2015). *Health measurement scales. A practical guide to their development and use* (5th ed.). Oxford University Press.

Strickland, L. H., Murray, D. W., Pandit, H. G., & Jenkinson, C. (2020). Development of a patient-reported outcome measure (PROM) and change measure for use in early recovery following hip or knee replacement. *Journal of Patient-Reported Outcomes*, 4(91), 1-17.

Tennstedt, S., Howland, J., Lachman, M., Peterson, E., Kasten, L., & Jette, A. (1998). A randomized controlled trial of a group intervention to reduce fear of falling and associated activity restriction in older adults. *Journal of Gerontology: Psychological Sciences*, 53B(6), P384-P392.

Teno, J., Kiel, D. P., & Mor, V. (1990). Multiple stumbles: a risk factor for falls in community-dwelling elderly. A prospective study. *Journal of the American Geriatrics Society*, 38(12), 1321-1325.

Terry, G., & Kayes, N. (2019). Person centered care in neurorehabilitation: a secondary analysis. *Disability and Rehabilitation*, 42(16), 2334-2343.

Terwee, C. B., Prinsen, C. A. C., Chiarotto, A., Westerman, M. J., Patrick, D. L., Alonso, J., . . . Mokkink, L. B. (2018). COSMIN methodology for evaluating the content validity of patient-reported outcome measures: a Delphi study. *Quality of Life Research*, 27(5), 1159-1170.

Timsina, L. R., Willetts, J. L., Brennan, M. J., Marucci-Wellman, H., Lombardi, D. A., Courtney, T. K., & Verma, S. K. (2017). Circumstances of fall-related injuries by age and gender among community-dwelling adults in the United States. *PLoS One*, 12(5), e0176561.

Tinetti, M. E., Mendes de Leon, C. F., Doucette, J.T., et al. (1994). Fear of falling and fall-related efficacy in relationship to functioning among community-living elders. Journal of Gerontology: Medical Sciences. 49(3): M140-M147.

Tinetti, M. E., & Powell, L. (1993). Fear of falling and low self-efficacy: a case of dependence in elderly persons. *The Journals of Gerontology*, 48, 35-38.

Tinetti, M. E., Richman, D., & Powell, L. (1990). Falls efficacy as a measure of fear of fall. *Journal of Gerontology: Psychological Sciences*, 45(6), 239-243.

Tinetti, M. E., Speechley, M., & Ginter, S. F. (1988). Risk factors for falls among elderly persons living in the community. *The New England Journal of Medicine*, 319(26), 1701-1707.

Tokur, D., Grimmer, M., & Seyfarth, A. (2020). Review of balance recovery in response to external perturbations during daily activities. *Human Movement Science*, 69, 1-18.

Tractenberg, R. E. (2010). Classical and modern measurement theories, patient reports, and clinical outcomes. *Contemporary Clinical Trials*, 31, 1-3.

Van der Wees, P. J., Nijhuis-van der Sanden, M. W., Ayanian, J. Z., Black, N., Westert, G. P., & Schneider, E. C. (2014). Integrating the use of patient-reported outcomes for both clinical practice and performance measurement: views of experts from 3 countries. *The Milbank Quarterly*, 92(4), 754-775.

van Dulmen, S. A., van der Wees, P. J., Bart Staal, J., Braspenning, J. C., & Nijhuis-van der Sanden, M. W. (2017). Patient reported outcome measures (PROMs) for goalsetting and outcome measurement in primary care physiotherapy, an explorative field study. *Physiotherapy*, 103(1), 66-72.

Velozo, C. A., & Peterson, E. W. (2001). Developing meaningful fear of falling measures for community dwelling elderly. *American Journal Of Physical Medicine & Rehabilitation*, 80(9), 662-673.

Wang, Y. C., Sindhu, B., Lehman, L., Li, X., Yen, S. C., & Kapellusch, J. (2018). Rasch analysis of the Activities-specific Balance Confidence scale in older adults seeking outpatient rehabilitation services. *The Journal Of Orthopaedic And Sports Physical Therapy*, 48(7), 574-583.

Weldring, T., & Smith, S. M. (2013). Patient-reported outcomes (PROs) and patient-reported outcome measures (PROMs). *Health Services Insights*, 6, 61-68.

WHO. (2012, August 29). *Strategy and action plan for healthy ageing in Europe, 2012–2020.* http://www.euro.who.int/__data/assets/pdf_file/0008/175544/RC62wd10Rev1-Eng.pdf.

WHO. (2018, October 18). *Falls*. https://www.who.int/news-room/fact-sheets/detail/falls

Wiering, B., De Boer, D., & Delnoij, D. (2017). Patient involvement in the development of patient-reported outcome measures: a scoping review. *Health Expectations*, 20(1), 11-23.

Wilberforce, M., Challis, D., Davies, L., Kelly, M. P., Roberts, C., & Loynes, N. (2016). Person-centredness in the care of older adults: a systematic review of questionnaire-based scales and their measurement properties. *BMC Geriatrics*, 16(63), 1-12.

Wilson, I. B., & Cleary, P. D. (1995). Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. *JAMA*, 273(1), 59-65.

Wilson, R. (2018). Patient led PROMs must take centre stage in cancer research. *Research Involvement and Engagement*, 4(7), 1-8.

Winter, D. A., Patla, A. E., & Frank, J. S. (1990). Assessment of balance control in humans. *Medical Process through Technology*, 16, 31-51.

Woollacott, M. & Tang, P. F. (1997) Balance Control During Walking in the Older Adult: Research and Its Implications. *Physical Therapy,* 77(6), 646-660.

Yardley, L., & Smith, H. (2002). A prospective study of the relationship between feared consequences of falling and avoidance of activity in community-living older people. *Gerontologist*, 42, 17-23.

Yardley, L., Beyer, N., Hauer, K., Kempen, G., Piot-Ziegler, C., & Todd, C. (2005). Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age and Ageing*, 34(6), 614-619.

Yoshikawa, A., & Smith, M. L. (2019). Mediating role of fall-related efficacy in a fall prevention program. *American Journal of Health Behavior*, 43(2), 393-405.

Yuen, B., & Soh, E. (2017). *Housing for older people in Singapore: an annotated bibliography*. Springer.

Appendices

Appendix 1: Supplementary materials for Chapter 3

Appendix 1A PROSPERO record: CRD42019124366

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International prospective register of systematic reviews

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Falls efficacy instruments for community-dwelling older adults: a COSMIN-based systematic review

Shawn Leng-Hsien Soh, Chee-wee Tan, Judith Lane, Nigel Gleeson, Tianma Xu

Citation

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Review question

What are the empirical evidence for the content development, content validity and structural validity of falls efficacy-related scales for community-dwelling older adults?

Searches

A comprehensive language-unrestricted search was conducted between 1st January 1990 and 31st May 2019 amongst MEDLINE (EBSCOhost), Web of Science Core Collection, PsycINFO (EBSCOhost), Scopus (Scopus.com) and CINAHL Plus with full text (EBSCOhost) databases. COSMIN-guided searching consisted of three groups of search terms using Boolean operators, detailing: (1) construct of interest, (2) target population and (3) measurement properties (see Additional file 1).

Studies that focused on the development of falls efficacy related instruments measuring falls efficacy or balance confidence were included for the assessment of content validity (Table 1). Content validity studies were eligible if they were full-text original articles that featured community-dwelling older adults or professionals (e.g. falls-related researchers, clinicians), in order to assess the relevance, comprehensiveness, or comprehensibility of the content of at least one instrument. Cross-cultural adaptation studies of instruments were included if comprehensibility pretesting of the adapted questionnaire within the target population had been performed. Similarly, the availability of content validity studies for instruments in comparable populations was included. Structural validity studies were included only as full-text original articles about community-dwelling older adults, assessing instrument dimensionality via factor or item response theory analysis [30].

Types of study to be included

Studies will be included in the review if the study concerns self reported outcome measures measuring the cognitive construct of falls-efficacy, balance, balance recovery in community-dwelling older adults in the area of falls prevention as well as fall-related scales developed using Bandura's self-efficacy theory as the unpinning theoretical concept.
Studies addressing fear of falling, anxiety, depression, activity-avoidance, emotive-related constructs or behavioural-related constructs will be excluded.

Condition or domain being studied

Content development, content validity and structural validity of falls efficacy related scales and balance confidence scales.

Participants/population

Community-dwelling older adults.

Intervention(s), exposure(s)

Not applicable.

Context

In the last decades, different constructs measured by falls-efficacy scales have led to much confusion to researchers and clinicians, cascading to different interpretations and affecting clinical rehabilitation work. In present context of falls, 'falls-efficacy' and 'balance confidence' are viewed to be synonymous and seen to be used interchangeably. A greater attention needs to be devoted to ensure the construct that researchers and clinicians are measuring and the scales used to measure it, should be same. Modifications made to different falls-related scales could also affect the psychometric properties e.g. reliability, validity and responsiveness of the scale. There is a need of a systematic review conducted in a methodologically sound approach for falls-related self-efficacy scales and balance confidence scales in which the psychometric properties will be gathered and evaluated, accompanied by clear recommendations for the most suitable scales available to researchers and clinicians.

Main outcome(s)

To establish the content development, content validity and structural validity of falls efficacy related scales and balance confidence scales.

Additional outcome(s)

To provide a summary of the development, content validity and structural validity studies on falls efficacy and balance confidence scales for the community-dwelling older adults.

Data extraction (selection and coding)

Two review authors will screen the titles and abstracts of articles to assess whether they will meet the eligibility criteria. If deemed eligible or uncertain of eligibility, they will be included for further review. Further review of full text articles will be assessed against the eligibility criteria which will be established in consensus within the review team guided by the COSMIN method. Any articles for which there is disagreement between two reviewers will be discussed and if consensus between two reviewers cannot be reached, a third reviewer within the team will be consulted.

The documentation of the selection process will be presented in a PRISMA flow diagram including information of the total number of abstracts selected, total number of full text articles selected, main reasons for excluding other full-text articles,

Data extraction will be entered into a Microsoft Excel data extraction sheet by one reviewer which will be verified by another reviewer to avoid missing relevant information. Where missing information is encountered, corresponding authors will be contacted for this information. Data including study characteristics, participants' characteristics and measurement properties will be extracted.

Risk of bias (quality) assessment

The risk of bias of included studies will be examined using the COSMIN risk of bias checklist. The development and content validity of the included measures will be evaluated first based on COSMIN pre-defined criteria for what constitutes good content validity. Measures with high quality evidence of inadequate content validity will be excluded from further assessment in the systematic review. The remaining measurement properties in the checklist will then be reviewed in each included study against a criteria for good measurement properties. The quality of the evidence will be graded by using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach. The information will be presented in a data summary table in the review.

Strategy for data synthesis

A COSMIN reporting checklist format will be referenced to report all studies meeting the eligibility criteria with a summary of findings. The relevant studies on content development, content validity and structural validity will be reported and assessed using the COSMIN quality criteria.

Analysis of subgroups or subsets

Not applicable

Contact details for further information

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Appendix 1B Certificate of Participation

CERTIFICATE OF PARTICIPATION

1ST WORLD CONGRESS on FALLS & POSTURAL STABILITY
KUALA LUMPUR
4-7 December 2019

This is to certify that

Leng Hsien Soh

In recognition and appreciation of your contribution as Oral Presenter towards the success of the congress.

1st World Congress on Falls and Postural Stability

4-7 December 2019, Kuala Lumpur Convention Centre

Professor Tan Maw Pin
Organising chairperson
WCFPS 2019

Professor Tahir Masud
President
British Geriatric Society

Organised by

Supported by

Endorsed by

Premier Sponsors

Appendix 1C First page of publication (DOI: 10.1186/s12877-020-01960-7)

Research article | Open Access | Published: 07 January 2021

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BMC Geriatrics **21**, Article number: 21 (2021) | Cite this article

1645 Accesses | **1** Citations | **9** Altmetric | Metrics

Abstract

Background

Falls efficacy is a widely-studied latent construct in community-dwelling older adults. Various self-reported instruments have been used to measure falls efficacy. In order to be informed of the choice of the best measurement instrument for a specific purpose, empirical evidence of the development and measurement properties of falls efficacy related instruments is needed.

Methods

The Consensus-based Standards for the Selection of Health Measurement Intruments (COSMIN) checklist was used to summarise evidence on the development, content validity, and structural validity of instruments measuring falls efficacy in community-dwelling older adults. Databases including MEDLINE, Web of Science, PsychINFO, SCOPUS, CINAHL were searched (May 2019). Records on the development of instruments and studies assessing content validity or structural validity of falls efficacy related scales were included. COSMIN methodology was used to guide the review of eligible studies and in the assessment of their methodological quality. Evidence of content validity: relevance, comprehensiveness and comprehensibility and unidimensionality for structural validity were synthesised. A modified GRADE approach was applied to evidence synthesis.

