Measuring community walking in stroke survivors using physiotherapists' perspectives and the International Classification of Functioning, Health and Disability (ICF) framework

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Statement of Authorship

This thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma.

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All research procedures reported in the thesis received the approval of the relevant Ethics Committees (where required).

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Podium Presentations

- Suzanne Kuys, Neelam Nayak, Belinda Bilney, Nancy Low Choy "Measures of community walking in stroke survivors: A systematic review" at Stroke 2018, Sydney on 7-10 August 2018

- Neelam Nayak, Suzanne Kuys, Nancy Low Choy "Measuring community walking in stroke survivors, what do physiotherapists think?" at Smart Strokes conference, Gold Coast, QLD on 10-11 August 2017

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- Suzanne Kuys, Neelam Nayak, Nancy Low Choy "Community walking in stroke survivors: What are we missing" at Stroke 2017, Queenstown on 23-25 August 2017

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Abstract

Community walking is a multifactorial task and an important functional goal for stroke survivors. Measuring community walking is challenging because there is not a good understanding of what is considered successful community walking or how this could be measured. Physiotherapists currently use a range of measures to assess community walking. Furthermore, the factors contributing to community walking that are captured by these measures are not yet well understood. This thesis, comprising two studies, explores these gaps.

The first study is a qualitative exploration of physiotherapists' perspectives of community walking measurement in stroke survivors. Physiotherapists experienced in stroke rehabilitation were recruited to participate in focus groups. Semi-structured interviews were utilised to explore physiotherapists' perspectives on measuring community walking in stroke survivors. Interviews were transcribed verbatim and thematically analysed. Four themes were identified: successful community walking is goal-dependent, physiotherapists lack consistency in measurement of community walking, current measures don't reflect actual community walking, and measures of community walking should be multifactorial. Physiotherapists perceived that stroke survivors' goals related to community walking played an important role in achieving success in community walking. However, for physiotherapists, successful community walking implied stroke survivors satisfying specific criteria for gait speed, distance walked and ability to dual- task while walking. There appeared to be a range of ways in which physiotherapists measure community walking. For example, physiotherapists working in in-patient rehabilitation used more functional measurement such as observing the task of walking and commenting on assistance required. Whereas

physiotherapists working in outpatient and community rehabilitation more objectively inferred community walking using measures including Berg Balance Scale, Dynamic Gait Index, 10-Meter Timed Walk and 6-Minute Walk Test. Even when using specific measures, physiotherapists reported using different values or cut-off scores as representative of stroke survivors' community walking. Physiotherapists reported that stroke survivors' goals were taken into account when selecting a measure. Physiotherapists noted that current measures of community walking were performed in a clinical setting, not necessarily involving situations reflective of community walking. Physiotherapists identified a range of factors that were important to be included in a measure of community walking including stroke survivors' satisfaction and confidence in activities related to community walking. Physiotherapists' evaluation of walking in an environment reflecting community walking, dual tasking, dynamic balance ability and stroke survivors' safety awareness were suggested to be included in a measure of community walking.

The second study, a systematic review, identified current measures of community walking and explored the content of these measures within the International Classification of Functioning, Disability and Health (ICF) framework. Search strategies were conducted in databases of CINAHL, EMBASE, PubMed, Scopus and Web of Science. Twenty measurement tools were identified from 27 studies included in the final synthesis. The identified measures of community walking were categorised as instrumented measures, patient-reported measures and therapist-reported measures. Content covered by the identified measures was then analysed within the ICF framework using an established ICF linking process. Across all measures, 169 ICF categories were linked. The majority were linked with Activity and Participation component (88%), with remaining categories linked with Environmental factors (10%) and Body functions (2%). All

measures covered Activity and Participation, in which mobility categories were the most commonly linked and included walking on different surfaces, climbing, and walking around obstacles. Environmental categories were covered by half of the identified measures and included use of assistive devices for indoor and outdoor mobility and products and technology for gaining access to facilities inside buildings. Three of the identified measures covered Body functions and included categories of confidence and proprioception. Measures of community walking for stroke survivors illustrated diversity in the content covered, with most measures covering activity of walking. None of the measure comprehensively covered factors associated with community walking.

Findings from Study 1 and Study 2 highlight that there is a lack of a comprehensive measurement tool of community walking in stroke survivors, as no single tool measures all of the important factors contributing to community walking. Community walking is mostly inferred based on some components of these measurement tools. Physiotherapists take into account stroke survivors' goals when selecting a measure of community walking, at the same time relying on measures that they think best represent community walking.

Acronyms

10MTW	10-Meter Timed Walk
6MWT	6-Minute Walk Test
ABC	Activities-Specific Balance Confidence
CB&M	Community Balance and Mobility
EAMQ	Environmental Analysis of Mobility Questionnaire
FAC	Functional Ambulation Categories
GPS	Global Positioning System
ICF	International Classification of Functioning, Disability and Health
mEFAP	Modified Emory Functional Ambulation Profile
MOSES	ICF-oriented “mobility”, “self-care” and “domestic life”
SAM	Step Activity Monitor
SIPSO	Subjective Index of Physical and Social Outcome
WAQ	Walking Ability Questionnaire
WHO	World Health Organization

1. Introduction

Stroke is one of the leading causes of global mortality and disability (American Heart Association, 2017). Following stroke, being able to walk in the community is rated as an important goal by stroke survivors (Bohannon, Andrews, & Smith, 1988; Hill, Ellis, Bernhardt, Maggs, & Hull, 1997; Lord, McPherson, McNaughton, Rochester, & Weatherall, 2004). Stroke survivors commonly experience limitations in walking, with impaired walking occurring in two out of three stroke survivors in the acute stage (Jørgensen, Nakayama, Raaschou, & Olsen, 1995). By the end of rehabilitation approximately 64% of stroke survivors can walk independently (Jørgensen et al., 1995). A recent Australian study reported only 27% of stroke survivors have the physical ability required for walking in the community when they leave inpatient rehabilitation (Blennerhassett, Levy, Mackintosh, Yong, & McGinley, 2018).

Community walking is a complex activity whereby walking needs to be integrated within various environments (Lord et al., 2004; Shumway-Cook et al., 2002) with the purpose of undertaking specific tasks, such as visiting the doctor or going shopping (Lord et al., 2004). For stroke survivors, walking in the community is challenging as compared to healthy older adults (Robinson, Matsuda, Ciol, & Shumway-Cook, 2013), with limitations in community walking leading to dissatisfaction and poor quality of life in stroke survivors (Pound, Gompertz, & Ebrahim, 1998; Robinson, Shumway-Cook, Ciol, & Kartin, 2011). The consequences of limited community walking are known to be associated with reduced participation in community life, thus impacting stroke survivors' social integration (Nanninga, Meijering, Postema, Schönherr, & Lettinga, 2017; Nanninga, Meijering, Schönherr, Postema, & Lettinga, 2015; Pang, Eng, & Miller, 2007).

For physiotherapists working with stroke survivors, rehabilitation of walking may well be considered a priority, with physiotherapists reported to spend most of the therapy time on improving walking-related activities (Latham et al., 2005). Measurement of community walking therefore would appear to be also important. Measurement of patient goals, through goal-setting, is deemed central to neurological rehabilitation (McMillan & Sparkes, 1999; Sugavanam, Mead, Bulley, Donaghy, & Van Wijck, 2013). Indeed, recent clinical practice guidelines for stroke rehabilitation strongly recommend goals for recovery should be patient-centred (Stroke Foundation, 2017a).

Current measures of community walking include devices such as pedometers or accelerometers, and self-report tools or questionnaires (Lord & Rochester, 2005; Macko et al., 2002; Shaughnessy, Michael, Sorkin, & Macko, 2005). Another method of determining community walking in stroke survivors' is to predict capacity for independent community walking by, for example, measuring walking speed and/or distance, and comparing against minimum criteria (Lerner-Frankiel, Vargas, Brown, Krusell, & Schoneberger, 1986). The use and purpose of these measures varies; either for characterising community walking or predicting the potential to walk in the community. For example, pedometers quantify and measure community walking volume while measures such as gait speed and distance are used to predict whether the stroke survivor is capable of walking in the community. Thus, clinicians may use the measures available to them and select the tool that suits their purpose to either characterise or predict potential for community walking. In contrast, the scientific literature related to community walking after stroke largely focuses upon factors believed to contribute to community walking and researchers' experience. The range and type of measures of community walking used in the scientific literature needs to be investigated.

The multifactorial nature of community walking and lack of consensus regarding measurement poses potential challenges for physiotherapists working with stroke survivors. Physiotherapists' perspectives of skills and abilities required by stroke survivors to walk in the community has previously been investigated (Corrigan & McBurney, 2012). However, it is not clear how physiotherapists perceive successful community walking of stroke survivors. Additionally, physiotherapists have identified inadequacies in the measurement of the environmental factors associated with community walking (Corrigan & McBurney, 2008). It is possible there are other challenges faced by physiotherapists when measuring community walking that are yet to be identified. The views of physiotherapists involved in the care of stroke survivors will be explored to determine their perspectives of community walking of stroke survivors and how community walking should be measured.

The International Classification of Functioning, Disability and Health (ICF) framework provides a basis to examine community walking. In the ICF, walking is classified within the component of Activity and Participation (WHO, 2001). In addition, the ICF components of Physical factors (Body structures and functions), Environmental factors and Personal factors can be applied to community walking. Linking using the ICF framework is a method of content analysis that has been used to link items of a measurement tool to ICF components (Cieza et al., 2002). The ICF linking process has been previously used to explore outcome measures used in people with stroke (Geyh, Cieza, Kollerits, Grimby, & Stucki, 2007; Geyh et al., 2004).

This thesis will explore the measurement of community walking in stroke survivors. Physiotherapists' perspectives of community walking in stroke survivors will be investigated using qualitative methodology. Additionally, a systematic review of the scientific literature will seek to identify current measures of community walking in stroke survivors. The content

of these measures will then be analysed within the ICF framework using an established linking process. This approach will identify the content covered by the community walking measurement tools.

1.1. Overview of the Thesis

This thesis comprises six chapters. The first chapter introduces the research program. An outline of the remaining chapters is described below.

Chapter 2 provides the background to the thesis and introduces the concept of community walking in stroke survivors and its measurement. The International Classification of Functioning, Disability and Health framework and existing literature regarding community walking in stroke survivors is reviewed.

Chapter 3 outlines the methodology used for the two studies that make up this thesis. For Study 1, this includes a detailed description of the qualitative methodology utilised and ethical considerations. For Study 2, a comprehensive description of the procedure for the systematic review identifying the measurement tools is presented. Additionally, an overview of the ICF linking process is described.

Chapter 4 presents the first study in this thesis, a qualitative study to explore perspectives of physiotherapists regarding community walking in stroke survivors. Results are presented as descriptive themes.

Chapter 5 describes the second study in this thesis, which is a systematic review of the literature investigating the measurement tools used for community walking in stroke survivors. Results are presented as a descriptive synthesis of the identified measurement tools and the content of the measures within the ICF framework.

Chapter 6 comprises the discussion and conclusion of this thesis. This chapter contains a summary of the main findings from both studies included in this thesis as well as a comment on the limitations associated with these studies. Clinical implications and future directions for research are discussed and a concluding remark completes the thesis.

1.2. Research Objectives, Aims and Questions

The primary objective of this thesis is to explore how community walking in stroke survivors is measured by physiotherapists. Two studies are planned to meet the primary objective. The two studies informing this Master of Philosophy program of research will be broadly defined and will include the specific research aim and question/s to be addressed by each study.

Study 1: Physiotherapists' perspectives of community walking: a qualitative study

Research Aim: To explore physiotherapists' perspectives of community walking

Research Questions:

1. How do physiotherapists describe successful community walking in stroke survivors?
2. How do physiotherapists measure community walking in stroke survivors?
3. How do physiotherapists perceive community walking should be measured?

Study 2: Systematic review of measures of community walking in stroke survivors and content analysis using ICF linking Research Aim: Using a systematic review approach to identify measurement tools used to evaluate community walking and identify the content of the tools using an ICF linking process.

Research Questions:

1. What measures or components of measures have been used to evaluate stroke survivors' ability to walk in the community?

2. What content is included in these measures, and how does the content link within the ICF framework?

2. Background

2.1 Stroke

Stroke is a cerebrovascular disease that had a global prevalence of 33 million people in 2010; of which approximately half the stroke survivors had experienced their first stroke (American Heart Association, 2017). In Australia, 475,160 people were living with effects of stroke in 2017 (Stroke Foundation, 2017b). It is estimated that by 2032 there will be more than 700,000 Australians living with stroke, representing 2.4% of the population (Stroke Foundation, 2017b). Approximately 60% of people who have experienced a stroke die or become dependent (American Heart Association, 2017) making this condition a leading cause of disability worldwide.

Due to the important clinical, quality of life, socioeconomic and public health implications that stroke carries—such as permanent neurological damage, disabilities, and even death— stroke has been described as "one of the most life-altering syndromes affecting the world population" (T. Wolf, Baum, & Conner, 2009, p.621). Despite the public health impact of this condition, the definition of stroke is not consistent in clinical practice or research (Sacco et al., 2013). The World Health Organization (WHO) in 1970 defined stroke as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin" (World Health Organization, 1988, p.105). This definition will be used throughout this thesis.