Results

Thirty-five studies, of which 18 instruments had been identified, were included in the review. High-quality evidence showed that the Modified Falls Efficacy Scale (FES)-13 items (MFES-13) has sufficient relevance, yet insufficient comprehensiveness for measuring falls efficacy. Moderate quality evidence supported that the FES-10 has sufficient relevance, and MFES-14 has sufficient comprehensibility. Activities-specific Balance Confidence (ABC) Scale–Simplified (ABC-15) has sufficient relevance in measuring balance confidence supported by moderate-quality evidence. Low to very low-quality evidence underpinned the content validity of other instruments. High-quality evidence supported sufficient unidimensionality for eight instruments (FES-10, MFES-14, ABC-6, ABC-15, ABC-16, Iconographical FES (Icon-FES), FES–International (FES-I) and Perceived Ability to Prevent and Manage Fall Risks

Appendix 1D Search Strategy

Cinahl Plus with Full Text via EBSCOhost	
January 1990 – May 2019	
Results: 655	
Searches	Search Terms
1	TI-AB=elder* OR TI-AB=senior OR TI-AB=older OR TI-AB= aged
2	TI-AB=falls efficacy OR TI-AB=falls self-efficacy OR TI-AB=balance confidence OR TI-AB=balance efficacy OR TI-AB=balance self-efficacy OR TI-AB=balance recovery confidence OR TI-AB=balance recovery efficacy OR TI-AB=balance recovery self-efficacy OR (TI-AB=falls AND TI-AB=perceived control OR TI-AB=self-perceived control OR TI-AB=perceived ability OR TI-AB=self-perceived ability)
3	psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR “internal consistency” OR psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR “internal consistency” OR (cronbach* OR cronbach* AND (alpha OR alpha OR Talphas OR alphas)) OR (item OR item AND (correlation* OR correlation* OR selection* OR selection* OR reduction* OR reduction*)) OR agreement OR precision OR imprecision OR “precise values” OR test-retest OR agreement OR precision OR imprecision OR “precise values” OR test-retest OR (test OR test AND retest OR retest) OR (reliab* OR reliab* AND (test OR test OR retest or retest)) OR stability OR interrater OR interrater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra-examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR stability OR interrater OR inter-rater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR ((replicab* OR replicab* OR repeated OR repeated) AND (measure OR measure OR measures OR measures OR findings OR findings OR result OR result OR results OR results OR test OR test OR tests OR tests)) OR generaliza* OR generalisa* OR concordance OR generaliza* OR generalisa* OR concordance OR (intraclass OR intraclass AND correlation* or correlation*) OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR (multitrait OR multitrait AND scaling OR scaling AND (analysis OR analysis OR analyses OR analyses)) OR item discriminant OR

	interscale correlation* OR error OR errors OR "individual variability" OR item discriminant OR interscale correlation* OR error OR errors OR "individual variability" OR (variability OR variability AND (analysis OR analysis OR values OR values)) OR (uncertainty OR uncertainty AND (measurement OR measurement OR measuring OR measuring)) OR "standard error of measurement" OR sensitiv* OR responsive* OR "standard error of measurement" OR sensitiv* OR responsive* OR ((minimal OR minimally OR clinical OR clinically OR minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable OR important OR significant OR detectable) AND (change OR change OR difference OR difference)) OR (small* OR small* AND (real OR real OR detectable OR detectable) AND (change OR change OR difference OR difference)) OR meaningful change OR "ceiling effect" OR "floor effect" OR "Item response model" OR IRT OR Rasch OR "Differential item functioning" OR DIF OR "computer adaptive testing" OR "item bank" OR "cross-cultural equivalence" OR outcome assessment OR meaningful change OR "ceiling effect" OR "floor effect" OR "Item response model" OR IRT OR Rasch OR "Differential item functioning" OR DIF OR "computer adaptive testing" OR "item bank" OR "cross-cultural equivalence" OR outcome assessment)
4	AND/#1-#3

MEDLINE via Ebscohost	
January 1990 – May 2019	
Results: 742	
Searches	Search Terms
1	TI-AB=elder* OR TI-AB=senior OR TI-AB=older OR TI-AB= aged
2	TI-AB=falls efficacy OR TI-AB=falls self-efficacy OR TI-AB=balance confidence OR TI-AB=balance efficacy OR TI-AB=balance self-efficacy OR TI-AB=balance recovery confidence OR TI-AB=balance recovery efficacy OR TI-AB=balance recovery self-efficacy OR (TI-AB=falls AND TI-AB=perceived control OR TI-AB=self-perceived control OR TI-AB=perceived ability OR TI-AB=self-perceived ability)
3	psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR "internal consistency" OR psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR "internal consistency" OR (cronbach* OR cronbach* AND (alpha OR alpha OR Talphas OR alphas)) OR (item OR item AND (correlation* OR correlation* OR selection* OR selection* OR reduction* OR reduction*)) OR agreement OR precision OR imprecision OR "precise values" OR test-retest OR agreement OR precision OR imprecision OR "precise values" OR test-retest OR (test OR test AND retest OR retest) OR (reliab* OR reliab* AND (test OR test OR retest or retest)) OR stability OR interrater OR interrater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra-examiner OR interassay OR

	inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR stability OR interrater OR inter-rater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR ((replicab* OR replicab* OR repeated OR repeated) AND (measure OR measure OR measures OR measures OR findings OR findings OR result OR result OR results OR results OR test OR test OR tests OR tests)) OR generaliza* OR generalisa* OR concordance OR generaliza* OR generalisa* OR concordance OR (intraclass OR intraclass AND correlation* or correlation*) OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR (multitrait OR multitrait AND scaling OR scaling AND (analysis OR analysis OR analyses OR analyses)) OR item discriminant OR interscale correlation* OR error OR errors OR “individual variability” OR item discriminant OR interscale correlation* OR error OR errors OR “individual variability” OR (variability OR variability AND (analysis OR analysis OR values OR values)) OR (uncertainty OR uncertainty AND (measurement OR measurement OR measuring OR measuring)) OR “standard error of measurement” OR sensitiv* OR responsive* OR “standard error of measurement” OR sensitiv* OR responsive* OR ((minimal OR minimally OR clinical OR clinically OR minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable OR important OR significant OR detectable) AND (change OR change OR difference OR difference)) OR (small* OR small* AND (real OR real OR detectable OR detectable) AND (change OR change OR difference OR difference)) OR meaningful change OR “ceiling effect” OR “floor effect” OR “Item response model” OR IRT OR Rasch OR “Differential item functioning” OR DIF OR “computer adaptive testing” OR “item bank” OR “cross-cultural equivalence” OR outcome assessment OR meaningful change OR “ceiling effect” OR “floor effect” OR “Item response model” OR IRT OR Rasch OR “Differential item functioning” OR DIF OR “computer adaptive testing” OR “item bank” OR “cross-cultural equivalence” OR outcome assessment)
4	AND/#1-#3

PsychINFO via Ebscohost	
January 1990 – May 2019	
Results: 323	
Searches	Search Terms
1	TI-AB=elder* OR TI-AB=senior OR TI-AB=older OR TI-AB= aged
2	TI-AB=falls efficacy OR TI-AB=falls self-efficacy OR TI-AB=balance confidence OR TI-AB=balance efficacy OR TI-AB=balance self-efficacy

	OR TI-AB=balance recovery confidence OR TI-AB=balance recovery efficacy OR TI-AB=balance recovery self-efficacy OR (TI-AB=falls AND TI-AB=perceived control OR TI-AB=self-perceived control OR TI-AB=perceived ability OR TI-AB=self-perceived ability)
3	psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR “internal consistency” OR psychometr* OR observer variation OR reproducib* OR reliab* OR unreliab* OR valid* OR coefficient OR homogeneity OR homogeneous OR “internal consistency” OR (cronbach* OR cronbach* AND (alpha OR alpha OR Talphas OR alphas)) OR (item OR item AND (correlation* OR correlation* OR selection* OR selection* OR reduction* OR reduction*)) OR agreement OR precision OR imprecision OR “precise values” OR test-retest OR agreement OR precision OR imprecision OR “precise values” OR test-retest OR (test OR test AND retest OR retest) OR (reliab* OR reliab* AND (test OR test OR retest or retest)) OR stability OR interrater OR interrater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra-examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR stability OR interrater OR inter-rater OR intrarater OR intra-rater OR intertester OR inter-tester OR intratester OR intra-tester OR interobserver OR inter-observer OR intraobserver OR intra-observer OR intertechnician OR inter-technician OR intratechnician OR intra-technician OR interexaminer OR inter-examiner OR intraexaminer OR intra examiner OR interassay OR inter-assay OR intraassay OR intra-assay OR interindividual OR inter-individual OR intraindividual OR intra-individual OR interparticipant OR inter-participant OR intraparticipant OR intra-participant OR kappa OR kappa’s OR kappas OR repeatab* OR ((replicab* OR replicab* OR repeated OR repeated) AND (measure OR measure OR measures OR measures OR findings OR findings OR result OR result OR results OR results OR test OR test OR tests OR tests)) OR generaliza* OR generalisa* OR concordance OR generaliza* OR generalisa* OR concordance OR (intraclass OR intraclass AND correlation* or correlation*) OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR discriminative OR “known group” OR factor analysis OR factor analyses OR dimension* OR subscale* OR (multitrait OR multitrait AND scaling OR scaling AND (analysis OR analysis OR analyses OR analyses)) OR item discriminant OR interscale correlation* OR error OR errors OR “individual variability” OR item discriminant OR interscale correlation* OR error OR errors OR “individual variability” OR (variability OR variability AND (analysis OR analysis OR values OR values)) OR (uncertainty OR uncertainty AND (measurement OR measurement OR measuring OR measuring)) OR “standard error of measurement” OR sensitiv* OR responsive* OR “standard error of measurement” OR sensitiv* OR responsive* OR ((minimal OR minimally OR clinical OR clinically OR minimal OR minimally OR clinical OR clinically) AND (important OR significant OR detectable OR important OR significant OR detectable) AND (change OR change OR difference OR

	difference)) OR (small* OR small* AND (real OR real OR detectable OR detectable) AND (change OR change OR difference OR difference)) OR meaningful change OR “ceiling effect” OR “floor effect” OR “Item response model” OR IRT OR Rasch OR “Differential item functioning” OR DIF OR “computer adaptive testing” OR “item bank” OR “cross-cultural equivalence” OR outcome assessment OR meaningful change OR “ceiling effect” OR “floor effect” OR “Item response model” OR IRT OR Rasch OR “Differential item functioning” OR DIF OR “computer adaptive testing” OR “item bank” OR “cross-cultural equivalence” OR outcome assessment)
4	AND/#1-#3

SCOPUS	
January 1990 – May 2019	
Results: 135	
Searches	Search Terms
1	((TITLE (elder*) AND PUBYEAR > 1989) OR (TITLE (senior) AND PUBYEAR > 1989) OR (TITLE (older) AND PUBYEAR > 1989) OR (TITLE (aged) AND PUBYEAR > 1989))
2	TITLE (falls AND efficacy) AND PUBYEAR > 1989) OR (TITLE (falls AND self-efficacy) AND PUBYEAR > 1989) OR (TITLE (balance AND confidence) AND PUBYEAR > 1989) OR (TITLE (balance AND efficacy) AND PUBYEAR > 1989) OR (TITLE (balance AND self-efficacy) AND PUBYEAR > 1989) OR (TITLE (balance AND recovery AND confidence) AND PUBYEAR > 1989) OR (TITLE (balance AND recovery AND efficacy) AND PUBYEAR > 1989) OR (TITLE (balance AND recovery AND self-efficacy) AND PUBYEAR > 1989)) OR ((TITLE-ABS (falls) AND PUBYEAR > 1989) AND ((TITLE-ABS (perceived AND control) AND PUBYEAR > 1989) OR (TITLE-ABS (self-perceived AND control) AND PUBYEAR > 1989) OR (TITLE-ABS (perceived AND ability) AND PUBYEAR > 1989) OR (TITLE-ABS (self-perceived AND ability) AND PUBYEAR > 1989))))
3	(TITLE (psychometr*) OR TITLE (observer AND variation) OR TITLE (reproducib*) OR TITLE (reliab*) OR TITLE (unreliab*) OR TITLE (valid*) OR TITLE (coefficient) OR TITLE (homogeneity) OR TITLE (homogeneous) OR TITLE ("internal consistency") OR ABS (psychometr*) OR ABS (observer AND variation) OR ABS (reproducib*) OR ABS (reliab*) OR ABS (unreliab*) OR ABS (valid*) OR ABS (coefficient) OR ABS (homogeneity) OR ABS (homogeneous) OR ABS ("internal consistency") OR (TITLE (cronbach*) OR TITLE (cronbach*) AND (TITLE (alpha) OR ABS (alpha) OR TITLE (alphas) OR ABS (alphas))) OR (TITLE (item) OR ABS (item) AND (TITLE (correlation*) OR ABS (correlation*) OR TITLE (selection*) OR ABS (selection*) OR TITLE (reduction*) OR ABS (reduction*))) OR TITLE (agreement) OR TITLE (precision) OR TITLE (imprecision) OR TITLE ("precise values") OR TITLE (test-retest) OR ABS (agreement) OR ABS (precision) OR ABS (imprecision) OR ABS ("precise values") OR ABS (test-retest) OR (TITLE (test) OR ABS (test) AND TITLE (retest) OR ABS (retest)) OR (TITLE (reliab*) OR (ABS (reliab*) AND TITLE (test) OR ABS (test) OR TITLE (retest) OR ABS (retest))) OR TITLE

(stability) OR TITLE (interrater) OR TITLE (interrater) OR TITLE (intrarater) OR TITLE (intra-rater) OR TITLE (intertester) OR TITLE (inter-tester) OR TITLE (intratester) OR TITLE (intra-tester) OR TITLE (interobserver) OR TITLE (inter-observer) OR TITLE (intraobserver) OR TITLE (intra-observer) OR TITLE (intertechnician) OR TITLE (inter-technician) OR TITLE (intratechnician) OR TITLE (intra-technician) OR TITLE (interexaminer) OR TITLE (inter-examiner) OR TITLE (intraexaminer) OR TITLE (intra-examiner) OR TITLE (interassay) OR TITLE (inter-assay) OR TITLE (intraassay) OR TITLE (intra-assay) OR TITLE (interindividual) OR TITLE (inter-individual) OR TITLE (intraindividual) OR TITLE (intra-individual) OR TITLE (interparticipant) OR TITLE (inter-participant) OR TITLE (intraparticipant) OR TITLE (intra-participant) OR TITLE (kappa) OR TITLE (kappa's) OR TITLE (kappas) OR TITLE (repeatab*) OR ABS (stability) OR ABS (interrater) OR ABS (inter-rater) OR ABS (intrarater) OR ABS (intra-rater) OR ABS (intertester) OR ABS (inter-tester) OR ABS (intratester) OR ABS (intra-tester) OR ABS (interobserver) OR ABS (inter-observer) OR ABS (intraobserver) OR ABS (intra-observer) OR ABS (intertechnician) OR ABS (inter-technician) OR ABS (intratechnician) OR ABS (intra-technician) OR ABS (interexaminer) OR ABS (inter-examiner) OR ABS (intraexaminer) OR ABS (intra-examiner) OR ABS (interassay) OR ABS (inter-assay) OR ABS (intraassay) OR ABS (intra-assay) OR ABS (interindividual) OR ABS (inter-individual) OR ABS (intraindividual) OR ABS (intra-individual) OR ABS (interparticipant) OR ABS (inter-participant) OR ABS (intraparticipant) OR ABS (intra-participant) OR ABS (kappa) OR ABS (kappa's) OR ABS (kappas) OR ABS (repeatab*) OR ((TITLE (replicab*) OR ABS (replicab*) OR TITLE (repeated) OR ABS (repeated)) AND (TITLE (measure) OR ABS (measure) OR TITLE (measures) OR ABS (measures) OR TITLE (findings) OR TITLE (result) OR ABS (result) OR TITLE (results) OR ABS (results) OR TITLE (test) OR ABS (test) OR TITLE (tests) OR ABS (tests))) OR TITLE (generaliza*) OR TITLE (generalisa*) OR TITLE (concordance) OR ABS (generaliza*) OR ABS (generalisa*) OR ABS (concordance) OR (TITLE (intraclass) OR ABS (intraclass) AND TITLE (correlation*) OR ABS (correlation*)) OR TITLE (discriminative) OR TITLE ("known group") OR TITLE (factor AND analysis) OR TITLE (factor AND analyses) OR TITLE (dimension*) OR TITLE (subscale*) OR ABS (discriminative) OR ABS ("known group") OR ABS (factor AND analysis) OR ABS (factor AND analyses) OR ABS (dimension*) OR ABS (subscale*) OR (TITLE (multitrait) OR ABS (multitrait) OR ABS (scaling) AND (TITLE (analysis) OR ABS (analysis) OR TITLE (analyses) OR ABS (analyses))) OR TITLE (item AND discriminant) OR TITLE (interscale AND correlation*) OR TITLE (error) OR TITLE (errors) OR TITLE ("individual variability") OR ABS (item AND discriminant) OR ABS (interscale AND correlation*) OR ABS (error) OR ABS (errors) OR ABS ("individual variability") OR (TITLE (variability) OR ABS (variability) AND (TITLE (analysis) OR ABS (analysis) OR TITLE (values) OR ABS (values))) OR (TITLE (uncertainty) OR ABS (uncertainty) AND (TITLE (measurement) OR ABS (measurement) OR TITLE (measuring) OR ABS (measuring))) OR TITLE ("standard error of measurement") OR TITLE (sensitiv*) OR TITLE (responsive*) OR ABS ("standard error of measurement") OR ABS (sensitiv*) OR ABS

	(responsive*) OR ((TITLE (minimal) OR TITLE (minimally) OR TITLE (clinical) OR TITLE (clinically) OR ABS (minimal) OR ABS (minimally) OR ABS (clinical) OR ABS (clinically)) AND (TITLE (important) OR TITLE (significant) OR TITLE (detectable) OR ABS (important) OR ABS (significant) OR ABS (detectable)) AND (TITLE (change) OR ABS (change) OR TITLE (difference) OR ABS (difference))) OR (TITLE (small*) OR ABS (small*) AND (TITLE (real) OR ABS (real) OR TITLE (detectable) OR ABS (detectable) AND (TITLE (change) OR ABS (change) OR TITLE (difference) OR ABS (difference))))) OR TITLE (meaningful AND change) OR TITLE ("ceiling effect") OR TITLE ("floor effect") OR TITLE ("Item response model") OR TITLE (irt) OR TITLE (rasch) OR TITLE ("Differential item functioning") OR TITLE (dif) OR TITLE ("computer adaptive testing") OR TITLE ("item bank") OR TITLE ("cross-cultural equivalence") OR TITLE (outcome AND assessment) OR ABS (meaningful AND change) OR ABS ("ceiling effect") OR ABS ("floor effect") OR ABS ("Item response model") OR ABS (irt) OR ABS (rasch) OR ABS ("Differential item functioning") OR ABS (dif) OR ABS ("computer adaptive testing") OR ABS ("cross-cultural Equivalence") OR ABS (outcome AND assessment) AND PUBYEAR > 1989)
4	AND/#1-#3

Web of Science Core Collection	
January 1990 – May 2019	
Results: 203	
Searches	Search Terms
1	TS=elder* OR TS=senior OR TS=older OR TS=aged
2	TI=falls efficacy OR TI=falls self-efficacy OR TI=balance confidence OR TI=balance efficacy OR TI=balance self-efficacy OR TI=balance recovery confidence OR TI=balance recovery efficacy OR TI=balance recovery self-efficacy OR (TS=falls AND TI=perceived control OR TI=self-perceived control OR TI=perceived ability OR TI=self-perceived ability)
3	TI=psychometr* OR TI=observer variation OR TI=reproducib* OR TI= reliab* OR TI=unreliab* OR TI=valid* OR TI=coefficient OR TI=homogeneity OR TI=homogeneous OR TI="internal consistency" OR AB=psychometr* OR AB=observer variation OR AB=reproducib* OR AB=reliab* OR AB=unreliab* OR AB=valid* OR AB=coefficient OR AB=homogeneity OR AB=homogeneous OR AB="internal consistency" OR (TI=cronbach* OR AB=cronbach* AND (TI=alpha OR AB=alpha OR TI=alphas OR AB=alphas)) OR (TI=item OR AB=item AND (TI=correlation* OR AB=correlation* OR TI=selection* OR AB=selection* OR TI=reduction* OR AB=reduction*)) OR TI=agreement OR TI=precision OR TI=imprecision OR TI="precise values" OR TI=test-retest OR AB=agreement OR AB=precision OR AB=imprecision OR AB="precise values" OR AB=test-retest OR (TI=test OR AB=test AND TI=retest OR AB=retest) OR (TI=reliab* OR AB=reliab* AND (TI=test OR AB=test OR TI=retest or AB=retest)) OR TI=stability OR TI=interrater OR TI=interrater OR TI=intrarater OR TI=intra-rater OR TI=intertester OR TI=inter-tester OR TI=intratester OR TI=intra-tester OR TI=interobserver OR TI=inter-

observer OR TI=intraobserver OR TI=intra-observer OR TI=intertechnician OR TI=inter-technician OR TI=intratechnician OR TI=intra-technician OR TI=interexaminer OR TI=inter-examiner OR TI=intraexaminer OR TI=intra-examiner OR TI=interassay OR TI=inter-assay OR TI=intraassay OR TI=intra-assay OR TI=interindividual OR TI=inter-individual OR TI=intraindividual OR TI=intra-individual OR TI=interparticipant OR TI=inter-participant OR TI=intraparticipant OR TI=intra-participant OR TI=kappa OR TI=kappa's OR TI=kappas OR TI=repeatab* OR AB=stability OR AB=interrater OR AB=inter-rater OR AB=intrarater OR AB=intra-rater OR AB=intertester OR AB=inter-tester OR AB=intratester OR AB=intra-tester OR AB=interobserver OR AB=inter-observer OR AB=intraobserver OR AB=intra-observer OR AB=intertechnician OR AB=inter-technician OR AB=intratechnician OR AB=intra-technician OR AB=interexaminer OR AB=inter-examiner OR AB=intraexaminer OR AB=intra examiner OR AB=interassay OR AB=inter-assay OR AB=intraassay OR AB=intra-assay OR AB=interindividual OR AB=inter-individual OR AB=intraindividual OR AB=intra-individual OR AB=interparticipant OR AB=inter-participant OR AB=intraparticipant OR AB=intra-participant OR AB=kappa OR AB=kappa's OR AB=kappas OR AB=repeatab* OR ((TI=replicab* OR AB=replicab* OR TI=repeated OR AB=repeated) AND (TI=measure OR AB=measure OR TI=measures OR AB=measures OR TI=findings OR AB=findings OR TI=result OR AB=result OR TI=results OR AB=results OR TI=test OR AB=test OR TI=tests OR AB=tests)) OR TI=generaliza* OR TI=generalisa* OR TI=concordance OR AB=generaliza* OR AB=generalisa* OR AB=concordance OR (TI=intraclass OR AB=intraclass AND TI=correlation* or AB=correlation*) OR TI=discriminative OR TI="known group" OR TI=factor analysis OR TI=factor analyses OR TI=dimension* OR TI=subscale* OR AB=discriminative OR AB="known group" OR AB=factor analysis OR AB=factor analyses OR AB=dimension* OR AB=subscale* OR (TI=multitrait OR AB=multitrait AND TI=scaling OR AB=scaling AND (TI=analysis OR AB=analysis OR TI=analyses OR AB=analyses)) OR TI=item discriminant OR TI=interscale correlation* OR TI=error OR TI=errors OR TI="individual variability" OR AB=item discriminant OR AB=interscale correlation* OR AB=error OR AB=errors OR AB="individual variability" OR (TI=variability OR AB=variability AND (TI=analysis OR AB=analysis OR TI=values OR AB=values)) OR (TI=uncertainty OR AB=uncertainty AND (TI=measurement OR AB=measurement OR TI=measuring OR AB=measuring)) OR TI="standard error of measurement" OR TI=sensitiv* OR TI=responsive* OR AB="standard error of measurement" OR AB=sensitiv* OR AB=responsive* OR ((TI=minimal OR TI=minimally OR TI=clinical OR TI=clinically OR AB=minimal OR AB=minimally OR AB=clinical OR AB=clinically) AND (TI=important OR TI=significant OR TI=detectable OR AB=important OR AB=significant OR AB=detectable) AND (TI=change OR AB=change OR TI=difference OR AB=difference)) OR (TI=small* OR AB=small* AND (TI=real OR AB=real OR TI=detectable OR AB=detectable) AND (TI=change OR AB=change OR TI=difference OR AB=difference)) OR TI=meaningful change OR TI="ceiling effect" OR TI="floor effect" OR TI="Item response model" OR TI=IRT OR TI=Rasch OR TI="Differential item functioning" OR TI=DIF OR TI="computer adaptive testing" OR TI="item bank" OR TI="cross-cultural equivalence" OR TI=outcome assessment OR AB=meaningful change OR AB="ceiling

	effect" OR AB="floor effect" OR AB="Item response model" OR AB=IRT OR AB=Rasch OR AB="Differential item functioning" OR AB=DIF OR AB="computer adaptive testing" OR AB="item bank" OR AB="cross-cultural equivalence" OR AB=outcome assessment
4	AND/#1-#3

Appendix 1E Criteria guide to rate studies on structural validity

Criteria used in this systematic review to determine if the results of each study displayed positive, negative or unknown unidimensionality on the instruments. These updated consensus-based criteria on structural validity published by Prinsen et al. (2018).

Rating	Criteria
Satisfactory (+)	CTT: CFA: CFI or TLI or comparable measure > 0.95 OR RMSEA < 0.06 OR SRMR < 0.08 IRT/Rasch No violation of unidimensionality: CFI or TLI or comparable measure > 0.95 OR RMSEA < 0.06 OR SRMR < 0.08 AND no violation of local independence: residual correlations among the items after controlling for the dominant factor < 0.20 OR Q3's < 0.37 AND no violation of monotonicity: adequate looking graphs OR item scalability > 0.30 AND adequate model fit IRT: $\chi2 > 0.001$ Rasch: infit and outfit mean squares ⩾ 0.5 and ⩽ 1.5 OR Z-standardized values > −2 and < 2
Unsatisfactory (−)	Criteria for '+' not met
Unknown (?)	CTT: not all information for '+' reported IRT/Rasch: model fit not reported

CTT = Classical Test Theory; CFA = Confirmatory Factor Analysis; CFI = Comparative fit Index; TLI = Tucker-Lewis index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; IRT = Item Response Theory

Appendix 1F Characteristics and quality assessment of the studies on the development of the included instruments

						Concept elicitation study	
Name abbreviation	**Reference**	**Primary language**	**Construct definition**	**Target population**	**Intended context of use**	**COSMIN quality rating**	**Were patients involved?**
List of falls efficacy scales							
FES-10	Tinetti 1990	English (US)	Fall-related self-efficacy as the confidence in performing common daily activities without falling. 'Low perceived self-efficacy or confidence at avoiding fall' can be operationally defined as 'fear of falling'	Community-dwelling older adults	Assess 'fear of falling' interpreted from the total score determined from falls-related self-efficacy. Guide to clinical practice and research.	Inadequate[a]	No
MFES-11	Edwards 2008	French	Probably like FES	Community-dwelling older adults	Clinical practice and research to assess confidence and fear of falling to perform challenging activities of daily living including the use of stairs in the home and community without falling	Inadequate[a]	No
MFES-12	Tennstedt 1998	English (US)	Probably like FES	Community-dwelling older adults	Probably like FES	Inadequate[a]	No
MFES-13	Hellstrom 1998	Swedish	Assess confidence in completing activity without falling	Stroke	Clinical practice and research to assess confidence to perform basic and instrumental activities of daily living without falling.	Inadequate[a]	No
MFES-14	Hill 1996	English (Australia)	Probably like FES	Community-dwelling older adults with and without balance dysfunction	Simple, quick, easy-to-administer clinical evaluation for older people	Inadequate[a]	No
PAPMFR	Yoshikawa 2019	English (US)	Perceived ability to prevent and manage falls	Community – dwelling older adults	Status assessment in clinical practice	Inadequate[a]	No