2.2 Community walking in stroke survivors

Approximately one third of stroke survivors are reported to have residual disability following stroke (Hankey, Jamrozik, Broadhurst, Forbes, & Anderson, 2002). Common impairments after stroke include visual deficits, upper and lower limb sensory-motor deficits, and balance deficits (Lawrence et al., 2001). Stroke survivors are also known to have reduced cardiovascular endurance (Ivey, Macko, Ryan, & Hafer-Macko, 2005). These multisystem impairments contribute to reduced walking performance (Bohannon & Andrews, 1995) which subsequently impacts community participation of stroke survivors (Blömer, van Mierlo, Visser-Meily, van Heugten, & Post, 2015; Desrosiers et al., 2006).

Achieving independence in walking is important to stroke survivors with approximately three-quarters of stroke survivors discharged from rehabilitation reporting "the ability to get out and about in the community as essential or very important" (Lord et al., 2004, p.234). Pound et al. (1998) similarly identified that stroke survivors who reported difficulty in getting out of the house felt unhappy and dissatisfied with their quality of life.

2.2.1 Definitions

The term community walking is often used interchangeably with community ambulation, community mobility and functional ambulation. For this thesis, the term community walking will be used. A range of definitions and criteria to define community walking have been used within the literature. Lerner-Frankiel et al. (1986) proposed that, to be able to walk in the community, an individual should be able to walk sufficient distance, negotiate curbs and be able to cross a street which has timed signals. Lerner-Frankiel et al. (1986) aimed to establish gait speed and distances required to achieve independent community walking. For ten

independent stroke survivors walking in their communities, average gait speeds of 0.63 m/s were needed to cross roads with timed walk signals and distances up to 600 meters were required to walk to their desired destinations (Lerner-Frankiel et al., 1986). Environmental challenges were also encountered by stroke survivors such as curbs and revolving doors. Based on these investigations, the authors recommended that a definition of independent community walking should include appropriate gait speed, distance and ability to ascend and descend curbs (Lerner-Frankiel et al., 1986).

Perry, Garrett, Gronley, and Mulroy (1995) developed a classification system to categorise stroke survivors' walking recovery. This classification known as functional walking categories, comprises six categories (Perry et al., 1995). The highest level within these categories describes a community walker as being independent in home activities, visiting places for appointments and restaurants, managing uneven terrains, and negotiating a crowded shopping centre with supervision (Perry et al., 1995). Interestingly, this description of a community walker did not include the components identified by Lerner-Frankiel et al. (1986), including minimum distances and gait speeds required for walking to a range of destinations.

Patla and Shumway-Cook (1999) furthered the definition developed by Lerner-Frankiel et al. (1986) suggesting that community mobility was a complex phenomenon comprising more than speed, distance and terrain. Patla and Shumway-Cook (1999) developed an operational definition of community walking for older adults with and without disability that encompassed the influence of environmental factors. It was identified that mobility should not be determined only by the ability to perform tasks, but also the environmental context in which these tasks are performed (Patla & Shumway-Cook, 1999). This framework proposed defining community

mobility with respect to eight environmental factors including traffic levels, ambience and terrain. These environmental factors will be explored further in Section 2.2.4.

A more recent definition developed by Lord et al. (2004), described community ambulation "as independent mobility outside the home, which includes the ability to confidently negotiate uneven terrain, private venues, shopping centres and other public venues" (Lord et al., 2004, p.236). This is the only definition identified that is based on stroke survivors' views on places of choice to visit. However, the choices identified were places visited prior to stroke, therefore may not reflect places stroke survivors need to or choose to visit post- stroke.

These definitions of community walking, developed over a span of 30 years, mainly focus on the ability to negotiate uneven terrain (Lord et al., 2004; Patla & Shumway-Cook, 1999; Perry et al., 1995) and visit shopping centres (Lord et al., 2004; Perry et al., 1995). Being independent in activities inside (Perry et al., 1995) and outside the home (Lord et al., 2004) has also been included in the definition of community walking in stroke survivors. Gait speed and distance have not been explicitly included in a definition since Lerner-Frankiel et al. (1986). However, it could be reasoned that to negotiate uneven terrain, visit shopping centres and to be independent outside the home would require a minimum level of gait speed and walking distance capacity.

These definitions appear to be largely based on existing literature at the time of the definition development and researchers' experience. These definitions emphasise performance variables such as ability to negotiate terrain and curbs, achieving a certain gait speed and distances walked. Thus, it is evident that community walking in stroke survivors is a multifactorial, complex task that has been defined in various ways.

The multifactorial concept of community walking can be understood with the help of the ICF, which is the WHO's framework for classifying health and health-related domains (WHO, 2001). The following section describes the structure of the ICF and explores the concept of community walking within this framework.

2.2.2 Community walking and the International Classification of Functioning, Disability and Health

The ICF belongs to the WHO Family of International Classifications and complements the International Classification of Diseases (ICD) (WHO, 2001). These classifications serve the purpose of coding a wide range of health-information such as diagnosis and functioning, at the same time providing a standardised common language across the world to effectively communicate information among various disciplines (WHO, 2001).

The ICF framework provides information about functioning and restrictions associated with health and health-related conditions (WHO, 2001). Within this framework, the information is interrelated and is organised in a structured manner. The ICF framework organises this information in two broad categories; Functioning and Disability, and Contextual factors (Figure 2.1). Under the ICF framework, body components consist of two classifications, one for functions of body and one relating to body structures (WHO, 2001). Activity is defined "as the execution of a task or action by an individual", whereas participation is defined "as involvement in a life situation" (WHO, 2001, p.10).

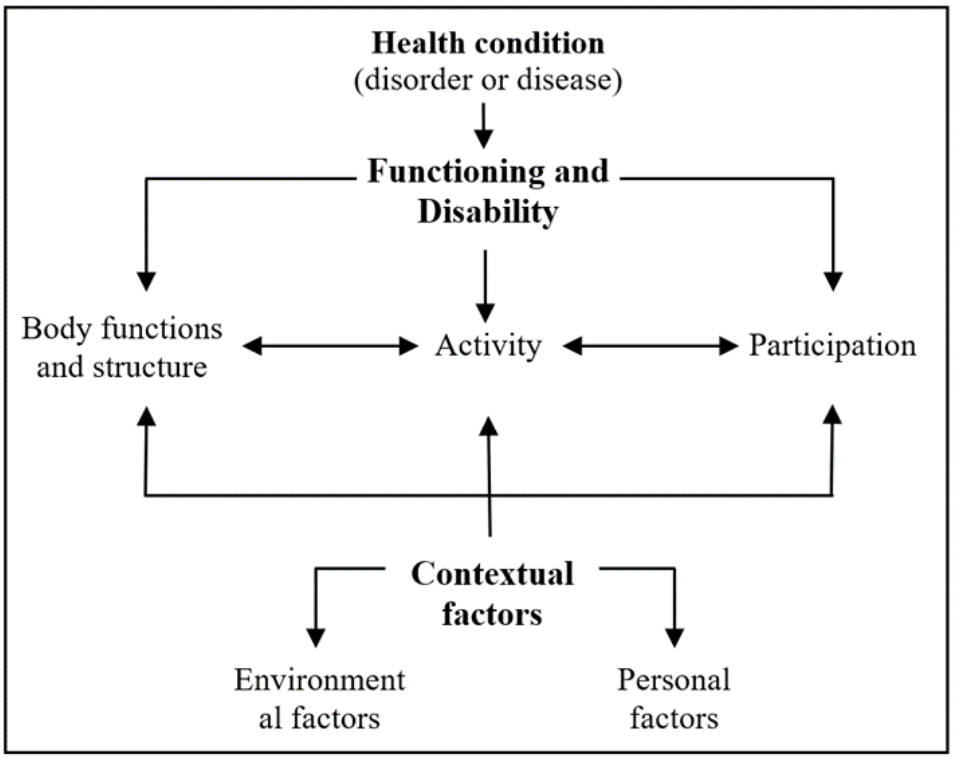

Figure 2.1 The International Classification of Functioning, Disability and Health Framework
Source: WHO (2001).

Environmental factors are the "physical, social and attitudinal environment in which people live and conduct their lives" (WHO, 2001, p.10). Personal factors are not defined in this classification owing to the variance in social and cultural aspects. Age, coping style, confidence and mood are some of the variables considered as personal factors (WHO, 2001). The ICF framework acknowledges the interplay between functioning, disability and contextual factors (WHO, 2001). For example, any physical impairment can potentially affect activity and participation capacity, which in turn can also be influenced by the contextual factors.

Community walking, as the term suggests, comprises walking as an activity within the context of social participation. Figure 2.2 illustrates community walking in stroke survivors

within the ICF framework. Environmental factors, such as terrain and traffic levels (Robinson et al., 2013; Shumway-Cook et al., 2002) and personal factors, including age and confidence in balance abilities can impact community walking (Durcan, Flavin, & Horgan, 2016). Thus, it is crucial to apply the interactive link that the ICF proposes when defining, evaluating and treating community walking in stroke survivors. For this thesis, the ICF framework will be used to explore the content of measures of community walking proposed in the scientific literature.

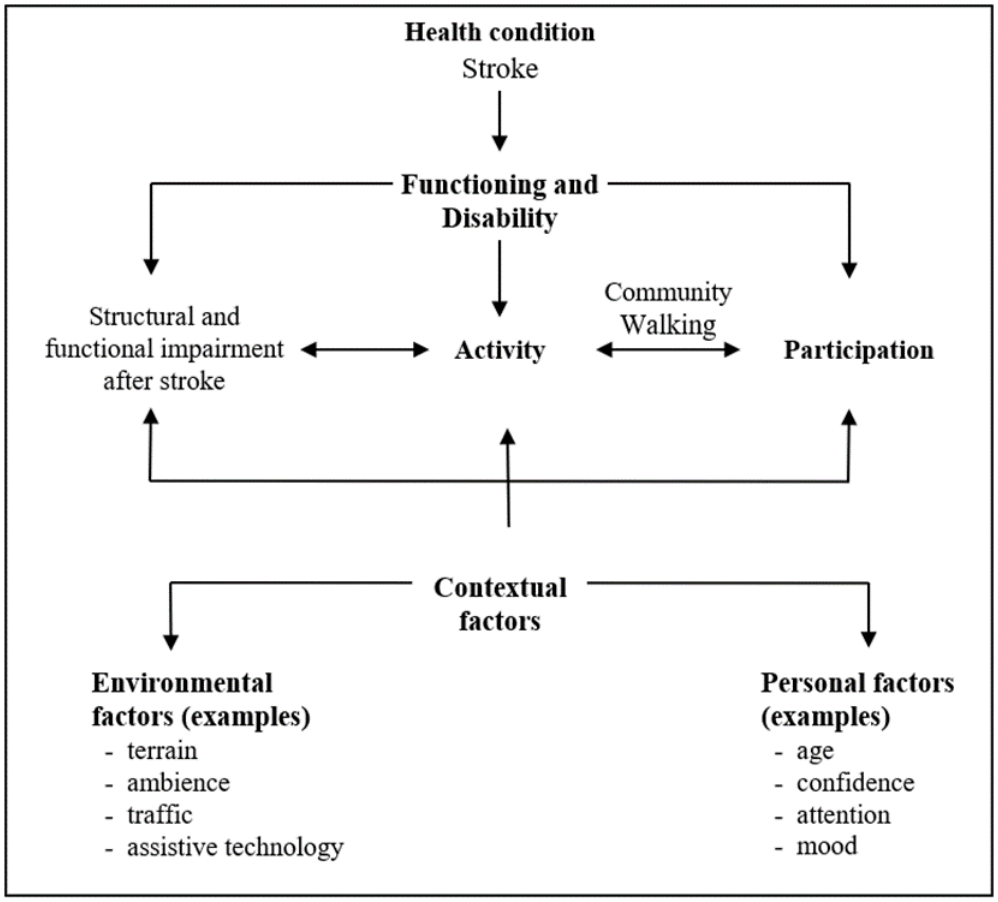

Figure 2.2 Community walking within the International Classification of Functioning, Disability and Health framework
Source: Adapted from WHO (2001)

2.2.3 Structure of the International Classification of Functioning, Disability and Health framework

To understand the ICF classification and its application to measurement of community walking, it is important to review the hierarchical structure of the ICF which is elaborated below. Figure 2.3 illustrates the ICF structure.

Within the ICF taxonomy, classification refers to the overall organisation of ICF and is the top heading in the hierarchy. The classification of ICF has two subdivisions, namely Part 1 - Functioning and Disability and Part 2 - Contextual Factors. These two parts are each further subdivided into two components. The components of Part 1 are Body functions and structures, and Activity and Participation. The components of Part 2 are Environmental factors and Personal factors (WHO, 2001).

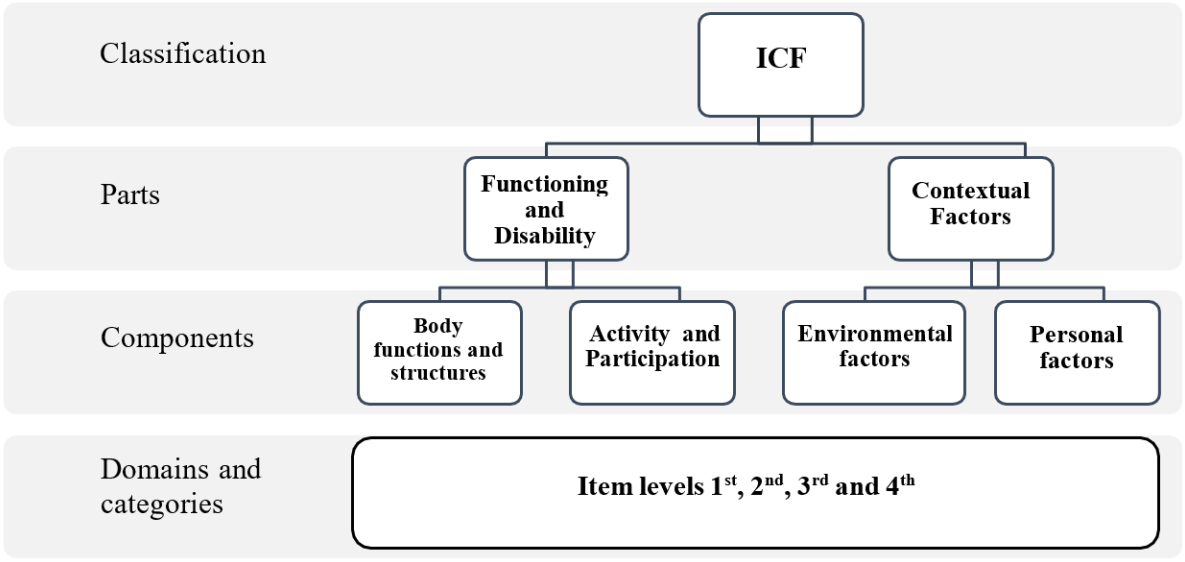

Figure 2.3 The International Classification of Functioning, Disability and Health structure

Source: WHO (2001)

Each of the four components are further subdivided into domains and then categories. Domains imply a meaningful set of related actions or tasks, areas of life and physiological functions. Domains are the first level of classification in the hierarchy and form the chapters of ICF (WHO, 2001). Categories form the lowest level of the hierarchy and are the basic units of classification in ICF (WHO, 2001). Each chapter comprises second-level, third-, and in certain cases, fourth-level categories (WHO, 2001). These categories denote increasingly exhaustive arrangements. The following example illustrates a component of Body functions and the hierarchy of categories. The coding is described in more detail in Section 3.2.3.

b2	Sensory functions and pain	(Domain/chapter, first-level)
b280	Sensation of pain	(second-level category)
b2801	Pain in body part	(third-level category)
b28016	Pain in joints	(fourth-level category)

Within the ICF framework, walking and walking related tasks are classified under the domain of Mobility under Activity and Participation component. This includes categories of walking short and long distances, crossing obstacles, moving to different locations, walking inside the home and outside (WHO, 2001).

The ICF linking process

The ICF linking is a rigorous process, whereby measures (either the whole measure or individual items of measures) are linked to the most precise ICF category (Cieza et al., 2005; Geyh et al., 2004). A set of rules has been developed for linking outcome measures to ICF (Cieza, Fayed, Bickenbach, & Prodinger, 2016). The ICF linking process has been used

previously to link functional outcome measures in stroke survivors (Geyh et al., 2007; Geyh et al., 2004). The ICF linking provides a process to explore, analyse and compare measurement tools (Cieza et al., 2016). Based on the ICF linking process, items in each measurement tool are identified and linked to the most precise ICF category. Details of this process are described in further detail in Chapter 3 Methodology and Design.

A detailed understanding of the content of measures using ICF linking may, in combination with an understanding of the psychometrics properties of the tools, assist researchers and clinicians to choose an appropriate measurement tool. An evaluation of psychometric properties of the measurement tools used to measure community walking in stroke survivors is beyond the scope of this thesis.

2.2.4 Contributors to community walking

There are multiple contributing factors that may influence community walking in stroke survivors. Based on the definitions reported in the literature, community walking appears to have some association with physical factors such as gait speed, walking distance, balance and muscle strength. Additionally, environmental and personal factors have been investigated as contributors to or predictive of community walking. This section will review the physical, environmental and personal contributors to community walking in stroke survivors.

Physical factors

The following section describes physical factors contributing to community walking including gait speed, distance walked, balance and muscle strength.

Gait speed

Gait speed is a commonly used clinical measure in neurological populations (Graham, Ostir, Kuo, Fisher, & Ottenbacher, 2008), and is indicative of walking ability in stroke survivors (Dickstein, 2008). Gait speed can be used to discriminate stroke survivors' ability to walk in the community (Lord et al., 2004) and predict independent community walking in moderately affected stroke survivors (An, Lee, Shin, & Lee, 2015). However, standing balance, time post-stroke, and fear of falling have been shown to confound gait speed as a predictor of community walking (Bijleveld-Uitman, van de Port, & Kwakkel, 2013). Regardless, even after adjusting for these confounders, gait speed has 85% accuracy (95% CI 0.80 to 0.89) for predicting the ability of a stroke survivor to be able to walk in the community (Bijleveld-Uitman et al., 2013; Lord et al., 2004).

There is little consensus on the minimal gait speed required by stroke survivors to walk in the community. van de Port, Kwakkel, and Lindeman (2008) reported that chronic stroke survivors able to walk in the community had a minimum gait speed of 0.66 m/s. Lerner- Frankiel et al. (1986) identified that people with chronic stroke required a gait speed of 1.21 m/s to cross a street controlled by timed walk signals in an urban environment. Fulk, Reynolds, Mondal, and Deutsch (2010), Hill et al. (1997) and Perry et al. (1995) have used a gait speed of 0.80 m/s as the minimum threshold for community walking in stroke survivors. This latter threshold appears to be commonly used to distinguish people able to walk in the community from those who aren't (Hollands et al., 2013; Taylor, Stretton, Mudge, & Garrett, 2006).

Variability in the range of gait speed associated with community walking in stroke survivors can be attributed to multiple factors. Different methods have been used to evaluate gait speed

(Graham et al., 2008), and this may have contributed to the variability observed in outcomes among these tests. For example, different track lengths have been used to measure gait speed. van de Port et al. (2008) reported a minimum gait speed of 0.66 m/s required for community walking when conducting the test over 5 meters (5-Meter Timed Walk). In contrast, Perry et al. (1995) used a 10-Meter Timed Walk (10MTW) reporting 0.80 m/s as the threshold gait speed. However, the 10MTW has been suggested to overestimate gait speed when walking longer distances (Dean, Richards, & Malouin, 2001) such as when walking in the community. Thus, in addition to the variability reported in the minimum speed required for successful community walking, it is possible that assessment of gait speed over short distances overestimates speeds required when walking longer distances, such as those required in the community.

Age of stroke survivors might also contribute to the variability in reported gait speed required for community walking. For example, participants were relatively young, with a mean age of approximately 58 years, in a study reporting 0.78 m/s as the gait speed required for walking in the community (Bijleveld-Uitman et al., 2013). In contrast, in a study of stroke survivors, approximately 10 years older, a slower gait speed of 0.66 m/s was reported (van de Port et al., 2008). Given that gait speed reduces with age (Bohannon & Andrews, 1995), it is possible that part of the variability is attributable to differences in age of the participants between the studies.

Distance walked or walking endurance

Community walking requires walking endurance or being able to walk certain distances. Walking distance, commonly measured using a 6-Minute Walk Test (6MWT), is regarded as an important contributor of community walking (Hill et al., 1997; Michael, Allen, &

Macko, 2005); particularly for high functioning people with stroke (Fulk et al., 2010). Distance walked has been shown to have an accuracy rating of 77% (95% CI 0.72 to 0.80) for predicting independent community walking (Bijleveld-Uitman et al., 2013).

A range of distances are identified in the literature as required for stroke survivors' community walking. Threshold distances of 368 meters (Bijleveld-Uitman et al., 2013; Fulk et al., 2010) and 318 meters (An et al., 2015) has been found to be predictive of walking in the community for stroke survivors. Additionally, minimal distances required for stroke survivors to walk in the community has been reported as less than 261 meters (Lee, Lim, et al., 2015) and 220 meters (Lord et al., 2004).

The variability in the reported distances could be attributed partly to the method employed to measure the distance. For example, Lord et al. (2004) measured this distance on a treadmill, whereas the other studies used the 6MWT (An et al., 2015; Bijleveld-Uitman et al., 2013; Fulk et al., 2010; Lee, Lim, et al., 2015). Walking on a treadmill may require greater balance (Bayat, Barbeau, & Lamontagne, 2005), increased energy cost (Greig, Butler, Skelton, Mahmud, & Young, 1993), and reduced gait speed compared to over ground walking (Bayat et al., 2005). In addition, increasing age is associated with reduction in distances walked (Bohannon & Andrews, 1995) and thus, some part of the variability may be also due to the differences in age of the participants between the studies.

Balance and muscle strength

Impairments in balance have been associated with stroke survivors walking ability (Michael et al., 2005; Patterson et al., 2007; Schmid et al., 2012). Joa et al. (2015) reported Berg Balance Scale score of > 42 points could be used to discriminate stroke survivors as household and community walkers (sensitivity: 92%, specificity: 89%). Additionally, Durcan et al. (2016) and Robinson, Shumway-Cook, Matsuda, and Ciol (2011) reported that balance was a contributor to community walking; however, in these studies balance was not found to be a predictor of ability to walk in the community.

Perry et al. (1995) reported strength of knee flexors and extensors along with gait speed as a significant discriminator for stroke survivors walking independently in the home and in the community. Robinson, Shumway-Cook, Matsuda, et al. (2011) reported an association of ankle dorsiflexors and knee extensor strength to community walking; however, muscle strength did not play a role in predicting community walking. These findings suggest that community walking ability may require more complex attributes than balance and muscle strength alone.

Environmental factors

Patla and Shumway-Cook (1999) proposed eight environmental dimensions of community mobility in older adults that consist of distance, ambient conditions, terrain characteristics, temporal factors, physical load, postural transitions, attentional demands, and traffic levels (Figure 2.4). Older adults, including those with and without mobility difficulty, were observed walking in their communities (Shumway-Cook et al., 2002). Four factors appeared to distinguish between older adults who experience difficulty with their mobility in the community compared to those who did not. These factors are the number of trips or times in

a trip that people encounter stoplights and busy streets (temporal factors), carry parcels or need to open doors (physical load), negotiate uneven terrain including stairs, slopes and escalators (terrain) and need to stop, reach or turn around during their trip (postural transitions) (Shumway-Cook et al., 2002). Those older adults who experienced difficulty with their mobility in the community tended to take fewer trips, carried fewer parcels/objects and performed fewer activities in a trip as compared to older adults without mobility difficulty (Shumway-Cook et al., 2002).

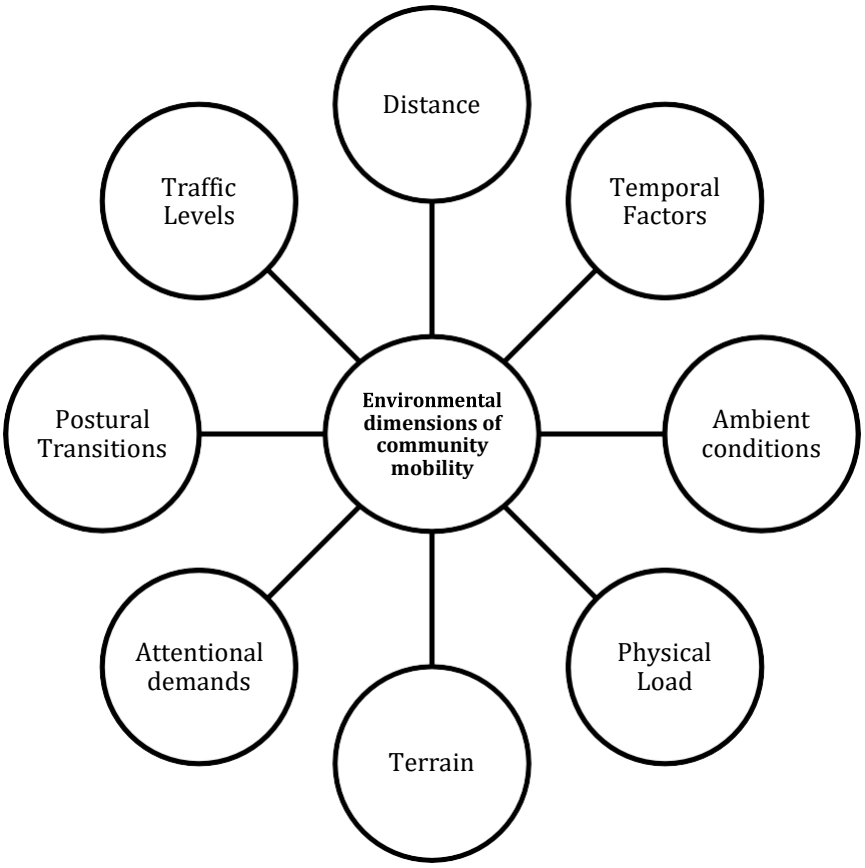

Figure 2.4 Environmental dimensions of community mobility

Source: Patla and Shumway-Cook (1999).

The association of these eight environmental dimensions with community walking was explored during community trips undertaken by chronic stroke survivors (Robinson et al., 2013). Walking long distances was the most commonly avoided environmental dimension by stroke survivors. However, stroke survivors demonstrated overall higher avoidance for all dimensions when compared to healthy adults. Additionally, temporal factors identified as crossing a busy street and crossing a traffic light intersection area also appears to impact the number of trips taken by stroke survivors in the community. However, regression analyses identified that these environmental factors explained only 37% of variance in the model (Robinson et al., 2013), suggesting that other factors were contributing to the number of trips involving community walking following stroke. It is important to note that the studies exploring environmental dimensions (Robinson et al., 2013; Shumway-Cook et al., 2002) have investigated the physical domain of environmental factors, mainly focusing on natural environment and human made changes to environment. Other ICF domains such as social and attitudinal environmental factors (WHO, 2001) have not been investigated with respect to community walking in stroke survivors.

Personal factors

The ICF acknowledges personal factors as part of contextual factors; however, ICF does not classify personal factors, owing to the large cultural and social variance (WHO, 2001). Personal factors include, but are not limited to, age, gender, balance self-efficacy, interest levels, and depression (Rimmer, 2006; WHO, 2001). The following section describes personal factors relevant to stroke survivors' community walking.