GES-8	Rosengren 1998	English (US)	Probably like GES-10	Community-dwelling older adults	Probably like GES-10	Inadequate[a]	No
GES-10	McAuley 1997	English (US)	Assessing perceived walking ability to negotiate stairs, curbs and object in their path without falling	Community-dwelling older adults	Clinical trials to study confidence to perform in situation involving walking or stepping without falling	Inadequate[a]	No
PCOF	Tennstedt 1998	English (US)	Assess perceived control over falling	Community-dwelling older adults	Brief assessment to determine attitude and self-efficacy relating to falls	Inadequate[a]	No
PAMF	Tennstedt 1998	English (US)	Assessed perceived ability to manage risk of falls or actual falls	Community-dwelling older adults	Brief assessment to determine attitude and self-efficacy relating to falls	Inadequate[a]	No
BSPT	Shumway Cook 1997	English (US)	Assessing confidence in performing basic activities of daily living and instrumental activities without fear of loss of balance	Community-dwelling older adults	Probably like FES-10	Inadequate[a]	No
List of balance confidence scales							
ABC-6	Peretz 2006	Hebrew	Assessing fear of falling and balance confidence focusing on a narrower spectrum of activity difficulty	Older adults with HLGD and older adults with PD	Clinical evaluation, management and care of patients with movement disorders	Inadequate[a]	No
ABC-15	Filiatrault 2007	English (Canada)	Probably like ABC-16	Community-dwelling older adults	Probably like ABC-16	Inadequate[a]	No
ABC-16	Powell 1995	English (Canada)	Perceived ability in performing ‘situation-specific’ activities of daily living in a wide continuum of activity difficulty without losing balance or becoming unsteady	High functioning community-dwelling older adults	Clinical practice and research involving high functioning older people	Doubtful[b]	Yes

CONFBal	Simpson 2009	English (UK)	Perceived ability to engage in everyday functional tasks without losing balance	General older adults and patient population with a greater range of health and mobility problems	Clinical rehabilitation practice to determine functional-activity-related balance confidence	Doubtful[b]	Yes
List of scales not measuring falls efficacy or balance confidence							
Icon-FES	Delbaere 2011	English (Australia)	Probably like FES-I	Community-dwelling older adults	Use of pictures to provide clear, unambiguous contexts in a broad range of activities. Use as a treatment utility tool as part of cognitive behavioural therapy program.	Inadequate[a]	No
FES-I	Yardley 2005	English (UK)	Assess fear of falling or "concerns about falling" relating to basic and more demanding activities both physical and social.	Community-dwelling older adults	Clinical trials to study fear of falling	Inadequate[a]	No
MES	Lusardi 1997	English (US)	Assess concerns about falling when performing a variety of challenging activities	Community-dwelling older adults	Intervention planning and outcome evaluation in rehabilitation of older adults	Doubtful[b]	Yes

Footnotes

Rating of standards:

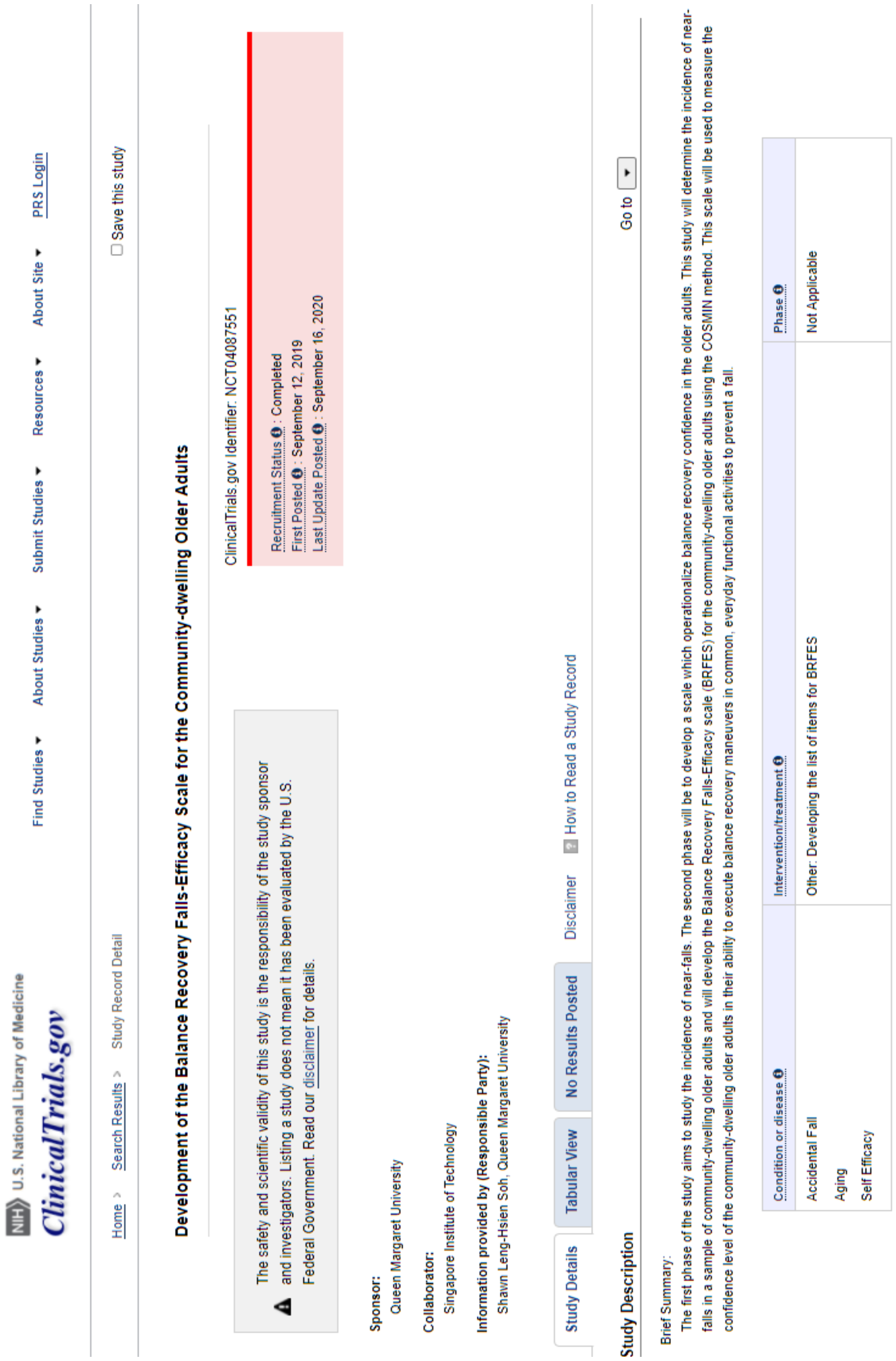
Inadequate[a] – Evidence rated not adequate on the quality aspect of the study because target population were not involved

Doubtful[b] – Evidence rated doubtful on the quality aspect of the study (not inadequate) because methods were not clearly described in the study

FES: Falls Efficacy Scale. MFES: Modified Falls Efficacy Scale. PAPMFR: Perceived Ability to Prevent and Manage Fall Risks. GES: Gait Efficacy Scale. PCOF: Perceived Control Over Falling. PAMF: Perceived Ability to Manage Risk of Falls or Actual Falls. BSPT: Balance Self-Perception Test. ABC: Activities-specific Balance Confidence. CONFbal: CONFbal scale of balance confidence. Icon-FES: Iconographical Falls Efficacy Scale. FES-I: Falls Efficacy Scale-International. MES: Mobility Efficacy Scale. HLGD: High Level Gait Disorders. PD: Parkinson's Disease.

Appendix 2: Supplementary materials for Chapter 4

Appendix 2A ClinicalTrials.gov record: NCT04087551



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Home > Search Results > Study Record Detail

☐ Save this study

Development of the Balance Recovery Falls-Efficacy Scale for the Community-dwelling Older Adults

The safety and scientific validity of this study is the responsibility of the study sponsor and investigators. Listing a study does not mean it has been evaluated by the U.S. Federal Government. Read our disclaimer for details.

ClinicalTrials.gov Identifier: NCT04087551

Recruitment Status : Completed
First Posted : September 12, 2019
Last Update Posted : September 16, 2020

Sponsor:
Queen Margaret University

Collaborator:
Singapore Institute of Technology

Information provided by (Responsible Party):
Shawn Leng-Hsien Soh, Queen Margaret University

Study Details | Tabular View | No Results Posted | Disclaimer | How to Read a Study Record

Study Description

Go to

Brief Summary:
The first phase of the study aims to study the incidence of near-falls. The second phase will be to develop a scale which operationalize balance recovery confidence in the older adults. This study will determine the incidence of near-falls in a sample of community-dwelling older adults and will develop the Balance Recovery Falls-Efficacy scale (BRFES) for the community-dwelling older adults using the COSMIN method. This scale will be used to measure the confidence level of the community-dwelling older adults in their ability to execute balance recovery maneuvers in common, everyday functional activities to prevent a fall.

Condition or disease	Intervention/treatment	Phase
Accidental Fall Aging Self Efficacy	Other: Developing the list of items for BRFES	Not Applicable

Detailed Description:

This study will progress through two phases

The first phase will recruit 30 older adults from ages of 65 and older living in the community. A study administrator will contact the participants daily over a 21-day period to obtain frequency and type of event experienced e.g. no fall, fall, near fall (hand), near-fall (leg) or near-fall (other). No other details of the event will be ascertained because this preliminary study will be to determine the incidence of near-falls in a sample of community-dwelling seniors.

The second phase will be to develop a scale which operationalize balance recovery confidence in community-dwelling older adults. In the first stage of the study, twelve older adults will be recruited to develop a comprehensive list of relevant items for the scale. Purposive sampling will be used to invite participants from the earlier study. This approach will ensure sample representativeness of the population and to include participants who have had demonstrated an understanding of near-falls and balance recovery maneuvres in the previous study to develop the scale. An exhaustive list of scale items will be generated from two focus group formed by six participants using a nominal group technique. This consensus-based technique ensures that all items in the scale are relevant and comprehensible to the community-dwelling older adults to discriminate the confidence level in one's ability to perform balance recovery maneuvres. The scale will then be sent to a panel of 50 experts including healthcare professionals as well as a new group of community-dwelling older adults to determine the appropriateness of items ensuring that the scale is relevant, comprehensive and comprehensible. Delphi technique will be adopted as the method to obtain a consensus among experts to finalize the Balance Recovery Falls-Efficacy Scale (BRFES).

Study Design

Go to

Study Type :	Interventional (Clinical Trial)
Actual Enrollment :	80 participants
Allocation:	N/A
Intervention Model:	Single Group Assignment
Intervention Model Description:	Phase 1 Participants will be requested to report the incidence of no fall, near-fall or a fall daily over the next 21-day period. There will be 3 options given to the participants: (1) a daily telephone call at a prearranged timing or (2) a daily text message given at a prearranged timing or both. A study administrator will contact the participant daily using the preferred mode of reporting. All information will be recorded in a logbook. Phase 2 The development of the Balance Recovery Falls-Efficacy scale will be guided using the COSMIN methodology. This development is based on inputs from the community-dwelling older adults to ensure relevance, comprehensiveness and comprehensibility. The scale would then be validated with a group of healthcare professionals and another new group of community-dwelling older adults using the Delphi method.
Masking:	None (Open Label)
Primary Purpose:	Other
Official Title:	Incidence of Near-falls and the Development of the Balance Recovery Falls-efficacy Scale (BRFES) for the Community-dwelling Older Adults.
Actual Study Start Date :	September 11, 2019
Actual Primary Completion Date :	September 15, 2020
Actual Study Completion Date :	September 15, 2020

Appendix 2B QMU ethical approval letter

Queen Margaret University

EDINBURGH

Shawn Soh
PhD Candidate
School of Health Sciences

Lucy Hinds
Quality Enhancement Officer
Queen Margaret University
Queen Margaret University Drive
Musselburgh
East Lothian EH21 6UU

Tel: 0131 474 0000
Email: researchethics@qmu.ac.uk

04 September 2019

Dear Shawn,

Ethical Approval – Incidence of near-falls and the development of the balance recovery falls-efficacy scale (BRFES) for the community-dwelling older adults.

Thank you for your response to the letter I sent you following consideration of your application by the Research Ethics Panel.

Dr Gemma Blackledge-Foughali, Convener of the Panel, has reviewed your response to the points you were required to address, and has confirmed that she is happy to take Convener's Action to grant full ethical approval for your research.

A standard condition of this ethical approval is that you are required to notify the Panel, in advance, of any significant proposed deviation from the original protocol. Reports to the Committee are also required once the research is underway if there are any unexpected results or events that raise questions about the safety of the research

We would like to thank you for your co-operation and wish you well with your project.

Yours sincerely

Lucy Hinds
Secretary to the Research Ethics Panel

DIVISION OF GOVERNANCE AND QUALITY ENHANCEMENT
QUEEN MARGARET UNIVERSITY, EDINBURGH
MUSSELBURGH
EAST LOTHIAN EH21 6UU
TELEPHONE: 0131 474 0000

Appendix 2C SIT ethical approval

SINGAPORE INSTITUTE OF TECHNOLOGY

Institutional Review Board
Approval Letter For Research Involving Human Subjects

Principal Investigator (SIT):	Mr Shawn Soh
Project Title:	Incidence of near-falls and development of the balance recovery falls-efficacy scale for the community dwelling older adults
Project Number:	2019129
Action:	APPROVED
Approval Date:	10 September 2019
Expiry Date:	30 June 2020

Dear Mr Shawn Soh

The materials for the project referenced above has been reviewed and approved by the SIT IRB by EXPEDITED REVIEW.

SIT IRB approval is given with the understanding that the most recently approved procedures will be followed and the most recently approved consenting documents will be used. If modifications are needed, those changes may not be initiated until such modifications have been submitted to the SIT IRB for review and have been granted approval.

Studies cannot be conducted beyond expiry date without re-approval by the SIT IRB. Please be reminded to apply for and receive continuing approval for the duration of the study.

SIT, Institutional Review Board

Professor Ponnampalam Gopalakrishnakone, Chairman of Singapore Institute of Technology – Institutional Review Board

Date: 10 September 2019 Signature:

Appendix 2D Template of participant consent form of participant

SINGAPORE INSTITUTE OF TECHNOLOGY

Queen Margaret University

Appendix A1: Participant Consent Form

Project title:
INCIDENCE OF NEAR-FALLS AND DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE (BRFES) FOR THE COMMUNITY DWELLING OLDER ADULTS

PHASE 1 (PREVALENCE OF NEAR-FALLS)

SIT IRB Approval Number: ____________________

☐ I voluntarily agree to take part in the screening tests associated with the above research study.

☐ I voluntarily agree to take part in the above research study upon meeting the eligibility criteria.