Balance self-efficacy

Recent studies have identified balance self-efficacy as the only significant personal factor that can predict the potential of stroke survivors to walk in the community (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011). Robinson, Shumway-Cook, Ciol, et al. (2011) found a significant association between balance self-efficacy and the number of community trips taken by stroke survivors. An association has also been reported between high balance self-efficacy and perceived satisfaction with community walking (Robinson, Shumway-Cook, Ciol, et al., 2011). Rosa, Marques, Demain, and Metcalf (2015) reported balance self-efficacy as predictive of independent community walking and discriminating between dependent and independent community walkers. Based on a series of studies exploring the role of physical, environmental and personal factors (Robinson et al., 2013; Robinson, Shumway-Cook, Ciol, et al., 2011; Robinson, Shumway-Cook, Matsuda, et al., 2011), balance self-efficacy has been suggested to be a stronger determinant of community walking ability than physical impairments (gait speed, range of motion and muscle strength) and environmental factors (ambience, terrain, physical load). This is further supported by a recent study (Durcan et al., 2016) reporting that balance self-efficacy has a strong predictive ability for community walking in stroke survivors. In this study, multivariate logistic regression was performed including factors of gait speed, balance and balance self-efficacy; finding balance self-efficacy to be the only variable predictive of community walking (Durcan et al., 2016).

Other personal factors

Some of the other personal factors relevant for community walking are age, post-stroke duration and depression. Age and post-stroke duration have been associated with capacity for community walking in stroke survivors (Bijleveld-Uitman et al., 2013; Durcan et al., 2016; Robinson, Shumway-Cook, Matsuda, et al., 2011). Increasing age was associated with

reduction in community walking; however, being older did not predict community walking ability (Durcan et al., 2016; Robinson, Shumway-Cook, Matsuda, et al., 2011). The mean age of stroke survivors in these studies was 65-66 years (Durcan et al., 2016; Robinson, Shumway-Cook, Matsuda, et al., 2011). Bijleveld-Uitman et al. (2013) reported that post- stroke duration acts as a confounding variable for association between gait speed and community walking; however, post-stroke duration was not predictive of community walking.

Goodwin and Devanand (2008) reported that depression is associated with limitations in walking ability. In fact, the interaction between depression and stroke was found to be a stronger predictor of walking limitations and poor physical functioning than either factor alone (Goodwin & Devanand, 2008). Interestingly, this association was found for limitations to walking short distances of several blocks. Limitations to walking longer distances were included in the model, but were not significantly associated with depression (Goodwin & Devanand, 2008). Depression has been associated with community walking; however, it has not been identified as an independent predictor (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011).

In all, personal factors appear important in relation to community walking. Balance self-efficacy has been identified as predictive of community walking (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011) and probably more important than physical or environmental factors in understanding community walking in stroke survivors (Robinson, Shumway-Cook, Ciol, et al., 2011).

Thus, it can be concluded that community walking is a multifactorial concept with varying influence of physical, environmental and personal factors. Most of the research has

investigated the role of physical factors, and a limited body of research is available on the impact of environmental and personal factors on community walking in stroke survivors. All these factors help explain the complexity of community walking in stroke survivors. The contribution of these factors to community walking has provided the basis to measure community walking, which is discussed in the section below.

2.3 Measurement tools relevant to community walking

Measurement of community walking may be challenging because of the influence of the physical, environmental and personal factors that were described in the previous section. Community walking in stroke survivors has been evaluated using different methods including device-based measures such as pedometers, step activity monitors and global positioning system devices. Patient-reported measures, and components of structured scales have been used to measure community walking. Community walking has also been assessed in terms of physical factors that are acknowledged to contribute to community walking, such as gait speed and distance walked. The following section will review measures relevant to community walking in stoke survivors.

2.3.1 Device-based measures

Recent advances in technology such as pedometers, accelerometers, and global positioning system devices, have made it possible to quantify the number of steps, trips and destinations visited by stroke survivors. Typical measures of community walking provided by these devices include number of steps as well as number and destination of trips outside home to different locations.

Pedometers

Pedometers are simple, low cost devices used to measure the number of steps taken and walking distance in older adults and have been used in community settings for stroke survivors (Fini, Holland, Keating, Simek, & Bernhardt, 2015). Pedometers provide an accurate estimate of distance walked in older adults (Bassett Jr et al., 1996).

In stroke survivors, pedometers have been found to be feasible for use; however, it is reported that pedometers undercount steps at gait speeds above 0.5 m/s and walking activities of short duration (Carroll et al., 2012; Vanroy et al., 2014).

Accelerometers

Accelerometers are portable devices that can detect body motion (L. Green, 2014), providing minute by minute recording of number of steps taken. Step activity monitors are one type of accelerometer. Accelerometers are the most commonly used devices to measure physical activity following stroke (Fini et al., 2015). Step activity monitors are accurate measures of walking in older adults (Cavanaugh, Coleman, Gaines, Laing, & Morey, 2007; Haeuber, Shaughnessy, Forrester, Coleman, & Macko, 2004) and in stroke survivors (Macko et al., 2002; Michael et al., 2005). Step activity monitors provide more accurate and reliable information than pedometers for the evaluation of community walking in stroke survivors (Macko et al., 2002).

Global positioning systems devices

Global positioning system devices are portable instruments that track navigation to locations visited. This information is useful when combined with accelerometers for measuring

community walking in stroke survivors, in terms of destinations walked to and number of steps (Evans, Hanke, Zielke, Keller, & Ruroede, 2012; McCluskey, Ada, Dean, & Vargas, 2012). Global positioning system devices have been found to be valid and reliable for the number of steps taken by stroke survivors; however, these tools have not been found consistently valid and reliable for measuring the distance walked (Mahendran, Kuys, Downie, Ng, & Brauer, 2016), at least in locations around buildings.

2.3.2 Patient-reported measures

Two patient-reported measures relevant to stroke survivor's community walking include the Walking Ability Questionnaire (Perry et al., 1995) and community ambulation self-report questionnaire (Lord et al., 2004). These two measures will be described in detail.

Perry et al. (1995) developed a 19-item Walking Ability Questionnaire (WAQ), where stroke survivors' self-report their mobility in a range of activities within the home and community. Eleven of these items relate to walking in the community, and include visiting church, grocery store, and friends (Table 2.1). Walking ability for each item is rated based on the assistance required and is graded on a 5-point scale. The highest score of 4 is awarded for independent walking. Wheelchair use in each item is also recorded.

Table 2.1 Community items of the Walking Ability Questionnaire

	Wheelchair (0)	**Unable (1)**	**Assistance (2)**	**Standby (3)**	**Independent (4)**
Appointments (Doctor, dentist)					
Church					
Grocery store					
Neighbourhood					
Shopping centre: Uncrowded Unlimited times/areas					
Recreation: Visiting friend Restaurant Vacations/trips Other Unlimited					

Source: Perry et al. (1995)

Items on the WAQ appear to differentiate community walking ability in stroke survivors. Perry et al. (1995) developed a classification system comprising six levels, three relating to home and three relating to community walking. Physiotherapists subsequently categorised the stroke survivors' self-reported responses to the WAQ across these six functional walking categories. The criteria underpinning the classification were developed by a team of expert clinicians including physiotherapists, based on their experience. Table 2.2 illustrates the relationship between WAQ items and the three functional walking categories related to community walking as developed by Perry et al. (1995). It is important to note that entering and exiting the home and managing curbs were regarded as home walking (Perry et al., 1995) but have appeared in the descriptor of most-limited community walker.

Table 2.2 Community functional walking categories

Functional walking category	Walking activity questionnaire items
Most-limited community walker	Independent (without supervision) in either entering/exiting the home or managing curbs.
	Can manage both entering/exiting the home and curbs without assistance.
	Requires some assistance in both local store and uncrowded shopping centres.
Least-limited community walker	Can perform all moderate community activities without use of wheelchair.
	Needs at least some assistance with a crowded shopping centre.
	Can perform without assistance (but may need supervision) in local stores or uncrowded shopping centres.
Community walker	Independent in all home and moderate community activities.
	Can accept uneven terrain.
	Can negotiate a crowded shopping centre with supervision only.

Source: Perry et al. (1995)

The classification, though based on self-report, has some limitations with regards to understanding successful community walking. The authors did not propose a definition of community walking prior to the development of their classification system. Rather, stroke survivors' level of independence of walking in undertaking various community-based tasks was used to inform the classification. The descriptors of the most-limited and least-limited community walkers refer to performing moderate community activities, which are described as visiting restaurants and attending appointments (Perry et al., 1995). However, it is unclear how moderate activities were classified. Additionally, even for the most successful community walking classification, the community walker, stroke survivors in this category can still require supervision to negotiate a crowded shopping centre.

Lord et al. (2004) developed a 6-item questionnaire focusing on the importance given by stroke survivors to getting out of the home, the choice of places visited before their stroke, physical assistance and equipment required to get out of the home (Table 2.3). This questionnaire was developed as one of the measures in a study with the aim of understanding the importance of community walking to stroke survivors and to inform a definition of community walking.

Based on the response to the second question in this tool related to the choice of places visited before their stroke, stroke survivors were classified into four levels of community walking (Lord et al., 2004):

- not being able to walk outside the home;
- walk outside to the letterbox;
- walking in the immediate environment; and
- walking in a shopping centre and/or area of special interest.

Table 2.3 Lord's community ambulation self-report questionnaire

1. How important is it for you to be able to get out of the home? Not important - Mildly important - Important -Very important - Essential
2. Which places outside the home did you like to get to before your stroke? (Please list a maximum of 3 types of places, in order of preference.)
3. Are you able to get out and about, by yourself, without physical assistance or supervision from anyone? Outdoors (eg, as far as the letterbox) but no farther- (go to question 5.) Yes - (Give up to 3 examples.) No - (Go to question 5.)
4. Do you require special equipment to achieve this? (If yes, please state type of equipment, for example, wheelchair, scooter, and type of walking aid.) Yes/ No
5. Does the assistance you require to get out and about cause any problems to you or your carers? (If yes, please identify.) Yes/ No
6. Do you have any other comments you would like to make regarding getting out of the home?

Source: Lord et al. (2004)

Lord's community ambulation self-report questionnaire has been used in recent years to classify stroke survivors according to the level of community walking (Bijleveld-Uitman et al., 2013; Durcan et al., 2016; van de Port et al., 2008).

2.3.3 Structured scales

Several structured scales and/or classification scales include items relevant to measuring community walking. A selection of these will be presented.

Functional Ambulation Categories

The Functional Ambulation Categories (FAC) grade the walking ability of an individual according to six categories, scored 0 to 5, based on the assistance required (Holden, Gill, Magliozzi, Nathan, & Piehl-Baker, 1984). The highest score of 5 indicates an independent ambulator with a score of 0 indicating a non-functional ambulator. Functional ambulation categories are a commonly used tool to classify walking in stroke survivors (Hollands et al., 2013; Maguire et al., 2012; Masiero, Avesani, Armani, Verena, & Ermani, 2007).

Though the FAC were not originally designed to measure community walking, Mehrholz, Wagner, Rutte, Meißner, and Pohl (2007) found a score of 4 or more was able to predict community walking ability at six months following rehabilitation with 100% sensitivity and 78% specificity in a group of stroke survivors admitted for rehabilitation. However, community walking in this study was defined and measured according to predetermined criteria, using gait speed of 1.2 m/s, distance walked of 332 meters and ability to negotiate stairs (Mehrholz et al., 2007). Thus, these results might be limited in generalisation and applicability to all stroke survivors.

Functional Independence Measure

The Functional Independence Measure is a measure to assess activities of daily living, based on the assistance required (Keith, Granger, Hamilton, & Sherwin, 1987). This measure consists of 18 items, which are grouped in two domains, namely motor tasks and cognitive tasks. All items are graded on a seven-point scale; the highest level is complete independence without any need for assistance or supervision and the lowest level is complete dependence (Keith et al., 1987). The Functional Independence Measure has demonstrated excellent internal consistency (α coefficient ≥ 0.84) for use with stroke survivors (Hsueh, Lin, Jeng, & Hsieh, 2002) and excellent test-retest reliability ($r = 0.83$) (Ottenbacher, Hsu, Granger, & Fiedler, 1996).

Walking is assessed in two items as part of the motor domain. Item 12, Locomotion, includes walking and manual wheelchair use. Item 12 assesses the distance walked or wheeled up to 50 m and assistance required (use of walking aid and physical assistance). Item 13, Stairs, assesses the ability of a person to negotiate a flight of 12 stairs. Hill et al. (1997) used a score of 5 for Locomotion item (Item 12) on Functional Independence Measure as one of the four criteria to classify community walking in stroke survivors.

Rivermead Mobility Index

The Rivermead Mobility Index assesses mobility with a 15-item tool consisting of 14 questions regarding mobility and direct observation of one additional component, which is standing (Collen, Wade, Robb, & Bradshaw, 1991). The Rivermead Mobility Index has a maximum score of 15 (Collen et al., 1991). Components of mobility examined include bed mobility, sitting balance, sit to stand, standing balance and transfers (Forlander & Bohannon, 1999).

Eight items are related to walking and include walking 10 meters with or without an assistive device, managing a flight of stairs with and without a rail, walking outside and running. Walking outside is included in two items; the first consists of walking outside alone on pavements and the second walking on uneven ground such as grass, gravel, dirt, snow or ice (Forlander & Bohannon, 1999). The Rivermead Mobility Index has been used as a mobility outcome in a study measuring community walking in stroke survivors (Lord et al., 2004). Scores were found to discriminate between stroke survivors able to walk in the community from those able to walk only inside the home (Lord et al., 2004). Median scores of 12-14 were reported for stroke survivors able to walk in the community (Lord et al., 2004).

Dynamic Gait Index and Functional Gait Assessment

The Dynamic Gait Index assesses the ability of individuals to adapt their gait to changing demands and consists of eight items including a change in gait speed, performing head turns while walking, pivot turns, negotiating obstacles and stairs (Shumway-Cook, Taylor, Matsuda, Studer, & Whetten, 2013). Items are scored on a three-point scale with a probable highest score of 24 suggesting better mobility. A cut-off score of 18 has been identified for fall risk for community dwelling older adults (Shumway-Cook, Baldwin, Polissar, & Gruber, 1997). A ceiling effect with Dynamic Gait Index has been reported for higher functioning older adults and stroke survivors (Herman, Inbar-Borovsky, Brozgol, Giladi, & Hausdorff, 2009; Lin, Hsu, Hsu, Wu, & Hsieh, 2010; Wrisley, Walker, Echternach, & Strasnick, 2003). For this reason, the Functional Gait Assessment was developed as an extension of the Dynamic Gait Index (Wrisley et al., 2003).

The Functional Gait Assessment comprises ten items, seven of which are the same as the Dynamic Gait Index (Wrisley et al., 2003). Item 7 of the Dynamic Gait Index, negotiating around cones while staying within the walkway, was removed and three items were added to make the Functional Gait Assessment. The additional items, heel-toe walking, walking backwards and walking forward with eyes closed, were added to ensure sufficient challenge for higher functioning older adults (Wrisley, Marchetti, Kuharsky, & Whitney, 2004). Each item is rated (0-3) with higher scores representing better functioning and a maximum score of 30 achieved. A cut-off score of 22 was shown to be predictive of fallers in a 6-month follow-up study of older adults (Wrisley & Kumar, 2010). Both these tools are valid and reliable measures of dynamic balance in stroke survivors (Jonsdottir & Cattaneo, 2007). Items reflect tasks that may be undertaken in the community but do not seem to measure actual walking taking place in the community.

Environmental Analysis of Mobility Questionnaire

The Environmental Analysis of Mobility Questionnaire (EAMQ) is a 21-item self-reported measure to evaluate mobility disability on eight environmental dimensions of community mobility (Shumway-Cook et al., 2005). This measure reports frequency of encounter and avoidance of 24 environmental features and has been shown to be valid and reliable in older adults (Shumway-Cook et al., 2005).

Although the EAMQ was originally developed for use with older adults, it has also been used to explore self-perceived environmental barriers for community walking in stroke survivors (Robinson et al., 2013). Stroke survivors, more than three months following stroke, reported on the frequency of encounter and avoidance of environmental challenges during community

walking. For example, stroke survivors were asked, “When you go on a trip away from your home, how often do you encounter/avoid the need to walk across a busy street?”(Robinson et al., 2013). Stroke survivors mostly avoided walking long distances (more than ¼ mile) and ambient conditions of darkness, rain, snow and ice. Avoidance of these environmental features was associated with reduced number of reported trips in the community (Robinson et al., 2013).

2.3.4 Pre-determined criteria for community walking

Several studies have utilised pre-determined criteria for community walking. Lerner- Frankiel et al. (1986) investigated gait speed (1.20 m/s), walking distance (332 meters) and ability to negotiate curbs to be able to walk in the community in Los Angeles. Hill et al. (1997) used four criteria; independence in gait (measured on Functional Independence Measure, Locomotion item score of 5), ability to negotiate uneven terrain measured on FAC score of 6, gait speed of 0.80 m/s and distance walked of more than 500 meters.

Robinett and Vondran (1988) proposed criteria for independent community walking in rural, small towns and urban locations. Ranges for criteria including gait speed, distance walked and negotiating curbs were developed for each setting (rural, small town and urban locations). Gait speed, for example, ranged from 0.50 m/s in a rural setting to 1.30 m/s in an urban setting for safely crossing a street (Robinett & Vondran, 1988). Cohen, Sveen, Walker, and Brummel-Smith (1987) identified a walking distance of 360 meters as the requirement for community walking in older adults, whereas a more recent update recommended a walking distance of 600 meters, as a requisite for successful community walking (Andrews et al., 2010).

A recent systematic review investigated the reported gait speed and walking distances required for older adults to walk in the community (Salbach et al., 2014) with a wide range of both speed and distance required identified in literature. Average gait speed of 0.74 m/s to cross the street in rural areas and 1.06 m/s for cities was reported. Average walking distance was reported as ranging from 129-380 meters for supermarkets and department stores and within the range of 38-98 meters for banks and post offices (Salbach et al., 2014).

2.4 Measurement in neurological physiotherapy practice

Measuring community walking in stroke survivors is important and should be considered an essential component of physiotherapy practice. In fact, use of outcome measures across the continuum of rehabilitation is considered to be good clinical practice (Haigh et al., 2001). The following section will outline the importance of measurement in neurological physiotherapy practice, a process to guide selection of a measurement tool for neurological physiotherapy practice based on the ICF framework and application of this process to the measurement of community walking in stroke survivors.

Good clinical practice is derived from efficient decision making, based on the best clinical evidence available (McGinnis, Hack, Nixon-Cave, & Michlovitz, 2009). The Institute of Medicine is the American national academy of scientists that provides evidence-based research for public health and science policy (Institute of Medicine, 2013). The Institute of Medicine recommends collecting measurement data in clinical practice in order to understand patients' perspectives, facilitate delivery of care, and implement optimal clinical decisions (Institute of Medicine, 2013). Measurement data are also acknowledged as being important to promote community-clinical partnerships, informing public health policies and improving health at the community level (Institute of Medicine, 2013).

2.4.1 Importance of measurement in neurological physiotherapy practice

In the initial stages of patient care, measurement may augment clinical decision making by helping physiotherapists develop the plan of care and goal-setting (Jette, Halbert, Iverson, Miceli, & Shah, 2009; Potter, Fulk, Salem, & Sullivan, 2011). In acute care settings, measurement tools are important to identify patients who may be at risk for poor outcomes (Lansky, Butler, & Waller, 1992) and in facilitating a smooth transition from acute care to another setting (Johnston, Graves, & Greene, 2007). In the post-acute and rehabilitation setting, measurement is important to monitor progress and for planning the rehabilitation program (J. Moore et al., 2018; Potter et al., 2011).

A key outcome of rehabilitation of stroke survivors is the recovery of walking. Stroke survivors have identified community walking as an important goal to achieve (Lord et al., 2004). Therefore, it is reasonable to suggest that measuring community walking would be important to monitor patient-specific goal attainment related to community walking. From a

rehabilitation perspective, measurement of community walking can be used to inform the design of a rehabilitation program to address patient goals. Additionally, measurement of community walking is required to monitor progress and evaluate the efficacy of rehabilitation. Adopting a patient-centered approach to health-care, which includes acknowledging not only clinical goals but also the patients' goals, has been recommended (Bokhour et al., 2009; Institute of Medicine, 2013). Such an approach to patient care is expected to be responsive to patient's needs and preferences (Institute of Medicine, 2013).

2.4.2 Process for selection of a measurement tool for neurological physiotherapy practice

Potter et al. (2011) and Sullivan, Andrews, Lanzino, Perron, and Potter (2011) outlined a process for choosing a measure for neurological physiotherapy practice, based on the ICF framework. The five-step process uses deductive reasoning to inform physiotherapists' examination and selection of a measure and is illustrated in Figure 2.5. The first step in the process identifies what to measure based on initial review of medical records and understanding the health condition (Potter et al., 2011). Based on this preliminary information collected, physiotherapists can anticipate a broad list of probable measures that capture relevant ICF components applicable to the health condition. Further steps in the process serve to customise this list of measures to suit patient-specific circumstances. The second step comprises taking into consideration the feasibility of these measures with respect to the clinical setting and available resources. The third step involves observing performance of the patient, based on which physiotherapists can confirm if the anticipated list of measures is suitable. The list of measures may be narrowed down at this stage based on the ceiling and floor effects of the measures. After this step, patients' goals and priority areas of concerns are identified.

Understanding the context in which the patient wants to function further guides refinement of the list of probable measures. The last step involves a thorough examination of the patient that involves multi-system assessments and directs the final selection of a measure.

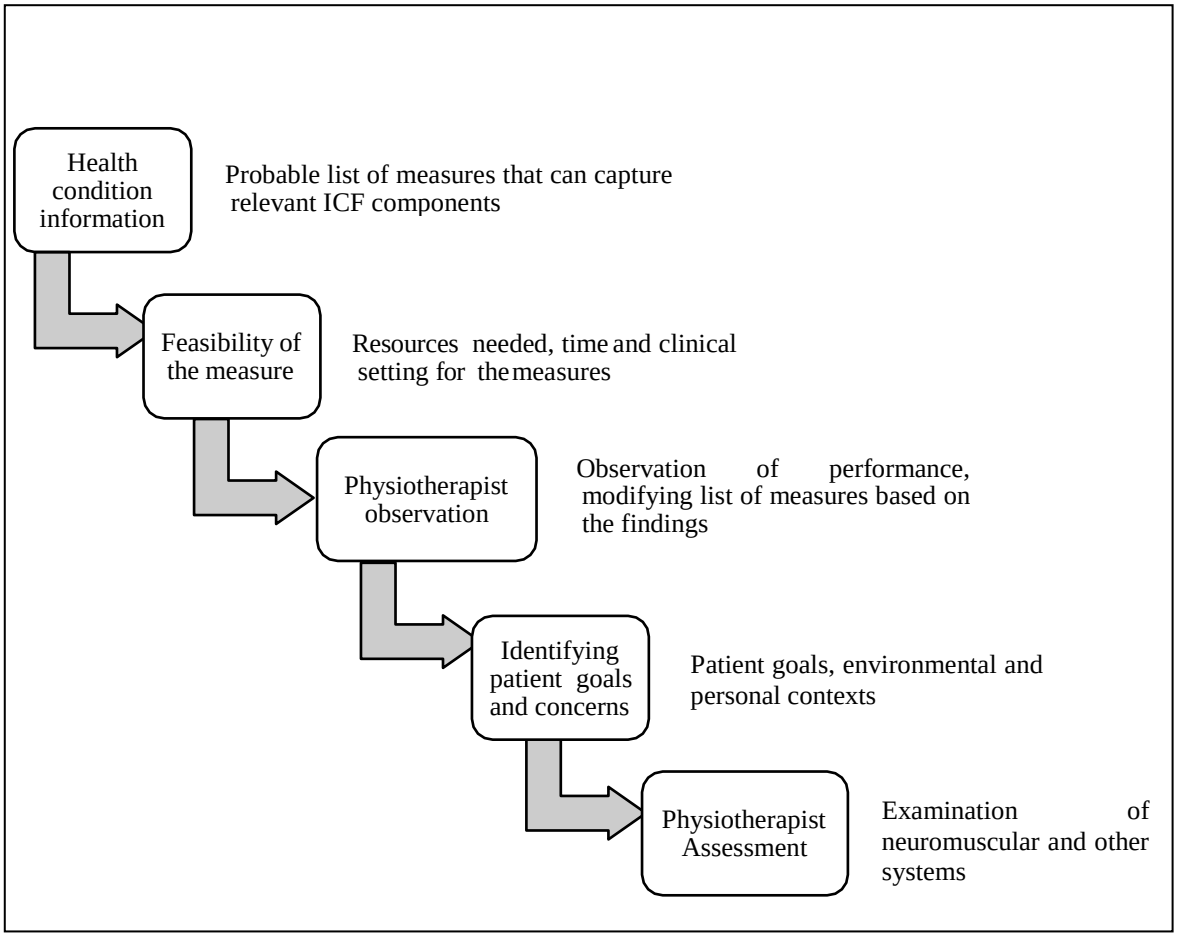

Figure 2.5 Process for selection of a measure
Source: Potter et al. (2011)

Throughout the process of selecting a measure, factors that should be considered include the type (patient-reported or performance based) and purpose of the measure (discriminative or predictive), as well as feasibility of use and psychometric properties of the measure (Potter et al., 2011). Feasibility of a measure takes into account time and space needed for administration, equipment and costs associated with the measure (Potter et al., 2011). Psychometric properties of measures are considered central to the process of selecting a measure (Potter et al., 2011; Sullivan et al., 2011). Before finalising the selection of a measure, reviewing the psychometric

properties is recommended to confirm if the selected measure can capture the identified components (validity), can be implemented with minimal error (reliability) and able to detect change in the outcome (responsiveness and minimal clinically important difference) (Potter et al., 2011; Sullivan et al., 2011).

2.4.3 Applying the selection process to choose a measure of community walking

The process outlined by Potter et al. (2011) for selecting a measure is recommended for use in neurological physiotherapy within a range of clinical settings and physiotherapy education (Potter et al., 2011; Sullivan et al., 2011). Using measurement tools supported by research evidence has been recommended for physiotherapists (American Physical Therapy Association, 2001; Rothstein et al., 1991). In fact, evidence-based practice for physiotherapists comprises the use of reliable and valid tests of measurements (Rothstein et al., 1991). However, there is conflicting evidence regarding the measurement of community walking in stroke survivors, with a range of factors recommended to be important for measurement. It is not yet clear how physiotherapists measure stroke survivors' community walking or what guides their clinical reasoning regarding selecting an appropriate measurement tool of community walking. Therefore, understanding physiotherapists' perspectives regarding their choice of measurement tool for community walking requires investigation.