☐ I have been given a copy of the Participant Information Sheet (attached as Appendix A). The investigators had given me a full explanation on the nature, purpose, location and likely duration of the study, and of what I will be expected to do. I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given.

☐ I understand that I am free to withdraw from the study at any time without justifying my decision and without prejudice and consequence whatsoever.

☐ I give consent to the use of my personal data in this study. I understand that all personal data relating to this study is held and processed in the strictest confidence, and in accordance with the relevant data protection laws in Singapore and EU General Data Protection Regulation (GDPR). I give/do not give my consent to be re-identified in the case of an incidental finding (if any).

☐ I agree that I will not have any right or claim to any share in the commercial gain derived from the research (if any).

☐ I agree/do not agree to be contacted for matters relating to the above research study.

☐ I allow / will not allow the subsequent use of my personal data for future research activities/innovation/commercial activities whether or not related to this research, upon the completion of this research

Name and Signature (Participant)	Date
Name and Signature (Consent Taker)	Date
Name and Signature (Witness)	Date

For further information on the above research study or to provide feedback, please contact:
MR SHAWN SOH, LEAD PRINCIPAL INVESTIGATOR
EMAIL:SHAWN.SOH@SINGAPORETECH.EDU.SG OR CONTACT NUMBER: (65) 9699 7689

Appendix 2E Template of participant information form

Appendix A – Participant Information Sheet

Project title:
INCIDENCE OF NEAR-FALLS AND DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE (BRFES) FOR THE COMMUNITY DWELLING OLDER ADULTS

PHASE 1 (PREVALENCE OF NEAR-FALLS)

Principal Investigator: ___________________

Instructions to Participant

Please read this form and ask any questions that you may have about this research project. Your participation is voluntary and you can ask questions or withdraw at any time during the research.

What is the purpose of the study? Why have I been invited to take part in the study? How may I take part in this research study?

The purpose of this research study is to investigate the prevalence of near-falls in a sample of community-dwelling older adults.

Near-falls occur more commonly than falls. Near-falls can be defined as a loss of balance that would result in a fall if there is an inadequate execution of balance recovery maneuvers such as reach-to-grasp or compensatory step to regain balance. Near-falls can lead to increasing activity avoidance and fear of falling, affecting quality of life. It is also reported to be an independent predictor of substantial falls. However, there are very studies examining near-falls. This is because older adults may not recognize the events themselves or do not recognize the significance of these near-fall events.

Participating in this study will allow us to determine the incidence of near-falls and study its prevalence compared to falls. The results will be used to compare other studies reporting high incidence of near-falls. The findings will also demonstrate whether older adults are able to identify a near-fall and the use of balance recovery mechanisms to prevent a fall.

This study will require you to undergo a screening process. This screening is necessary for the project team to ensure that participants are able to execute balance recovery maneuvers in near-fall episodes. Participants will also need to recall these episodes to a study administrator during the study.

There will be 3 tests conducted:

1. 6-item cognitive impairment test (6CIT) (Brooke and Bullock 1999)
This test requires participants to complete 6 questions and will take about 3-4 minutes to complete. It is a useful dementia screening tool used in primary care.

2. Timed up and go (TUG) test (Podsiadlo and Richardson 1991)
This test requires participants to walk 6 metres, starting from a seated position. The participants will follow instructions "On the word GO, you will stand up, walk to the line on the floor, turn around and walk back to the chair and sit down." The participants will walk at their regular pace. It is a useful screening test to determine participants' ability to go out, functional level, gait speed and balance.

3. Ruler drop test (Johnson and Nelson 1986)
This test requires participants to catch a dropping rule without warning. It is a useful screening test to determine participants' reaction ability and the use of upper limb.

Interested participants will need to meet the inclusion and exclusion criteria of the study. The inclusion and exclusion criteria is established to ensure that the study population is relevant to the study. This approach will also allow findings from this study to be generalized to the target population and other similar studies on the community-dwelling older adults.

Inclusion Criteria	Exclusion Criteria
65-year-old and above	Requiring any physical assistance from another person to walk within home
Ability to read, write and communicate in English	Known active malignant conditions
History of at least one near-fall or one fall within the last 12 months	Cardiovascular conditions e.g. neurally mediated syncope, cardiac syncope, structural heart diseases e.g. aortic stenosis or hospitalization for myocardial infarction or heart surgery within 3 months
Living independently in the community	Pulmonary conditions e.g. serious chronic obstructive pulmonary disease or oxygen dependence
Not having any cognitive dysfunction by achieving a score of 7 or less in the 6-item cognitive impairment test (6CIT) (Brooke and Bullock 1999)	Musculoskeletal conditions e.g. moderate to severe osteoarthritis that could affect balance control and muscle function e.g. self-reported pain or dysfunction of the trunk and extremities, fractures or injuries in the extremities in the last 6 months.
Able to walk 6 meter within 12 seconds by performing the Timed Up and Go (TUG) test (Podsiadlo and Richardson 1991)	Neurological conditions such as Parkinson's Disease, sequelae of stroke, Amyotrophic Lateral Sclerosis (ALS), Multiple Sclerosis (MS) or severe Dementia or epilepsy
Able to catch a 30cm ruler by each hands using the ruler drop test (Johnson and Nelson 1986)	Legal blindness or severe visual impairment, impaired hearing loss or deafness

<u>What will I be expected to perform if I agree to participate in this research?</u>

If you meet the eligibility criteria and agree to be in this study, a briefing will be conducted to better understand the definitions of falls and near-falls. Several situations will be discussed so that you will have a clear and consistent understanding of what events will constitute a fall or a near-fall. After clarifying any concerns and doubts, the study will commence at a pre-determined date that you will allow a telephone surveyor to contact you every day over a period of 21-day.

During this 21-day period, you will have to report the frequency and type of events each day e.g. no fall, fall or near-fall. If you experience a near-fall event, you will need to indicate which balance recovery maneuver was used e.g. hands, legs or other body part which you will indicate. Alternatively, you may also update the telephone surveyor at a given number providing similar information whenever you experienced any event during the day when it is safe to do so. This is to help you avoid forgetting the event.

You will need to select an option of the preferred mode of communication to the study administrator. 3 options will be provided to you:

1. A daily telephone call at a prearranged timing
2. A daily text message at a prearranged timing
3. A daily telephone call and text message at a prearranged timing

After the 21-day period, a debriefing session will be arranged for you and to complete any necessary administrative procedures e.g. claim allowance.

If you do not meet the eligibility criteria or do not agree to participate in this study, general information about falls-prevention strategies will be provided to you to gain a better understanding about reducing the risk of falls among the community-dwelling older adults.

What are the possible Risks/Discomforts/Inconveniences for taking part in this study?

As you will have to recall events e.g. falls or near-falls daily, possible psychological discomfort e.g. anxiety or fear of falling may arise during the study. You may also face inconvenience to report these events daily.

What are the possible benefits of taking part?

The anticipated benefits of participation will allow participants to gain some understanding about different types of balance recovery strategies. Your participation will contribute to the knowledge gained through the study which will benefit other community-dwelling older adults in the future. This study emphases the importance of near-fall and will reiterate this importance to clinicians and researchers of the need to focus in this area to address fall prevention issues.

Will I receive payment for this study? Am I responsible for the expenses related to this study?

The participant will need to attend 2 sessions e.g. briefing and debriefing session at SIT as well as incurring telco expenses used in report events experienced during the day over a 21-day period. An allowance of $50 will be given for completion of participation.

What if there is a problem? Who should I contact if I feel unwell as a result of taking part in this study?

If you follow the directions of the PI-in-charge of this research study and you feel any discomfort, please contact the PI immediately. Please contact: Mr Shawn Soh, Lead Principal Investigator at email address: SHAWN.SOH@SINGAPORETECH.EDU.SG or at contact number: (65) 9699 7689. In the event of injury arising from participation in the study, compensation will be considered on a case by case basis. For more information and independent advice regarding the research and the rights of research participants, you may contact SIT IRB Secretariat at email: irb@singaporetech.edu.sg. By signing the consent form, you will not waive any legal rights or release the researchers from liability for negligence.

Will my taking part in the study be kept confidential?

All hard copied information generated in this research will be kept in a locked cabinet in the lead Principal Investigator's (lead PI) office. Electronic data files will be stored in an office computer, which is protected using a security password known only to the Lead PI. All files will be kept into a folder created for the project will be securely encrypted. Any hard copied and soft copied information will be obtained through the Lead PI. Confidentiality of the data will also meet the non-disclosure agreements signed between SIT and various healthcare institutions for purposes including but not limiting to exploring potential opportunities for developing innovative healthcare solutions and evaluating the feasibility of various business relationship and opportunities between the parties.

Findings and related knowledge emerging from the studies will be shared as brief study summary to all participants through email or any other modes of communications e.g. website as and whenever possible as well as through publication of findings, presentations in conferences, seminars, workshops or related activities. Any information in any circulation, publication or presentation that would make it possible to identify you will not be included in any publication or presentation. Data will also be retained for further research. For these reasons, hard copied data and electronic data will be stored for ten years upon completion of the research study and then be securely destroyed.

Appendix 2F First page of publication (DOI: 10.1186/s40814-020-00748-1)

Research | Open Access | Published: 12 January 2021

Near-falls in Singapore community-dwelling older adults: a feasibility study

Shawn Leng-Hsien Soh, Chee-Wee Tan, Judith Lane, Ting-Ting Yeh & Benjamin Soon

Pilot and Feasibility Studies **7**, Article number: 25 (2021) | Cite this article

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Abstract

Background

A near-fall is defined as a loss of balance that would result in a fall if sufficient balance recovery manoeuvres are not executed. Compared to falls, near-falls and its associated balance recovery manoeuvres have been understudied. Older adults may not recognise a near-fall or identify the use of their balance recovery manoeuvres to prevent a fall. The consensus on the methods to collect near-fall data is lacking. The primary objective of this study was to determine the feasibility of recruitment and retention. Secondary objectives were to establish evidence that Singapore community-dwelling older adults can identify near-falls and associated balance recovery manoeuvres. Texting and calling methods were explored as reporting methods.

Methods

This study took place in Singapore (September to October 2019). Participants were healthy, community-dwelling adults aged 65 or older. Recruitment was done through poster advertisement, and all participants gave informed consent. Participants attended a briefing session and reported their near-fall or fall incidence over 21 days using either daily texting or calling. The primary outcome measures were the recruitment rate, retention rate, preferred modes for data reporting and ability to report near-falls or falls. Secondary outcomes included the self-reported incidence of falls and near-falls.

Results

Thirty older adults were recruited in 5 weeks. All participants completed the study. They understood near-fall concepts and were able to report the occurrence and relevant balance recovery manoeuvres used to prevent a fall. 87% (26/30) chose to text while 13% (4/30) selected calling as their reporting method. One actual fall (0.16%) out of 630 responses was reported. Thirty-six incidents (5.7%) of near-falls were recorded. Sixteen participants (53.3%) experienced near-falls and half of this group experienced two or more near-falls. The use of reach-to-grasp strategy (36%), compensatory stepping (52.8%), and other body regions (11.2%) were used to prevent the fall.

Appendix 3: Supplementary materials for Chapter 5

Appendix 3A QMU Ethical Approval Letter

Queen Margaret University

EDINBURGH

Shawn Soh
PhD Candidate
School of Health Sciences

Lucy Hinds
Quality Enhancement Officer
Queen Margaret University
Queen Margaret University Drive
Musselburgh
East Lothian EH21 6UU

Tel: 0131 474 0000
Email: researchethics@qmu.ac.uk

04 September 2019

Dear Shawn,

Ethical Approval – Incidence of near-falls and the development of the balance recovery falls-efficacy scale (BRFES) for the community-dwelling older adults.

Thank you for your response to the letter I sent you following consideration of your application by the Research Ethics Panel.

Dr Gemma Blackledge-Foughali, Convener of the Panel, has reviewed your response to the points you were required to address, and has confirmed that she is happy to take Convener's Action to grant full ethical approval for your research.

A standard condition of this ethical approval is that you are required to notify the Panel, in advance, of any significant proposed deviation from the original protocol. Reports to the Committee are also required once the research is underway if there are any unexpected results or events that raise questions about the safety of the research

We would like to thank you for your co-operation and wish you well with your project.

Yours sincerely

Lucy Hinds
Secretary to the Research Ethics Panel

DIVISION OF GOVERNANCE AND QUALITY ENHANCEMENT
QUEEN MARGARET UNIVERSITY, EDINBURGH
MUSSELBURGH
EAST LOTHIAN EH21 6UU
TELEPHONE: 0131 474 0000

Appendix 3B SIT Ethical Approval Letter

Appendix A1: Participant Consent Form

Project title:
INCIDENCE OF NEAR-FALLS AND DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE (BRFES) FOR THE COMMUNITY DWELLING OLDER ADULTS

PHASE 1 (PREVALENCE OF NEAR-FALLS)

SIT IRB Approval Number: ________________________________

☐ I voluntarily agree to take part in the screening tests associated with the above research study.

☐ I voluntarily agree to take part in the above research study upon meeting the eligibility criteria.

☐ I have been given a copy of the Participant Information Sheet (attached as Appendix A). The investigators had given me a full explanation on the nature, purpose, location and likely duration of the study, and of what I will be expected to do. I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given.

☐ I understand that I am free to withdraw from the study at any time without justifying my decision and without prejudice and consequence whatsoever.

☐ I give consent to the use of my personal data in this study. I understand that all personal data relating to this study is held and processed in the strictest confidence, and in accordance with the relevant data protection laws in Singapore and EU General Data Protection Regulation (GDPR). I give/do not give my consent to be re-identified in the case of an incidental finding (if any).

☐ I agree that I will not have any right or claim to any share in the commercial gain derived from the research (if any).

☐ I agree/do not agree to be contacted for matters relating to the above research study.

☐ I allow / will not allow the subsequent use of my personal data for future research activities/innovation/commercial activities whether or not related to this research, upon the completion of this research

________________________________ ____________
Name and Signature (Participant) Date

________________________________ ____________
Name and Signature (Consent Taker) Date

________________________________ ____________
Name and Signature (Witness) Date

For further information on the above research study or to provide feedback, please contact:
MR SHAWN SOH, LEAD PRINCIPAL INVESTIGATOR
EMAIL:SHAWN.SOH@SINGAPORETECH.EDU.SG OR CONTACT NUMBER: (65) 9699 7689

Appendix 3C Template of participant consent form

Appendix B1: Participant Consent Form

Project title:
INCIDENCE OF NEAR-FALLS AND DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE (BRFES) FOR THE COMMUNITY DWELLING OLDER ADULTS

PHASE 2 (DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE) – FOCUS GROUP SESSION

SIT IRB Approval Number: ______________________________

☐ I voluntarily agree to take part in the above research study.

☐ I have been given a copy of the Participant Information Sheet (attached as Appendix B). The investigators had given me a full explanation on the nature, purpose, location and likely duration of the study, and of what I will be expected to do. I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given.

☐ I understand that I am free to withdraw from the study at any time without justifying my decision and without prejudice and consequence whatsoever.

☐ I give consent to the use of my personal data in this study. I understand that all personal data relating to this study is held and processed in the strictest confidence, and in accordance with the relevant data protection laws in Singapore and EU General Data Protection Regulation (GDPR). I give/do not give my consent to be re-identified in the case of an incidental finding (if any).

☐ I agree that I will not have any right or claim to any share in the commercial gain derived from the research (if any).

☐ I agree/do not agree for any audio-recording to be taken during the research study

☐ I agree/do not agree to be contacted for matters relating to the above research study.

☐ I allow / will not allow the subsequent use of my personal data for future research activities/innovation/commercial activities whether or not related to this research, upon the completion of this research

______________________________ ______________
Name and Signature (Participant) Date

______________________________ ______________
Name and Signature (Consent Taker) Date

______________________________ ______________
Name and Signature (Witness) Date

For further information on the above research study or to provide feedback, please contact:
MR SHAWN SOH, LEAD PRINCIPAL INVESTIGATOR
EMAIL:SHAWN.SOH@SINGAPORETECH.EDU.SG OR CONTACT NUMBER: (65) 9699 7689

Appendix 3D Template of participant information form

SINGAPORE INSTITUTE OF TECHNOLOGY Queen Margaret University

Appendix B – Participant Information Sheet

Project title:
INCIDENCE OF NEAR-FALLS AND DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE (BRFES) FOR THE COMMUNITY DWELLING OLDER ADULTS

PHASE 2 (DEVELOPMENT OF THE BALANCE RECOVERY FALLS-EFFICACY SCALE) – FOCUS GROUP SESSION

Principal Investigator: ___________________

Instructions to Participant

Please read this form and ask any questions that you may have about this research project. Your participation is voluntary and you can ask questions or withdraw at any time during the research.

<u>What is the purpose of the study? Why have I been invited to take part in the study? How may I take part in this research study?</u>

The purpose of this research study is to develop a scale that operationalize balance recovery confidence of community-dwelling older adults.

Balance recovery training is an emerging rehabilitation method enabling individuals to improve control of their balance recovery maneuvers through perturbation. However, such training have limited potential due to natural age-related deterioration of bodily systems such reduced muscle strength, stiffer joints, slower reflexivity and declining sensory system. Furthermore, these trainings conducted in a simulated environment pose difficulties for older adults to transfer acquired skills into a more challenging real-world scenarios.

A possibility to work with community-dwelling older adults will be to gain awareness of their perceived ability to execute balance recovery maneuvers in real-world context. Having such scale to measure balance recovery confidence will enable the older adults to identify differences between their perceived abilities and actual abilities. The scale will also allow healthcare professionals to plan targeted rehabilitation interventions addressing older adults' concerns and work with them to reduce their risks of falling or injurious falls. Unfortunately, such scale is unavailable and there is a need to develop one.

Participating in this study will allow us to generate a comprehensive list of items which can discriminate the confidence level in one's ability to perform balance recovery maneuvers in common, everyday functional activities among community-dwelling older adults. The preliminary draft developed in this study will undergo further validation.

You have been invited to take part in the study because you have participated in the earlier study "Phase 1 – Prevalence of near-falls". The knowledge gained in the previous study have provided you a better understanding of balance recovery maneuvers which allow you to contribute effectively to the development of the Balance Recovery Falls-Efficacy Scale (BRFES).

<u>What will I be expected to perform if I agree to participate in this research?</u>

If you agree to be in this study, a briefing will be conducted for you to better understand how the focus group session will be conducted. You will need to attend the session in person. The study administrator will inform you of the date, time and venue arranged for the session. The focus group will consist a total of 6 participants and a trained facilitator. The session will last for 4 hours.

The aim of the session is to generate a list of items which will be used to develop a scale to measure the confidence level of community-dwelling older adults in their perceived ability to execute balance recovery maneuvers in common, everyday functional activities in different environments.

The format of the focus group session will be as follows:

Format	Time taken (in minutes)	Remarks
Introduction and explanation	10	The facilitator will introduce self and group members. The facilitator will remind participants about study purpose and the flow of the session.
Silent generation of ideas	10	All participants will note their ideas into a paper
Sharing an idea in 'round robin' fashion until no new ideas	80	All participants will take a turn and state a single idea. The contribution of one idea will continue until no new ideas is generated.
Group discussion for any clarification and idea grouping	90	The facilitator will facilitate the process for group members to clarify ideas and will group similar ideas together with agreement from all participants
Anonymous voting "yes" or "no"	30	All participants will anonymously vote a "yes" or "no" to each item whether the item meets the construct of the scale.
Debriefing session	20	The facilitator will express appreciation for the contribution given by all members and complete necessary administration.
Total time taken	240 minutes (Estimated 4 hours)	

You will be expected to adhere to the rules of the focus group session and contribute your ideas to generate the list of items to be included in the preliminary scale. There will be two questions given to you during the briefing. These questions relates to the construct of the scale, ensuring that the items will measure what it intends to measure. Receiving these questions ahead of the focus group session allow you to prepare adequately for the session. The focus group discussion will be audio-recorded and the recordings may be used for data analysis.

What are the possible Risks/Discomforts/Inconveniences for taking part in this study?

There are no reasonably foreseeable risks, discomfort or inconveniences to a participant of this research study.

What are the possible benefits of taking part?

The anticipated benefits of participation will allow participants to gain some understanding about different types of balance recovery strategies. Your participation will contribute to the knowledge gained through the study which will benefit other community-dwelling older adults in the future. This study emphases the importance of near-fall and will reiterate this importance to clinicians and researchers of the need to focus in this area to address fall prevention issues.

The preliminary scale developed through this study will undergo further validation. The fully developed scale will be used for other studies benefiting community-dwelling older adults in the future.

Will I receive payment for this study? Am I responsible for the expenses related to this study?

The participant will need to attend one focus group session which will take approximately 2-3 hours. An allowance of $100 will be given for completion of participation.

Singapore Institute of Technology   Queen Margaret University

What if there is a problem? Who should I contact if I feel unwell as a result of taking part in this study?

If you follow the directions of the PI-in-charge of this research study and you feel any discomfort, please contact the PI immediately. Please contact: Mr Shawn Soh, Lead Principal Investigator at email address: SHAWN.SOH@SINGAPORETECH.EDU.SG or at contact number: (65) 9699 7689. In the event of injury arising from participation in the study, compensation will be considered on a case by case basis. For more information and independent advice regarding the research and the rights of research participants, you may contact SIT IRB Secretariat at email: irb@singaporetech.edu.sg. By signing the consent form, you will not waive any legal rights or release the researchers from liability for negligence.

Will my taking part in the study be kept confidential?

All hard copied information generated in this research will be kept in a locked cabinet in the lead Principal Investigator's (lead PI) office. Electronic and audio data files will be stored in an office computer, which is protected using a security password known only to the Lead PI. All files will be kept into a folder created for the project will be securely encrypted. Any hard copied and soft copied information will be obtained through the Lead PI. Confidentiality of the data will also meet the non-disclosure agreements signed between SIT and various healthcare institutions for purposes including but not limiting to exploring potential opportunities for developing innovative healthcare solutions and evaluating the feasibility of various business relationship and opportunities between the parties.

Findings and related knowledge emerging from the studies will be shared as brief study summary to all participants through email or any other modes of communications e.g. website as and whenever possible as well as through publication of findings, presentations in conferences, seminars, workshops or related activities. Any information in any circulation, publication or presentation that would make it possible to identify you will not be included in any publication or presentation. Data will also be retained for further research. For these reasons, hard copied data and electronic data will be stored for ten years upon completion of the research study and then be securely destroyed.

Appendix 3E First page of publication (DOI: 10.19043/ipdj.111.009)

International Practice Development Journal

Online journal of FoNS in association with the IPDC and ICoP (ISSN 2046-9292)

Constructing a measure of balance recovery confidence for older persons: content themes from different stakeholders

Original Practice Development and Research

Shawn Leng-Hsien Soh, Fiona Gilmour, Judith Lane, Shalini Asokan, Kang Ling Woan and Chee-Wee Tan

Volume 11, Issue 1, Article 9

May 2021

https://doi.org/10.19043/ipdj.111.009

Delphi technique, falls, nominal group technique, older persons, patient-reported outcome measures, self-efficac

Background: The absence of patient-reported outcome measures (PROMs) for a specific construct or target population suggests a need for such measures to be developed. A case in point is the domain of falls efficacy; a PROM for balance recovery confidence was proposed to improve older persons 'agency to arrest a fall. Appropriate participation in its development by relevant stakeholders was identified as essential to maximise the utility of the PROM and its potential to enhance patient care. There is a gap in the practice development literature in terms of PROMs for older persons. This article aims to encourage researchers to use the principles of practice development to address this gap by involving relevant stakeholders to gain greater insight.

Methods: The nominal group technique and the Delphi technique were used to generate and refine the content of the measure, and content analysis was applied to assess and summarise the data.

Findings: Unique themes emerged, such as 'agency of older people in the prevention of falls 'from the community-dwelling older adults in Singapore, and 'clinical specificity 'from an international panel of healthcare professionals. Common themes including 'relevance to the target population', 'comprehensibility 'and 'cultural and contextual sensitivity 'were found in both groups.

Conclusion: A collaborative, inclusive and participatory approach involving different stakeholders, underpinned by practice development methodology, can offer rich insights for PROM developers.

Appendix 3F Focus group interviewer guide

1

Queen Margaret University
EDINBURGH

SINGAPORE INSTITUTE OF TECHNOLOGY

Focus Group Schedule and Study Protocol

Date: **Time:** **Venue:**

1. Participant:	**2. Participant:**
3. Participant:	**4. Participant:**
5. Participant:	**6. Participant:**

Focus group schedule

The aim of the session is to elicit the participants' views to list out items to discriminate the confidence level in community dwelling older adults' ability to perform balance recovery manoeuvres in common, everyday functional activities given different built-in environmental and safety designs to prevent a fall.

This focus group session conducted by the nominal group technique enables all participants to have an equal opportunity to voice their idea to the group. All group members can share their opinions to reach consensus based on voting with their personal preferences. The facilitator's role will be to keep the sharing moving, following the structured process to ensure each participant is given opportunity to speak.

2

Study Protocol

Process stage	Details
Introduction and explanation (5 mins)	The facilitator will welcome all group members. Introductions will be made. The facilitator will brief the participants explaining the aims and objectives of the session and the process.
Silent generation of ideas (10 mins)	The facilitator will give out 2 questions which had been sent to the participants in advance. Participants will take this time to reflect and record their individual ideas in response to the questions.
Sharing an idea in 'round robin' fashion until no new ideas (30 mins)	The facilitator will ask one participant at a time to state a single idea to the group in a 'round robin' fashion. Participants will take their turn to express a single idea. Participants are able to think of new ideas during this process but will wait for their turn before sharing with the group. This stage will take as much time as needed until no new ideas are presented. All ideas will be recorded verbatim on a flipchart.
Group discussion for any clarification and idea grouping (30 mins)	The facilitator will go through each idea for clarification and discussion among the participants. Participants may exclude, include or alter ideas as well as to generate grouping themes. The facilitator will take the opportunity to group similar ideas together with agreement from all participants. Participants do no have to agree with all ideas which they ignore the idea by voting on personal preferences in the next stage.
Anonymous voting "Yes" or "No" (15 mins)	The facilitator will request the participants to vote "yes" or "no" for each generated idea whether it can discriminate the confidence level in one's ability to perform balance recovery manoeuvres in common, everyday functional activities to prevent a fall. Ideas with at least two participants voted "yes" will be accepted.

<u>Research questions</u>

1. What common and everyday activities that older people participates in (at home or outside home) which they can experience a near-fall event?
2. How can older people prevent a fall in these near-fall events while doing these activities?

3

<u>Introduction</u>

- Purpose of project to get your ideas to list down items to develop a balance recovery falls-efficacy scale.
- Ground rules for focus groups (in particular confidentiality)
- Format of focus groups
- Valuing your ideas and comments – YOU ARE THE EXPERTS!
- Reiterate consent procedures, and opportunity to ask questions before starting the session
- Introductions
- Obtain informed consent

Appendix 3G Picture showing a facilitator briefing the participants in the focus group session (Nominal Group Technique). Permission of photo use has been obtained.

Appendix 3H A cover letter used to invite healthcare experts for the Delphi study.

Cover letter

Subject: International Panel on Appropriateness of Balance Recovery Falls-efficacy Scale

Dear Sir/Madam,

You are invited to be part of an international Delphi panel to evaluate the content of a newly developed patient-reported outcome measure that aims to quantify the perceived balance recovery self-efficacy in community-dwelling older adults. You have been recognized by esteemed colleagues for your expertise in geriatrics. We value your inputs for the development of this instrument. This work has received ethics approvals under two institutions, Queen Margaret University, UK (Ref no: REP 0197) and Singapore Institute of Technology, Singapore (Ref no: 2019129).