Physiotherapists' views regarding community walking and measuring community walking in stroke survivors have received some consideration in the literature. Corrigan and McBurney (2012) interviewed physiotherapists to understand their perception of the requisites for community walking in stroke survivors. Physiotherapists identified various requirements such as ability to negotiate different terrains, varying walking speeds for regional and rural

communities, attentional demands, external assistance and motivation to walk in the community (Corrigan & McBurney, 2012). These views highlight the significance of environmental factors related to community mobility, however any influence of these factors on physiotherapists' selection and use of community walking measures has not yet been explored.

Another issue that could be challenging for physiotherapists when selecting a measure, is a lack of understanding of the content of the available measures. Knowledge of the content of the measures is important, given the multifactorial nature of community walking. It may not be clear if the content covered in the measures is relevant for community walking in terms of what is being measured or captured. The first step in applying the selection process outlined by Potter et al. (2011) to the measurement of community walking is to identify what to measure. Based on the patient information collected, the probable list of measures is expected to capture relevant ICF components (Potter et al., 2011). The multifactorial nature of community walking may make identifying and choosing the relevant ICF components to measure challenging. Choosing one ICF component over another at this stage may not seem reasonable and multiple components may need to be measured. For example, both activity-level measures and environmental-level measures are applicable for community walking, so would be measures at the physical impairment level. A key concern, however, in formulating a list of measures seems to be the limited information available regarding the ICF components captured by the current measures of community walking.

The ICF components covered by some health-related measures such as the Stroke Impact Scale and Stroke-Specific Quality of Life Scale have been explored (Geyh et al., 2007; Geyh et al., 2004), however the applicability of these measures for stroke survivors' community walking

is not clear. Knowledge about the ICF components reflected in the measures is the first and an important step in the process of selecting a measure (Potter et al., 2011). Knowing the content of measures based on the ICF would allow for comparison between a range of measures, thus facilitating choosing a measure to best suit the purpose (Cieza et al., 2016). Knowledge of ICF components being evaluated by a measurement tool is a pre- requisite for selection and would be important for physiotherapists to make a well-informed choice of measure. Understanding the ICF components of a community walking measurement tool may also assist in guiding rehabilitation of community walking based on the identified components.

2.5 Summary

The background presented above has highlighted a knowledge gap pertaining to the measurement of community walking in stroke survivors. Community walking is a complex multifactorial task, with a range of definitions identified in the literature. Community walking is an important functional goal for stroke survivors to achieve. Therefore, it is important that community walking for stroke survivors is measured. However, this may be challenging as there is conflicting evidence regarding measurement, in terms of which tool is better or preferable based on the contributing factor/s.

For physiotherapists who are required to choose a measure, this conflicting evidence may add to the challenges of measuring community walking. Furthermore, physiotherapists' perspective of measuring community walking has not been well-explored in the scientific literature and it is not clear how physiotherapists regard successful community walking and how this is measured. Exploring physiotherapists' perspectives may provide an insight into

how successful community walking is perceived and how the complexity of community walking is measured.

There seems to be a range of ways in which community walking can be measured and a range of contributing factors to measure, which further adds to the challenges of measuring community walking. A systematic review is needed to identify current measurement tools utilised for stroke survivors' community walking. In addition, factors contributing to community walking that are captured by the available measures are not yet well understood. Exploring the content of the measures is required to gain clarity about factors that are captured by the current measures. The ICF offers a systematic framework to analyse the content of the measures and identify which contributing factors relevant to community walking are covered by the measures. Knowledge of the content covered by measures may provide physiotherapists with relevant information when choosing a measurement tool for community walking.

This thesis, comprising two studies, explores the knowledge gaps outlined above. The focus of this thesis is on understanding physiotherapists' perspectives and analysing measures of community walking with regard to the content, using the ICF framework. Although it is acknowledged that understanding the psychometric properties of a measure is a key step in the selection of a measure, exploring the psychometric properties of the community walking measures is beyond the scope of this thesis.

3 Methodology and Design

This chapter describes the methodology for the two studies that make up this thesis. Study 1 comprised a qualitative study to explore physiotherapists' perspectives regarding measurement of stroke survivors' community walking. Study 2 consisted of a systematic review to identify measurement tools used to evaluate community walking in stroke survivors and analyse the content of these measures within the ICF framework. This chapter will outline design, methodology and data analyses for both studies. This chapter will also outline the ethical considerations for Study 1.

3.1. Study 1

Study 1 was designed to gain an understanding of physiotherapists' perspectives regarding successful community walking in stroke survivors, how physiotherapists measure community walking and how they perceive community walking in stroke survivors should be measured. The following section will outline methods and procedures in detail for this study.

3.1.1. Qualitative approach

Qualitative research involves studying a phenomenon in a natural setting, that examines people's experiences and behaviours and attempts to comprehend it, in terms of subjective meaning (Denzin, 2017; Griffiths, 2005). Methods in qualitative research generally involve systematic collection of data including observations and interviews, surveys, case studies and document analysis (Denzin, 2017; J. Green, Thorogood, & Holmberg, 2009). Qualitative research facilitates a deep understanding of a concept or phenomenon by exploring

individuals' perspectives about their experiences (Denzin, 2017; J. Green et al., 2009; Griffiths, 2005).

The contribution of qualitative research to evidence-based physiotherapy practice has been acknowledged (Gibson & Martin, 2003; McPherson & Kayes, 2012). In the field of physiotherapy, qualitative research has played an important role in understanding the impact of disability on quality of life and design of measurement tools (Power & Green, 2010). Community mobility in stroke survivors has been explored recently using qualitative methods (Nanninga et al., 2017; Nanninga et al., 2015). Study 1 adopts a qualitative approach to explore physiotherapists' perspectives of community walking in stroke survivors.

3.1.2. Study design

A qualitative study was designed to explore perspectives of physiotherapists regarding measurement of community walking in stroke survivors. Focus group discussions were conducted using a semi-structured interview guide.

Research questions

This qualitative study was designed to explore the following research questions:

1. How do physiotherapists describe successful community walking in stroke survivors?
2. How do physiotherapists measure community walking in stroke survivors?
3. How do physiotherapists perceive community walking in stroke survivors should be measured?

Eligibility criteria

Physiotherapists practicing in the area of neuro-physiotherapy and having clinical experience in working with stroke survivors, across all work settings, were eligible to be included. Physiotherapists of all years of experience were recruited. To be eligible to participate in this study, physiotherapists met the following inclusion and exclusion criteria.

Inclusion criteria:

- Registered physiotherapists working with stroke survivors

Exclusion criteria:

- Physiotherapy students
- Physiotherapy or allied health assistants

Focus group discussion

Focus group discussion is a technique used in qualitative research to collect data, whereby a group of people are interviewed (Liamputtong, 2013). The focus group discussion is facilitated by a researcher, also known as a moderator (Liamputtong, 2013). Focus group discussions in this study were conducted using a semi-structured interview guide. This approach was selected as focus group discussions facilitate interaction among participants (Acocella, 2012) and are useful to obtain rich information and perspectives of participants on a topic (Morgan, 1996). A strength of focus group discussions is that the expertise of the group is utilised, facilitating more diverse information (WHO, 2004) in comparison to individual interviews. For the current

study, a homogenous group was desirable as participants would likely share similar experiences regarding the topic being discussed (Patton, 2015; Wholey, 2010). The postgraduate cohort approached to participate in this study represented physiotherapists experienced in neurological rehabilitation and knowledgeable about measurement of community walking in stroke survivor.

Focus group discussion was selected as the best method to meet the aims of this study, which was to explore perspectives of physiotherapists on measurement of community walking. Given the varied and conflicting literature on measures of community walking and lack of gold-standard measure, a methodology that would exchange viewpoints and facilitate discussion was desired. Focus groups offer an efficient way of gathering views of many participants at one time (Denzin, 2017) and may enhance understanding of the topic as a result of the group dynamics or as a consequence of the discussion (Liamputtong, 2013). Other possible methods considered included surveys and individual interviews. Surveys do not provide the opportunity for conversation between the researcher and participants, and would likely not have provided the depth of understanding gained from a focus group (Denzin, 2017; Liamputtong, 2013). Focus groups may provide a more supportive environment in comparison to a one on one interview and thereofer participants may feel more relaxed expressing opinions when they are shared by others. Focus groups also allow participants to discuss contradicting ideas and opinions, which may result in different perspectives emerging from the discussion, which is not possible in a one on one interview (Denzin, 2017). Thus, focus groups may allow collection of rich information compared to surveys and individual interviews and were used in this study.

It is recommended that focus groups include six to ten participants; however, having three to fourteen participants has also been reported to be successful (Morgan, 1996). Participant

numbers may depend on the aims of the research and feasibility of participant recruitment. The number of focus groups conducted in a study are generally recommended to be between three to five; however, this depends on the point of saturation, which means the point at which additional data collection no longer generates new understanding (Corbin & Strauss, 2008).

Semi-structured interviews

Semi-structured interviews utilise a mix of closed and open-ended questions, often followed up with why or how questions (Wholey, 2010). Semi-structured interviews follow a more conversational and informal style (WHO, 2004), which facilitates exploring participants' perspectives easily and in-depth. In structured interviews, there are no follow-up questions rendering participants unable to expand on their answers, thus restricting the amount of information obtained (Corbin & Strauss, 2008; Denzin, 2017). Semi-structured interviews were used in the current study, as these provide in-depth information, where the researcher can probe to identify the perspectives of participants and gather a substantial body of information (WHO, 2004). One hour is deemed reasonably sufficient to conduct a semi- structured interview (Wholey, 2010).

An interview guide informs semi-structured interviews. The guide is a list of topics and questions that will be discussed in the interview. The sequence of questions is flexible (Morgan, 1996) and can be delivered depending on the flow of discussion. The interview guide for this study was developed in advance and covered questions regarding physiotherapists' perspectives of success of community walking in stroke survivors and measurement of community walking.

Interview guide

The interview guide was derived from the aims of the study and consisted of four open ended questions listed below:

1. What does community walking for stroke survivors mean to you?
2. What indicates successful community walking for stroke survivors?
3. How do you measure community walking?
4. How do you perceive community walking should be measured?

Questions were reviewed within the research team, relevant probes were identified and discussed and included in the interview guide. The interview guide was pilot tested prior to commencement of the study, with a group of final year physiotherapy students. Pilot testing prior to data collection is recommended (Gerrish & Lacey, 2006), preferably not in the population that will be targeted to recruit focus group participants (WHO, 2004). This is helpful for the researcher to ascertain if the interview guide is comprehensible and able to answer the proposed research questions (Gill, Stewart, Treasure, & Chadwick, 2008). The physiotherapy students were able to understand the questions, responded to prompts and raised several topics not anticipated. Amendments were made to the interview guide following pilot testing. Figure 3.1 presents the interview guide used for the current qualitative study.

Date:

Interview code number:

Preamble:

Welcome: Good morning/afternoon and welcome to this discussion. Thanks for giving your time and for volunteering to participate. I am pursuing research degree at ACU, Brisbane.

Purpose: Attainment of walking after stroke is important for physios as well as stroke survivors. We are specifically interested in understanding stroke survivors' walking in the community. The reason to have this discussion is that we want to understand physiotherapists' views about stroke survivors' community walking. So, today I will ask a few questions about community walking.

Instructions: Do you have any questions before we begin? (If the participant has questions, they will be answered by the researcher. After questions have been answered, the interview will begin). Please feel free to share your point of view. I am switching on the audio recording, so as to ensure the accuracy of the content.

Research Questions:

1. What does community walking in stroke survivors mean to you?

2. How would you describe/ indicate successful community walking in stroke survivors?

3. How do you measure community walking?

4. How community walking should be measured?

Probes: Based on the participant's response to the question (e.g., Could you say some more about that? /Would you please elaborate on that/ What are your views on …..)?

Summarize the interview:

We have completed the discussion now. Do you have any other questions or comments before we wrap up? Provide a summary of the discussion and confirm, if this is an adequate summary. Is there anything you would like to add?

Thank you for your time and for sharing your experiences!

Figure 3.1 Interview guide

3.1.3. Data collection

Sampling

Purposive sampling is a method of sampling used to identify information-rich participants (Patton, 2015), those who are experienced and knowledgeable about the topic being investigated. Homogenous purposive sampling implies a sample having a similar set of characteristics like occupation, age or background (Denzin, 2017). Recruiting a homogenous purposive sample is useful for focus group discussions, as it facilitates conversation and exchange of ideas among the group (Patton, 2015; Wholey, 2010).

A purposive sample of physiotherapists experienced in working with stroke survivors across a range of settings was desired. Additionally, physiotherapists with sound understanding of the importance of outcome measurement was also desired. It was anticipated that participants with these attributes would be informative and potentially provide insight relevant for the research questions of Study 1. Participants were physiotherapists recruited from postgraduate cohorts of Australian Catholic University's School of Physiotherapy. Sample characteristics purposively sought included physiotherapists working with stroke survivors from a range of settings (acute care, rehabilitation, community) and from all year levels (three) of the postgraduate program.

Thematic saturation

In qualitative research, the concept of saturation generally justifies sample size (Bowen, 2008) and is regarded as an indication of quality of research (Guest, Bunce, & Johnson, 2006). Thematic saturation implies a stage in data analysis whereby the same themes are repeated, and no new insights occur from additional data (O'Reilly & Parker, 2013). Thematic saturation

also suggests that the data consists of all crucial information to answer the research questions (Lowe, Norris, Farris, & Babbage, 2018). In the current study, sample size was not determined apriori but rather sampling and focus groups were planned to continue until thematic saturation was achieved.