We are pleased to attach some information about this study:

- Participant information sheet
- Background information to develop the self-reported instrument

This is a two-round survey to gather experts' inputs and to refine the scale. Please access the study through the link: https://qmu.onlinesurveys.ac.uk/brfes

Kindly complete the first-round online survey within 2 weeks of this email. In a few days, we may follow up on our email to confirm that you have received this email and to find out if you have any questions or comments you may have about the rating process. Should you have any questions, please reach me at my email address: ssoh@qmu.ac.uk

Thank you for your participation, and we look forward to receiving your inputs.

Yours sincerely,

Shawn Soh (Mr)
PhD student, QMU

Appendix 3I A screenshot of an item designed for the Delphi study using the JISC survey.

To refer to the Round 1 item and the evaluation of ratings, click here.

Item 12: Recover from a trip while carrying groceries with both hands.

Rationale

Both groups were in agreement with the appropriateness of this item.

The item is maintained with minor refinements made to improve the item descriptor and picture.

This part of the survey uses a table of questions, view as separate questions instead?

Q15: Please rate the appropriateness of Item 12 (of 19).

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	6	7	8	9	
Highly inappropriate	☐	☐	☐	☐	☐	☐	☐	☐	☐	Highly appropriate

Please input your opinions if your rating is 6 or less

‹ Previous

Next ›

Appendix 4: Supplementary materials for Chapter 6

Appendix 4A First page of publication (DOI: 10.1080/10833196.2021.1938867)

PHYSICAL THERAPY REVIEWS
2021, AHEAD-OF-PRINT, 1-10
https://doi.org/10.1080/10833196.2021.1938867

Open access

Validation of a new patient-reported outcome measure of balance recovery confidence (BRC) for community-dwelling older adults: a study protocol

Shawn Leng-Hsien Soh [a,b], Judith Lane [b], Nigel Gleeson [b], Tianma Xu [a], Fahria Bte Abdul Rahman [c], Ting-Ting Yeh [a], Benjamin Soon [a], and Chee-Wee Tan [d]

[a] Health and Social Sciences Cluster, Singapore Institute of Technology, Singapore, Singapore [b] Dietetics, Nutrition & Biological Sciences, Physiotherapy, Podiatry & Radiography Division, Queen Margaret University, Musselburgh, UK [c] Rehabilitation Department, St Luke's Hospital, Singapore, Singapore [d] Department of Physiotherapy and Paramedicine, Glasgow Caledonian University, Glasgow, UK

BACKGROUND Patient-reported outcome measures (PROMs) provide clinicians a greater understanding of patients' perceived ability in their physical performance. Existing PROMs on falls efficacy provide meaningful information about the perceived ability in older people to perform common activities of daily living without falling. However, the perceived ability to recover balance from a slip, a trip, or volitional movements has been inadequately assessed. Balance recovery confidence relates to the judgment of self-reactive ability. The scale of balance recovery confidence (BRC) is a new PROM that measures perceived balance recovery self-efficacy. The purpose of the study protocol is to describe the first psychometric evaluation of BRC's measurement properties.

OBJECTIVE This study is a validation phase of a newly developed PROM conducted in Singapore.

METHODS Two hundred community-dwelling older adults, aged 65 years and older, will complete five self-reported instruments (BRC, Activities-specific Balance Confidence Scale, Falls Efficacy Scale-International, Late-Life Function and Disability Instrument-Function and Global Perceived Effect) and three performance measures (Hand strength dynamometer, 30-second Chair Stand, Mini BESTest). Classical test theory methods will assess acceptability, data completeness, targeting of the items, scaling assumptions, internal consistency reliability and construct validity. Factor analysis will establish unidimensionality. Rasch analysis will evaluate item fit, differential item functioning, response scale ordering, targeting of persons and items and the reliability.

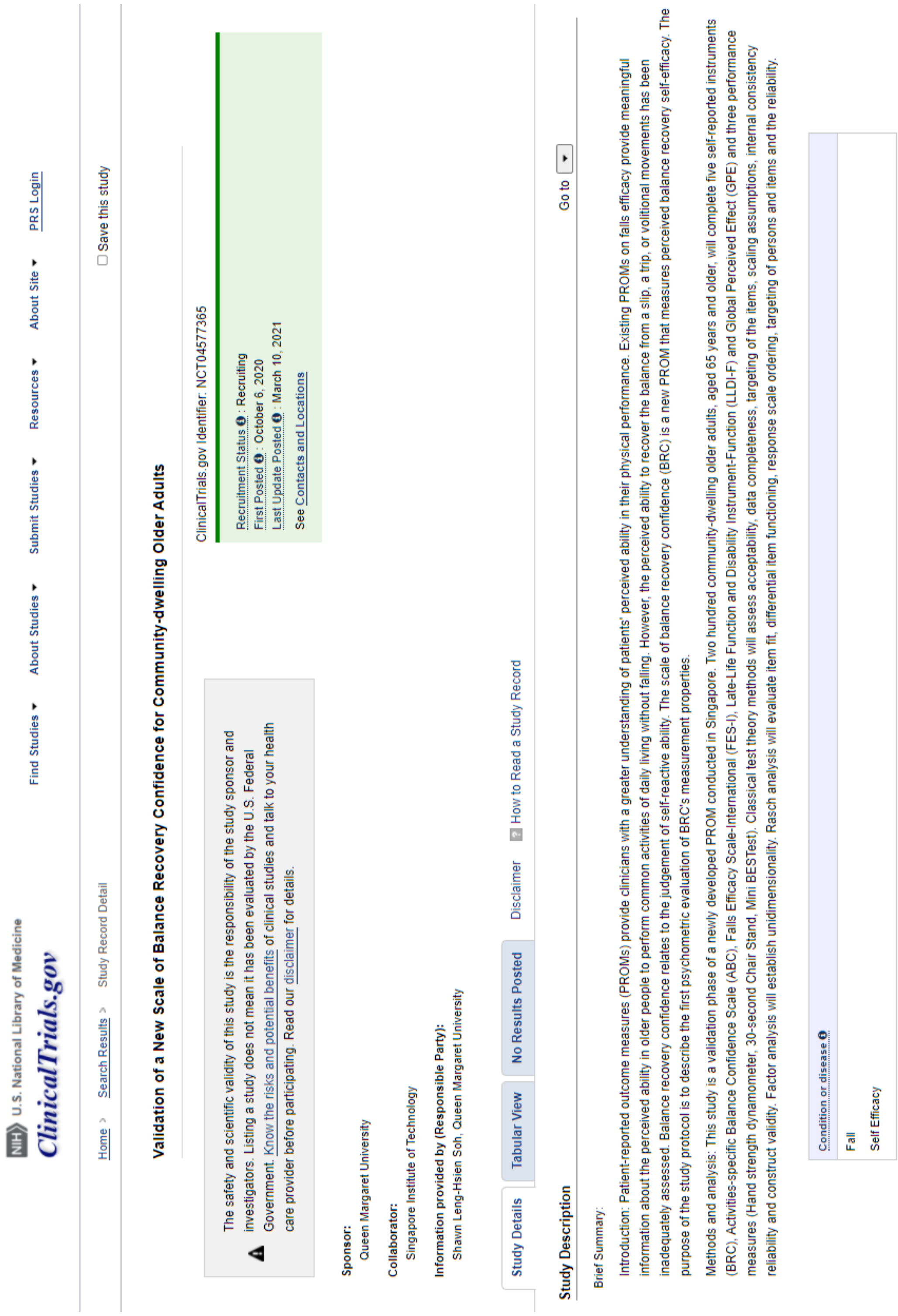
RESULTS The findings from this study will be published in peer-reviewed journals and presented at national and international conferences in rehabilitation-specific context.

CONCLUSIONS This is the first validation study of BRC. The study will give confidence among clinicians and researchers to use the BRC in fall management research and clinical practice.

KEYWORDS
Accidental falls, patient outcome assessment, postural balance, self-efficacy, quality of reporting

Appendix 5: Supplementary materials for Chapter 7

Appendix 5A ClinicalTrials.gov record: NCT04577365



U.S. National Library of Medicine

ClinicalTrials.gov

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Home > Search Results > Study Record Detail

☐ Save this study

Validation of a New Scale of Balance Recovery Confidence for Community-dwelling Older Adults

The safety and scientific validity of this study is the responsibility of the study sponsor and investigators. Listing a study does not mean it has been evaluated by the U.S. Federal Government. Know the risks and potential benefits of clinical studies and talk to your health care provider before participating. Read our disclaimer for details.

ClinicalTrials.gov Identifier: NCT04577365

Recruitment Status : Recruiting
First Posted : October 6, 2020
Last Update Posted : March 10, 2021

See Contacts and Locations

Sponsor:
Queen Margaret University

Collaborator:
Singapore Institute of Technology

Information provided by (Responsible Party):
Shawn Leng-Hsien Soh, Queen Margaret University

Study Details | Tabular View | No Results Posted | Disclaimer | How to Read a Study Record

Study Description

Go to

Brief Summary:

Introduction: Patient-reported outcome measures (PROMs) provide clinicians with a greater understanding of patients' perceived ability in their physical performance. Existing PROMs on falls efficacy provide meaningful information about the perceived ability in older people to perform common activities of daily living without falling. However, the perceived ability to recover the balance from a slip, a trip, or volitional movements has been inadequately assessed. Balance recovery confidence relates to the judgement of self-reactive ability. The scale of balance recovery confidence (BRC) is a new PROM that measures perceived balance recovery self-efficacy. The purpose of the study protocol is to describe the first psychometric evaluation of BRC's measurement properties.

Methods and analysis: This study is a validation phase of a newly developed PROM conducted in Singapore. Two hundred community-dwelling older adults, aged 65 years and older, will complete five self-reported instruments (BRC), Activities-specific Balance Confidence Scale (ABC), Falls Efficacy Scale-International (FES-I), Late-Life Function and Disability Instrument-Function (LLDI-F) and Global Perceived Effect (GPE) and three performance measures (Hand strength dynamometer, 30-second Chair Stand, Mini BESTest). Classical test theory methods will assess acceptability, data completeness, targeting of the items, scaling assumptions, internal consistency reliability and construct validity. Factor analysis will establish unidimensionality. Rasch analysis will evaluate item fit, differential item functioning, response scale ordering, targeting of persons and items and the reliability.

Condition or disease
Fall
Self Efficacy

Detailed Description:

Introduction: This study aims to conduct the first evaluation of measurement properties in the scale of balance recovery confidence. There are several measurement properties such as unidimensionality, validity (to what extent does the instrument measure the construct it purports to measure) and reliability (the degree to which measurement is free from error) of the PROM that is needed to be studied.

This psychometric validation aims to provide evidence that the PROM can be purposefully used in practice, given that rigorous methods have been applied for the development and validation of the BRC. For the study, balance recovery confidence is defined as the perceived ability to recover one's balance from perturbations, such as a slip, a trip, or a loss of balance that can occur in common, everyday activities. This focus will leave little ambiguity about precisely what is being measured. The resulting questionnaire is intended to be approximately 20 questions and should not take longer than 10 min to complete. The instrument is not intended to be used as a diagnostic tool of impaired specific balance recovery mechanisms. The BRC allows clinicians and researchers to quantifiably determine the balance recovery confidence in older adults and use the scale as a conduit for understanding older people's perspectives when encountering different perturbations during their daily activities.

The objectives are to:

1. To evaluate the measurement properties of the BRC, i.e. acceptability, targeting, scaling assumptions and reliability using Classical Test Theory (CTT), the internal scale structure using Rasch measurement theory in the Singapore community-dwelling older adults.
2. To assess the construct validity of the refined BRC against commonly used PROMs and performance measures in the Singapore community-dwelling older adults.
3. To refine the items, response categories, and scale structure of the BRC using Rasch measurement theory in an English-speaking sample of community-dwelling older adults in Singapore.

Methods: Participants will attend two sessions in the study. In the first session, the researcher will use a measurement data form to record the participants' results of four questionnaires: BRC, ABC, FES-I, LLFDI-F and three performance measures: Jamar hand strength dynamometer, 30-second chair stand test and Mini BESTest. After seven days, participants will attend the second session to complete the BRC, and the GPE scale which will be used to ensure participants' perception of their abilities remained unchanged during the seven days. The time interval of 7-day had been reported to be sufficient to minimise recall bias. Participants will be asked if they have had experienced a fall, near-fall, or encountered any incident that might affect their balance recovery ability over the past seven days.

Statistical analysis: Quantitative data will be analysed and interpreted through two measurement test theories using IBM SPSS Statistic V.26.0 and Winsteps V.4.5.0. Classical test theory is a traditional quantitative approach to test the validity and reliability of a scale based on its items. This approach is based on the assumption that every observed score is a function of an individual's true score and random error. In contrast, RA works on the probability of a person's level on an item is a function of the person's ability and of the difficulty of the item. RA evaluates a scale against a mathematical measurement model and analyses the scale at the level of each item, and each person. Measurement properties including unidimensionality, internal structure, validity and reliability will be evaluated.

Study Design

Go to

Study Type :	Observational
Estimated Enrollment :	200 participants
Observational Model:	Cohort
Time Perspective:	Cross-Sectional
Official Title:	Validation of a New Scale of Balance Recovery Confidence for Community-dwelling Older Adults
Actual Study Start Date :	February 22, 2021
Estimated Primary Completion Date :	September 2021
Estimated Study Completion Date :	December 2021

Appendix 5B QMU ethical approval letter

Queen Margaret University

EDINBURGH

Shawn Soh
PhD Candidate
School of Health Sciences

Lucy Hinds
Quality Enhancement Officer
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Queen Margaret University Drive
Musselburgh
East Lothian EH21 6UU

Tel: 0131 474 0000
Email: researchethics@qmu.ac.uk

27 August 2020

Dear Shawn,

Ethical Approval – Psychometric properties of the Balance Recovery Falls-Efficacy Scale (BRFES)

Thank you for your response to the letter I sent you following consideration of your application by the Research Ethics Panel.

Dr Gemma Blackledge-Foughali, Convener of the Panel, has reviewed your response to the points you were required to address, and has confirmed that she is happy to take Convener's Action to grant full ethical approval for your research.

A standard condition of this ethical approval is that you are required to notify the Panel, in advance, of any significant proposed deviation from the original protocol. Reports to the Committee are also required once the research is underway if there are any unexpected results or events that raise questions about the safety of the research

We would like to thank you for your co-operation and wish you well with your project.

Yours sincerely

Lucy Hinds
Secretary to the Research Ethics Panel

DIVISION OF GOVERNANCE AND QUALITY ENHANCEMENT
QUEEN MARGARET UNIVERSITY, EDINBURGH
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Appendix 5C SIT Ethical Approval Letter

SINGAPORE INSTITUTE OF TECHNOLOGY

Institutional Review Board
Approval Letter For Research Involving Human Subjects

Principal Investigator:	Mr Shawn Soh
Project Title:	Psychometric properties of the Balance Recovery Falls-Efficacy Scale (BRFES) ("Project")
Project Number:	2020098
Action:	APPROVED
Approval Date:	17 September 2020
Expiry Date:	31 December 2021

Dear Mr Shawn Soh

Based on the materials submitted, this Project has been reviewed and approved by the SIT-IRB by Expedited Review. If there are modifications to any of the materials, you are required to re-submit them for approval. Likewise, if this Project cannot be completed before the expiry date above, you are required to seek approval from the SIT-IRB to continue with it. Please be reminded that it is your duty to ensure that the SIT-IRB's approval covers the entire duration of this Project, and you maintain the records of the study as detailed in Appendix 1.

The approval for this study is only for the activities conducted on SIT premises.

In addition, please note the following due to the current COVID-19 pandemic:

1. Where possible, interviews with participants shall be conducted via telephone, tele-conferencing or video-conferencing;
2. Meeting research participants must be at public venues only; meetings at individuals' homes are not recommended as personal safety and hygiene/ risk level at the location (or as practised by the residents) cannot be effectively ascertained.
3. Safe Management Measures (SMM) must be adhered to;
4. PIs, students and research participants who are unwell, or who have household members on Home Quarantine Order/Stay Home Notice or have adult household members with flu-like symptoms such as fever and cough, are required not to engage in research activities;
5. If participant or researcher is neither a SIT staff or student, please ensure to inform the division POC to update the nominal roll accordingly if visiting SIT (Dover Campus).

SIT, Institutional Review Board
Professor Ponnampalam Gopalakrishnakone, Chairman of Singapore Institute of Technology – Institutional Review Board

Date: 17 September 2020 Signature: P. Gopalakrishnakone

Appendix 5D Template of participant consent form

Appendix B: Participant Consent Form

Project title:
Psychometric properties of the Balance Recovery Falls-Efficacy Scale (BRFES)

SIT IRB Approval Number: ______________________________

☐ I voluntarily agree to take part in the above research study upon meeting the eligibility criteria.

☐ I have been given a copy of the Participant Information Sheet (attached as Appendix A). The investigators had given me a full explanation on the nature, purpose, location and likely duration of the study, and of what I will be expected to do. I have been given the opportunity to ask questions on all aspects of the study and have understood the advice and information given.

☐ I understand that I am free to withdraw from the study at any time without justifying my decision and without prejudice and consequence whatsoever.

☐ I give consent to the use of my data in this study. I understand that all data relating to this study is held and processed in the strictest confidence, and following the relevant data protection laws in Singapore and EU General Data Protection Regulation (GDPR). I give/do not give my consent to be re-identified in the case of an incidental finding (if any).

☐ I agree that I will not have any right or claim to any share in the commercial gain derived from the research (if any).

☐ I agree/do not agree to be contacted for matters relating to the above research study.

☐ I allow / will not allow the subsequent use of my data for future research activities/innovation/commercial activities whether or not related to this research, upon the completion of this research

This research study has been explained to me in ____________ (state language), which I understand, by ______________________ (name of translator).

______________________ Name and Signature (Participant)   __________ Date

______________________ Name and Signature (Consent Taker)   __________ Date

______________________ Name and Signature (Witness)   __________ Date

For further information on the above research study or to provide feedback, please contact:
Mr Shawn Soh, Lead Principal Investigator
Email: shawn.soh@singaporetech.edu.sg or Contact number: (65) 9699 7689

Appendix 5E Template of participant information form

Appendix A: Participant Information Sheet

Project title:

Psychometric properties of the Balance Recovery Falls-Efficacy Scale (BRFES)

Principal Investigator: ________________

Instructions to Participant

Please read this form and ask any questions that you may have about this research project. Your participation is voluntary, and you can ask questions or withdraw at any time during the research.

<u>What is the purpose of the study? Why have I been invited to take part in the study? How may I take part in this research study?</u>

The purpose of this research study is to investigate the psychometric properties of a newly-developed instrument, Balance Recovery Falls-Efficacy Scale (BRFES). BRFES has been developed to provide a deeper understanding of the balance recovery confidence in community-dwelling older adults. The ability to recover balance effectively is a critical factor in stopping a fall after a loss of balance caused by different types of balance perturbation, e.g. slips and trips. This knowledge allows healthcare professionals to work with them and plan targeted rehabilitation interventions to address any concerns and develop their abilities to prevent a fall. With proper validation, the instrument can be usefully adopted into clinical and research practice. Your study participation will allow us to evaluate the validity and reliability of the BRFES and the results will provide evidence on how useful the BRFES can be used to measure balance recovery confidence in the community-dwelling older adults.

If you meet the eligibility criteria, you are invited to participate in the study. The eligibility criteria are established to ensure that the study population is relevant to the study. This approach will allow findings from this study to be generalised to the target population and other similar studies on the community-dwelling older adults. You can take part in the research study after meeting the eligibility criteria and have provided us with your written consent to participate.

Inclusion Criteria	Exclusion Criteria
65-year-old and above	Requiring any physical assistance from another person to walk within home
Able to read, write and communicate in English	Presenting with clinical observable severe cognitive impairment
Living independently in the community with or without use of a walking aid	Unable to provide written consent to participate in the study

<u>What will I be expected to perform if I agree to participate in this research?</u>

If you agree to participate in this research, you will complete four questionnaires and three performance measures in the first session and two questionnaires in the second session conducted seven days later.

Session 1 (Approximate duration: 60 minutes)

Questionnaire 1: Balance recovery Falls Efficacy Scale (BRFES)

The BRFES aims to measure the balance recovery confidence in community-dwelling older adults. A list of common fall-related situations are presented to determine how certain the respondent can recover their balance to prevent a fall if the situation was to occur in the last 3 weeks by recording a number from 0 to 10 with 10 indicating "Highly certain can do" and 0 refers to "Cannot do at all".

Questionnaire 2: Activities-specific Balance Confidence Scale (ABC) (Powell, 1998)

The ABC scale assesses older adults' confidence that they will not fall or lose their balance during a number of progressively challenging balance and mobility tasks. This scale provides a wide continuum of activity difficulty and contains situation-specific questions to determine the level of confidence in completing a task without falling or losing balance. The ABC Scale has 16 questions, with answers ranging from 0% (no confidence) to 100% (complete confidence)

Questionnaire 3: Falls Efficacy Scale – International (FES-I) (Yardley, 2005)

FES-I is a 16-item scale which measures fear of falling or "concerns about falling" relating to basic and more demanding activities both physical and social. Each question is answered with a four-graded scale (1-4); not at all concerned, somewhat concerned, fairly concerned and very concerned. A total score is calculated and ranges from 16 to 64, an ordinal scale (Yardley, 2005).

Questionnaire 4: Late Life Function and Disability Instrument-Function component (LLFDI) (Jette, 2002)

The Functional component of the instrument evaluates self-reported difficulty a person has in performing activities of daily living tasks. Factors that may influence the difficulty in task performance include pain, fatigue, fear, weakness, soreness, ailment, health conditions, and disabilities. There are 32 items with response options of "none," "a little," "some," "quite a lot," and "cannot do." An additional 8 items will be given to those who use canes or walkers.

Performance measure 1: Jamar hand strength dynamometer (JHSD) (NIHR, 2016)

The handheld dynamometer provides a quantitative measure of isometric grip strength of the hand by determining the amount of static force that the hand can squeeze around a dynamometer (Paltamaa, 2005). The test will be administered adopting standardised instructions and positioning recommended by the NIHR Southampton Biomedical Research Centre.

Performance measure 2: 30-second chair stand test (CDC, 2017)

A quantitative measure used as test functional lower extremity strength as well as to obtain an indicator of functional independence with repeated performance of sit to stand from a chair within 30 seconds. The test will be administered adopting standardised instructions and positioning recommended by the Stopping Elderly Accidents, Deaths and Injuries (STEADI).

Performance measure 3: Mini BesTest (Franchignoni et al., 2010)

A 14-item clinical test focusing on dynamic balance contained items belonging four of the six sections from the original BESTest (Horak et al., 2009). The administration time is about 10 minutes, which makes it efficient and feasible for implementation. The mini BESTest assesses individual's performance on tasks such as sit to stand, rise to toes, stand on 1 leg, stepping in 4 different directions, stance-eyes open, foam surface-eyes closed, incline-eye closed, gait during change speed, head turns, pivot turns, obstacles; cognitive "Get Up and Go" with dual task.

Session 2 (Conducted seven days later) (Approximate duration: 15 minutes)

Questionnaire 1: Balance recovery Falls Efficacy Scale (BRFES)

Described as above

Questionnaire 2: Global Perceived Effect (GPE) scale

Participants will rate their upper limb and lower limb functioning, compared to a week ago at follow-up. Response options were: (1) much better than a week ago, (2) somewhat better than a week ago, (3) about the same as a week ago, (4) somewhat worse than a week ago, and (5) much worse than a week ago.

What are the possible Risks/Discomforts/Inconveniences for taking part in this study?

The anticipated risk for taking part in this study is the mental fatigue that may arise during the completion of the four questionnaires. This risk will be managed by the study team to inform the participant that he or she can take a break whenever needed, and will regularly check with the participant during the session.

A possible discomfort will be that the participants might have some difficulty reading the questionnaire based on inappropriate print. The team member will ensure that the print in the questionnaires should be clear and adequate sized, e.g. 14 point type size in Arial font.

The inconvenience faced in the study will be that the participant will need to return back to the study site seven days later to complete two questionnaires. If there is a non-attendance, the study team will check with the participant if he or she will be able to attend the second session on the next day or to be withdrawn from the study.

What are the possible benefits of taking part?

The anticipated benefits of participation will allow participants to be more aware of their perceived balance recovery abilities as well as a better understanding of the different types of balance recovery strategies which they can apply into their interactions with the environment. This awareness may reduce the personal risk of falling. Findings and related knowledge emerging from the studies will be shared as a brief study summary to participants through different modes of communications e.g. website as and whenever possible.

Will I receive payment for this study? Am I responsible for the expenses related to this study?

The participant will need to attend 2 sessions at SIT or the participating centre. There is no payment provided.

What if there is a problem? Who should I contact if I feel unwell as a result of taking part in this study?

If you follow the directions of the PI-in-charge of this research study and you feel any discomfort, please contact the PI immediately. Please contact: Mr Shawn Soh, Lead Principal Investigator at email address: shawn.soh@singaporetech.edu.sg or at contact number: (65) 9699 7689. In the event of injury arising from participation in the study, compensation will be considered on a case by case basis.

For more information and independent advice regarding the research and the rights of research participants, you may contact SIT IRB Secretariat at email: irb@singaporetech.edu.sg. By signing the consent form, you will not waive any legal rights or release the researchers from liability for negligence.

If you wish to contact an independent advisor, please contact Associate Professor Benjamin Soon at email: Benjamin.Soon@SingaporeTech.edu.sg or contact number: (65) 6592 2165.

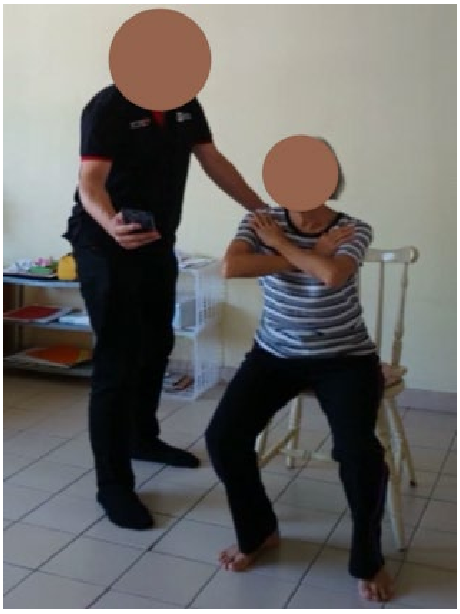
Will my taking part in the study be kept confidential?

All hard copied information generated in this research will be kept in a locked cabinet in the lead Principal Investigator's (lead PI) office. Electronic data files will be stored in an office computer, which is protected using a security password known only to the Lead PI. All records will be kept into a folder created for the project will be securely encrypted. Any hard copied and soft copied information will be obtained through the Lead PI. Confidentiality of the data will also meet the non-disclosure agreements signed between SIT and various healthcare institutions for purposes including but not limited to exploring potential opportunities for developing innovative healthcare solutions and evaluating the feasibility of different business relationship and opportunities between the parties.

Findings and related knowledge emerging from the studies will be shared as brief study summary to all participants through email or any other modes of communications, e.g. website as and whenever possible as well as through the publication of findings, presentations in conferences, seminars, workshops or related activities. Any information in any circulation, publication or presentation that would make it possible to identify you will not be included in any publication or presentation. Data will also be retained for further research. For these reasons, hard copied data and electronic data will be stored for ten years (1 August 2030) upon completion of the research study and then be securely destroyed. The means by which the personal data can be associated with individuals will be stored for purpose of data clarification and accountability. For this reason, hard copied version and electronic version of the link will be stored for three years (1 August 2023) upon completion of the research study and then be securely destroyed.

Appendix 5F Examples of the research process. Permission of photo use has been obtained.

5F(a) Picture showing a researcher obtaining the handgrip strength of a participant



5F(b) Picture showing a researcher conducting the 30-second chair stand test with a participant

"Do ordinary things with extraordinary love."

– Mother Teresa

School of Health Sciences, Division of Physiotherapy

Centre for Health, Activity and Rehabilitation Research

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