Procedure

Focus groups were planned to be conducted at a suitable date and time for those who volunteered to participate in the study. Participants were provided with the Participant Information sheet in advance and written Informed Consent was obtained prior to the focus group discussion. Focus groups were conducted by the research candidate who was not known to participants. Three focus groups were conducted using a semi-structured interview guide, which included open-ended questions regarding physiotherapists' perspectives of community walking, and their perception of success and measurement of community walking in stroke survivors, as shown in Figure 3.1. Each focus group consisted of 3-5 participants and lasted approximately one hour. Focus group discussions were audio-recorded and transcribed verbatim after each session Field notes were taken during all focus groups. At the conclusion of each focus group, a verbal summary was provided to participants to ensure clarity and accuracy of content. Data collection ceased when theme saturation was reached, based on the analysis of transcripts (Corbin & Strauss, 2008). Focus groups were conducted between February to April 2017.

Approach to data analysis

Data were analysed using an inductive thematic analysis approach (Braun & Clarke, 2006; Thomas, 2006). Thematic analysis is a method for finding and categorising patterns within data

(Braun & Clarke, 2006). Inductive approach to thematic analysis is based on researchers understanding of raw data (Thomas, 2006) and suggests that themes identified are strongly associated with the data, without trying to fit any pre-planned codes (Patton, 2015). In this approach, themes identified from focus group discussions may resemble posed interview questions; however, themes are not pre-determined by the researcher (Braun & Clarke, 2006; Patton, 2015; Thomas, 2006). Inductive thematic analysis was utilised in this study to obtain rich information from physiotherapists regarding their perspectives about community walking in stroke survivors. This is relevant, as there is scarcity of literature regarding physiotherapists' perspectives on community walking, and an inductive approach to data analysis would allow for direct information to evolve through the coding process, without being influenced by researcher's opinion or pre-determined codes. The six steps of inductive thematic analysis will be discussed below (Braun & Clarke, 2006).

Step 1: Become familiar with the data

The first step of inductive thematic analysis it to become familiar with the depth and breadth of the data. One way of becoming familiarised with the data is through transcribing the interviews verbatim. In Study 1, the research candidate listened to the audio recordings of the focus groups and completed all transcription. Transcription has other benefits for thematic analysis; it facilitates a thorough understanding of the content (Denzin, 2017) and is known to inform the initial steps of thematic analysis (Braun & Clarke, 2006). Prior to the commencement of coding the research candidate read and re-read all transcripts. It is recommended to read the entire dataset prior to coding as ideas and patterns will be acknowledged through this step (Braun & Clarke, 2006). During this step, ideas were marked.

Step 2: Generate initial codes

This second step of inductive thematic analysis involves organising data in a systematic way. After the preliminary list of ideas is noted, initial codes are generated based on these ideas. Codes imply the most basic segment of the data (Braun & Clarke, 2006) that is meaningful to the researcher. Two reviewers (NN, SK) independently coded data manually, by highlighting text and taking notes.

Step 3: Search for themes

In the third step of inductive thematic analysis, different codes identified from the previous step are sorted and collated into potential themes. This involves fitting codes into broader theme/s as well as gaining an understanding of the relationships between codes and overarching themes (Braun & Clarke, 2006).

Step 4: Review themes

The fourth step involves modifying and refining the initial themes identified in the previous step. Data related to each theme are reviewed to confirm if the data really does support the theme. Sub-themes, if any, are identified and reviewed with respect to the data supporting them. A thematic map can be created at this step to aid understanding of the inter- relationship between themes (Braun & Clarke, 2006). The entire data set is reviewed at this stage to identify any missing themes or create new themes. For the current study, two reviewers (NN, SK) discussed and reviewed identified themes.

Step 5: Define and name themes

Step 5 of inductive thematic analysis involves definitive refinement of each theme, which implies understanding the content or essence of each theme in relation to the research

questions. Themes are also reviewed in relation to other themes. Themes are then named to present in the final analysis (Braun & Clarke, 2006).

Step 6: Reporting

The last step involves final analysis and writing the report. Reporting thematic analysis is recommended to include a concise and logical narrative, with evidence of themes within the data. Reporting of important, to the point quotes illustrating a theme, is suggested (Braun & Clarke, 2006).

3.1.4. Triangulation, credibility and reflexivity

Triangulation in qualitative research implies that the phenomenon being studied can be best understood when considered with a combination of research methods (Given, 2008). There are four types of triangulation - triangulation of data collection methods, investigator triangulation, theory triangulation, and triangulation of data sources (Denzin, 2017). Utilising triangulation ensures that a robust and rich account of information is obtained (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014; Denzin, 2017), thereby strengthening the research findings (Given, 2008). One method of triangulation is investigator triangulation, whereby more than one investigator is involved in collection or analysis of data (Denzin, 2017). For the current study, triangulation of data analysis was ensured as two independent reviewers read and re-read transcripts and coded the data.

Credibility in qualitative research implies the extent to which a research process is trustworthy (Mills, Durepos, & Wiebe, 2010; O'Leary, 2007). Several strategies are proposed to ensure credibility (Seale, 2004). Member checking is regarded as an important step in ascertaining the

credibility of research (Mills et al., 2010; Seale, 2004). Member checking involves discussions with other members of the research team or study participants throughout data collection, data analysis, and report writing, and is recommended in order to ensure the accuracy of the data and findings drawn from the data (Mills et al., 2010). For the current study, member checking was utilised throughout. Credibility of data collection was ensured by cross-checking audio-files and transcripts by the other reviewer (SK). Additionally, a verbal summary of the interviews was provided to the focus group participants to ensure the accuracy and credibility of the data. Data analysis involved regular discussion between the reviewers (NN, SK) to assess independently coded data and themes. Similarly, report writing involved member checking within the research team.

One of the recommended strategies to enhance credibility involves documenting the researcher's experiences and perspectives throughout data collection and analysis (Alaszewski, 2006; Bloor & Wood, 2006; Hyers, 2018). Documentation using a research diary is commonly practiced in qualitative research and is used as an adjunct to focus group data (Bloor & Wood, 2006; Hyers, 2018). A research diary is used to document perspectives and activities during the research period (Bloor & Wood, 2006). The research diary is specifically designed for the purpose of the research and focuses on the area of research (Bloor & Wood, 2006; Hyers, 2018). The research diary is utilised to record conceptual or methodological ideas, with the interviews often serving to augment and explain the ideas recorded in the diary and ensuring the ideas or working research hypotheses are documented and retrievable (Bloor & Wood, 2006). For the current study, the research diary was maintained throughout the process by the research candidate. The diary was utilised during focus groups to record notes and participant perspectives. The notes were reviewed during the analysis of transcripts to understand the context of some of the participant perspectives.

Reflexivity in qualitative research implies a researcher's ongoing assessment and critical reflection of her/his own biases and conjectures and how these may have impacted various stages of the research process (Flick, 2014). By being reflexive, researchers self-critique their frame of reference and cultural biases (Flick, 2014). Reflexivity is an important issue in establishing the credibility of findings (Denzin, 2017). One of the methods to document the researcher's reflexive process is keeping a research diary or reflexive journal, which should consist of the researcher's study-related decision-making processes (Flick, 2014). After data collection, these perceptions can be checked for accuracy when compared with the transcribed interviews. This research diary informs the researcher about pre-assumptions and subjectivities, at the same time making the researcher aware of the impact of these influences on the credibility of the research (Flick, 2014). A research diary was utilised in the current study, where details of the study process were documented by the research candidate. The use of diary is recommended to enrich overall study design by providing a documented account of interviewer preconceptions that may have influenced the findings.

3.1.5. Ethical considerations

The ethical considerations of this study are based on the Australian Code for the Responsible Conduct of Research, and the National Statement of Ethical Conduct in Human Research (NHMRC, 2007). Ethical approval for this study was obtained from Australian Catholic University's Human Research Ethics Committee (ACU HREC Ethics Register Number: 2016-276E) (Appendix 1). This approval was obtained as a low-risk study. Specific ethical issues considered in this study are described below.

Informed Consent

Informed Consent is an essential part of ethics in qualitative and quantitative research. The guiding principle for researchers is that an individual voluntarily decides to participate in the research, based on adequate information and understanding of the proposed research (NHMRC, 2007). For qualitative researchers, it is important to stipulate in advance how the data will be collected and how it will be utilised (Hoeyer, Dahlager, & Lynoe, 2005; Sanjari, Bahramnezhad, Fomani, Shoghi, & Cheraghi, 2014). Participants should also know they have the right to withdraw from the study at any stage, without any negative consequences (NHMRC, 2007). For the current study, written Informed Consent was obtained from each participant as part of the recruitment process and prior to the focus group discussion. The Participant Information sheet and consent form provided to the participants outlined that data collection would occur through interviews which would be audio-recorded and transcribed. Additionally, participants were informed they could withdraw from the study at any time without any negative consequences. The consent form advised that data collected for the study would be used in a thesis as part of the requirements for a Master of Philosophy. Participants were also informed that the data collected may be published and if this occurred, individual participants would not be identifiable in any way. Participants were provided with an opportunity to ask questions prior to providing written Informed Consent.

Voluntary participation based on adequate information involves an understanding of the purpose, methods, risks and potential benefits of the research (NHMRC, 2007). The researcher is expected to fully inform participants about aspects of the research in a clear language. This includes the aims and objective of the research, participants' role in the research, and the types of questions which may be asked (NHMRC, 2007). Participants in the current study were

provided with the Participant Information sheet in advance. The information sheet included the aim of the study, which was to explore participants' perspectives of community walking in stroke survivors. Participants were informed that a focus group discussion would be conducted by the research candidate, lasting for approximately one hour, without the need for a follow-up visit. The information sheet advised that participants would be asked about community walking and the measurement of community walking in stroke survivors.

Informing the participants about how the collected data will be used, and risk and benefits of participation, is recommended (NHMRC, 2007). The Participant Information sheet advised that the current study may be published in peer reviewed journals and presented at relevant conferences. Participants were informed that they would be provided with a verbal summary of information obtained from the interview and general results of the research would be made available to them, on request. Participants were also advised that the current study involved no foreseeable risks for their participation and that there was no direct benefit gained from participating; that the information gained from the interviews would help broaden the understanding of measurement of community walking in stroke survivors.

Anonymity and confidentiality

Research participants are entitled to know how their anonymity and confidentiality of information shared in the study would be ensured (NHMRC, 2007). Anonymity involves protecting the identity of the participant and the institution/s they belong to and confidentiality includes protection of the data collected. The participants also have the choice to refuse the use of data-collection instruments such as video cameras and tape recorders (NHMRC, 2007). In the current study, the data collected was de-identified by attribution of a number to each

participant. In the transcribed records and presentation materials where direct quotes were illustrated, the attributed number was utilised. The confidentiality of the information shared in the focus group discussions was assured by removing any identifiable detail and secured storage of the coded data. Data collected included de-identified computer files (transcripts of the interviews) and audio-recordings, which were securely stored on a password-protected drive.

3.2 Study 2

The purpose of this study was to systematically review the existing literature on available measurement tools for evaluating community walking in stroke survivors. The focus of this study was twofold – firstly to identify current measurement tools for evaluating community walking in stroke survivors and secondly to analyse the content of identified measures within the ICF framework.

3.2.1. Research question and study protocol

Research questions designed for this systematic review were as follows:

1. What measures or components of measures evaluate stroke survivors' ability to walk in the community?
2. What content is included in these measures, and how does the content link within the ICF framework?

This review was undertaken in two phases. Phase I of the systematic review involved identifying tools used to measure community walking in stroke survivors. Phase II determined

the content included in the measurement tools used to evaluate community walking in stroke survivors by linking the content of identified measurement tools within the ICF framework.

3.2.2. Phase I

Search strategy

A detailed electronic search strategy was developed in consultation with library staff. Electronic search strategies were developed using a Population, Intervention, Comparison and Outcome (PICO) format and included keywords relevant to measurement of community walking. The term community walking can be used interchangeably with community ambulation as well as community mobility. The term is also used in literature within the context of social participation. These factors were taken into consideration and in consultation with library staff, the search strategy was designed to include relevant synonym terms. Where relevant, Medical Subject Headings (MeSH) and indexed terms were used to provide specific subject headings for the respective databases.

Searches were implemented in the databases of Cumulative Index to Nursing and Allied Health Literature (CINAHL), Excerpta Medica dataBASE (EMBASE), PubMed, Scopus and Web of Science. These databases were selected as containing the most relevant literature. Preliminary searches were also conducted in the databases of PsychInfo and PEDro. However, few relevant papers were retrieved, and these databases were removed from the search strategy. Databases were searched from date of creation to the month of search. Searches were conducted in June 2017. Appendix 2 outlines the search strategy used for each database. Table 3.1 provides an example of the search strategy designed for CINAHL.

Table 3.1 Search strategy for CINAHL

Search	String
S1	(((MH "Stroke+") OR (MH "Stroke Patients")) AND ((MH "Outcome Assessment+") OR (MH "Research Measurement+")) AND ((MH "Walking") AND ((MH "Community Living+"))
S2	(Stroke OR "Cerebrovascular accident" OR CVA OR "brain hemorrhage" OR "brain attack") AND (measure* OR scale* OR instrument* OR assessment) AND ("community walking" OR "community ambulation" OR "social participation")
S3	S1 AND S2

Note: MH: Mesh Heading

Protocol registration

The systematic review protocol, including the final search strategy was registered with international prospective register of systematic reviews (PROSPERO) to ensure that there was no duplication of the research protocol (Appendix 3). PROSPERO is an international database for systematic reviews registry in health-related and other disciplines under National Institute of Health Research (NIHR) and University of York Centre for Reviews and Dissemination (CRD), UK (Centre for Reviews and Dissemination and National Institute for Health Research, 2014).

Details of the protocol for this systematic review were registered on PROSPERO and can be accessed at www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016038995

An amendment to the registered protocol was made to include additional information related to the ICF linking process. The registered protocol includes a review of the psychometric properties of the identified measures of community walking which is planned for the future and is outside the scope of this thesis.

Eligibility

Inclusion and exclusion criteria were determined apriori and are detailed below. All studies reporting measures of community walking were included, irrespective of the type and design of the study. This was done to ensure that all possible measures for community walking were identified.

Inclusion criteria

1. Studies with male and female participants, aged 18 or above, with first or recurrent ischemic or haemorrhagic stroke.
2. Studies reporting measure/s of community walking were included. No restriction was applied on the type of measure – all measures such as self-report and performance-based measures were included.

Exclusion criteria:

1. Studies not reporting or measuring community walking in stroke survivors.
2. Studies with participants under 18 years of age.

3. Studies with participants with traumatic brain injury, neurodegenerative or neurosurgical disorders.

4. Studies not in English.

Search process

Searches were undertaken by the research candidate. The yield from these searches were downloaded into EndNote and duplicates removed. Two reviewers (NN, SK) independently screened titles and abstracts for relevant eligibility criteria for inclusion. In cases where it was not clear if eligibility criteria had been met or reviewers did not agree, papers were retained for full-text review. At this stage, full-texts of identified studies were retrieved. Two reviewers (NN, SK) independently reviewed the full-text of included papers against relevant eligibility criteria for inclusion. In case of disagreement, consensus was reached by discussion. Once the final included papers were identified, reference lists search of these included papers were undertaken by the candidate to identify any additional relevant papers. All included papers were then ready for data extraction.

Data extraction

Data were extracted by the candidate and checked by a second reviewer (SK). The following data were extracted from included studies, which consisted of details regarding the study, participants and measurement tools of community walking. Extracted data were stored and entered into Microsoft Excel (Appendix 4). This included the following:

- Publication details: Author and journal details, including date, title and details of publication.

- Study details: Data regarding type of study e.g. cross-sectional, randomised clinical trial, etc. and setting (inpatient, outpatient, and community rehabilitation).
- Participant data: Data related to age and gender of participants, total number of participants included in the study and post-stroke duration.
- Measurement of community walking: Name of the measure and procedure used for the measure was extracted including the setting or environment in which the measurement was conducted, for example, within the clinic or the community.

Quality assessment:

For systematic reviews, two types of quality assessments are generally undertaken; that is, the methodological quality of the included studies (how the study has been designed and conducted) and quality of reporting (how the study has been described) (Harrison, Reid, Quinn, & Shenkin, 2017). In the current systematic review, the identification of measures of community walking was not related to either the methodological or reporting quality of the study.

For systematic reviews focussing on properties of measurement tools, a quality assessment is recommended (Terwee, 2012). However, the current systematic review intended to analyse the content of the identified measures and not the psychometric properties reported. For the purpose of content analysis, the established ICF linking process (Cieza et al., 2016) was used, which consists of linking the content of measurement tools to the most precise ICF category. This process has been used previously for content analysis and comparison of a range measures (Cieza et al., 2016; Fayed, Cieza, & Edmond Bickenbach, 2011).

As the aim of the current review was to analyse the content of the identified measures, quality assessment of the included studies was not undertaken. This is in line with previous systematic reviews analysing content of measures using ICF linking, where quality assessment has not been undertaken (Ballert, Hopfe, Kus, Mader, & Prodinger, 2016; Geyh et al., 2004; Hoffman et al., 2014; Roe, Soberg, Bautz-Holter, & Ostensjo, 2013; Xu, Kohler, & Dickson, 2011).

Although beyond the scope of this thesis, the planned future investigation of the psychometric properties of the measures of community walking in stroke survivors would require quality assessment of the included papers. The recommended and planned quality assessment of studies included in the future investigation of the psychometric properties of these measures is the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) framework (Terwee, 2012).

3.2.3. Phase II

The aim of Phase II of this systematic review was to analyse the content of the identified measures in Phase I, using the ICF framework. This consisted of linking each measure or the components of each measure of community walking as appropriate with precise ICF categories. The ICF classifies functioning based on a hierarchical structure, consisting of a range of chapters and levels. The following section describes the ICF structure and coding and explains the ICF linking process that was used (Cieza et al., 2016).

The International Classification of Functioning, Disability and Health structure

The ICF structure consists of two parts; Functioning and Disability is the first part and Contextual factors is the second part. Each part comprises two components which are ascribed a letter code (WHO, 2001):

Part 1. Functioning and Disability

i. Body functions and structures

ii. Activity and Participation

Part 2. Contextual Factors

i. Environmental factors

ii. Personal factors

These components are coded as:

- ***b*** for Body functions
- ***s*** for Body structures
- ***d*** for Activity and Participation
- ***e*** for Environmental factors

It must be noted that the ICF acknowledges personal factors and their impact on the health condition (WHO, 2001); however personal factors are not classified in the ICF (WHO, 2001).

Each component is further classified into domains. For example, the component of Activity and Participation (the relevant component for this thesis) comprises nine domains, which are as follows:

- d1: Learning and applying knowledge
- d2: General tasks and demands
- d3: Communication
- d4: Mobility
- d5: Self-care
- d6: Domestic life
- d7: Interpersonal interactions and relationships
- d8: Major life areas
- d9: Community, social and civic life

Each domain is then classified into categories, which are the units of ICF classification (WHO, 2001). For example, the domain of Mobility consists of categories including walking and moving, changing body positions and moving around using transportation.

When coding using the ICF framework, components, domains and categories are coded up to three or four levels. The code starts with the relevant component prefix, that is, b, s, d or e which is followed by up to the four-digit code representing the relevant domain and category. For example, the task of "walking long distances" can be coded as:

d	Activities and participation (component)
d4	Mobility (first-level/domain)
d450	Walking (second-level/category)
d4502	Walking on different surfaces (third-level/category)

A number of codes can be utilised at each level of classification. Generally, the exhaustive third-level codes have been recommended for linking for rehabilitation outcome measures (WHO, 2001).

The ICF linking process

The ICF provides a common language to describe health and health-related states (WHO, 2001). To facilitate comparability of health-status measures, a systematic approach has been developed to link data using the ICF (Cieza et al., 2002; Cieza et al., 2016). The ICF linking process has been used for qualitative as well as quantitative measures including focus groups, interviews, clinical assessments and questionnaires (Bladh, Nilsson, Carlsson, & Lexell, 2013; Boldt et al., 2005; Geyh et al., 2007; Geyh et al., 2004).

Ten rules have been established for the ICF linking process (Cieza et al., 2016). Table 3.2 provides an abbreviated description of the ten rules as proposed by Cieza et al. (2016). The linking process consists of identifying the main concept of the item to be linked and understanding the perspective of the item. The main concept and additional concepts are then linked with most precise ICF category, recording the relevant specific codes to each item.

Table 3.2 The ICF linking Rules

Rule	Description (abbreviated)
1	Acquire good knowledge of the conceptual and taxonomical fundamentals of the ICF, as well as of the chapters, domains and categories of the detailed classification, including definitions before starting to link main concepts to the ICF categories.
2	Identify the purpose of the information to be linked by answering the question- what is this piece of information about? or What is this item about?
3	Identify any additional concepts in addition to the main concept(s) already identified.
4	Identify and document the perspective taken within a certain piece of information when linking it to the ICF.
5	Identify and document the categorisation of the response options. Note: this rule applies only to instruments, questionnaires, assessments or tests that contain response options.
6	Link all main concepts, the most relevant and additional ones, to the most precise ICF category.
7	Use ‘‘other specified [8]’’ or ‘‘unspecified [9]’’ ICF categories as appropriate. ‘‘8’’ is to be used when the concept is not contained within any of the other specific categories at the respective level of a chapter. The additional information is documented after the ICF code. ‘‘9’’ is used when the concept to be linked fits within a given chapter but there is not sufficient information at hand to assign it to a specific ICF category.
8	If the information provided by the main concept is not sufficient for making a decision about the most precise ICF category, assign the concept to nd (not definable).
9	If the main concept is not contained in the ICF, but is clearly a personal factor as defined in the ICF, assign the meaningful concept to pf (personal factors).
10	If the meaningful concept is not contained in the ICF, assign this meaningful concept to nc (not covered).

Source: Adapted from Cieza et al. (2016)
Note: ICF: International Classification of Functioning, Disability and Health

The first step of identifying the main concept is central to the linking process and requires an understanding about the item within the context of the measurement tool (Cieza et al., 2016; Cieza et al., 2005). The next step is to understand the perspective from which the information is collected by the measurement tool. This step indicates whether the item takes into consideration a person's expectation or satisfaction with performing a task (appraisal perspective), performance or capacity for carrying out a task (descriptive perspective), or amount of assistance needed when performing a task (need/dependency perspective) (Cieza et al., 2016), for example. Table 3.3 outlines the perspectives adopted in the ICF linking process.

Table 3.3 Perspectives adopted in the ICF linking process

Perspective	**Examples**
Appraisal Describes the extent of person's expectations or satisfactions	"Since your stroke, how satisfied are you with your overall ability to perform daily activities in and around the home?"
Descriptive Describes a person's capacity or performance	Walking over a 10-meter pathway
Need/dependency Describes assistance a person requires	Can walk independently on level surface but requires supervision to negotiate stairs and curbs

Source: Adapted from Cieza et al. (2016)
Note: ICF: International Classification of Functioning, Disability and Health

The linking process also take into consideration response options utilised within a measure or how the items are rated. According to the linking rules, response options are categorised as intensity, frequency duration, confirmation or agreement and qualitative attributes (Table 3.4).

However, documentation of these categories apply only to the measures that include response options (Cieza et al., 2016).

Table 3.4 Categorisation of response options within the ICF linking process

Response options	**Examples**
Intensity	Since your stroke, how much difficulty do you have dressing yourself fully? Response options: No difficulty - Slight difficulty - Some difficulty - A lot of difficulty - Can't dress
Frequency	Since your stroke, how often do you visit friends/others? Response options: Most days - At least once a week - At least once a fortnight - Once a month or less - Never
Duration	Speak with your neighbours Response option: How long?
Confirmation or agreement	Are you able to get out and about, by yourself, without physical assistance or supervision from anyone? Response options: Yes/No
Qualitative attributes	What does your pain feel like? Response options: Dull, sharp, flickering, throbbing

Source: Adapted from Cieza et al. (2016)
Note: ICF: International Classification of Functioning, Disability and Health

Procedure

Three members of the research team conducted the linking process based on the ten linking rules. The research team are experienced with ICF framework and one member (BB) has had previous experience using ICF linking with measurement tools. Literature regarding ICF linking was reviewed and discussed within the team before commencement of the linking process. All

three members independently linked items of the identified measures and assigned the most precise ICF codes to each item. These codes were discussed within the team to reach consensus.

Data extraction

Extracted data consisted of details of the measurement tool including name, verbatim items/questions and response options. Main and additional concepts and linked ICF codes for each item of each measure were documented. Perspectives and categorisation of responses used in the identified measures were noted.

4. Study 1: Physiotherapists' perspectives of community walking in stroke survivors

4.1. Introduction

Walking in the community after stroke is a complex activity that requires capacity across a range of factors including minimum walking speeds and distances (Bijleveld-Uitman et al., 2013; Lord & Rochester, 2005) and an ability to negotiate environmental dimensions such as terrains, obstacles and ambient conditions (Robinson et al., 2013). It is important to be able to measure the ability of stroke survivors to walk in the community as this has been identified as a key goal to be achieved by both stroke survivors and the rehabilitation team (Lord et al., 2004; Mayo et al., 1999). For physiotherapists, measurement of community walking is important in order to establish community walking capacity, monitor progress and evaluate efficacy of the rehabilitation program (Barclay, Stevenson, et al., 2015).

Choosing a measure of community walking can be challenging for physiotherapists as successful walking in the community is multidimensional, owing to the complex interaction of factors. Physiotherapists have identified gait speed, distance walked, ability to negotiate various environments and personal drive as important requirements for community walking (Corrigan & McBurney, 2012). However, conflicting evidence exists regarding which is the best measure of community walking in stroke survivors; with some studies identifying gait speed as more predictive (An et al., 2015; Donovan, Lord, McNaughton, & Weatherall, 2008; Lord et al., 2004) and others identifying distance walked as a better measure (Fulk et al., 2010; Lee, Lim, et al., 2015). Recent technological developments including global position

system devices and accelerometers have also been utilised to measure community walking in stroke survivors (Mahendran, Kuys, & Brauer, 2016).

It is not clear what are physiotherapists' perceptions of successful community walking or their perceptions of how community walking should be measured. As community walking is multifactorial, it is also not clear how physiotherapists select an appropriate tool to measure community walking. Gaining insight into physiotherapists' perspectives regarding success and measurement of community walking is important to understand how it is being measured. Physiotherapists' perspectives regarding measurement of community walking are particularly relevant given the conflicting evidence. This study aims to explore physiotherapists perspectives regarding successful community walking in stroke survivors, how community walking is measured and what should be included in a measure of community walking.

4.2. Methods

4.2.1. Study design

A qualitative study was designed to explore physiotherapists' perspectives regarding community walking in stroke survivors. Focus group discussions were conducted using a semi-structured interview guide. Focus groups were chosen to facilitate discussion and exchange of thoughts among physiotherapists (Acocella, 2012; Hennink, 2014), based on their experience with stroke survivors and perspectives in regards to community walking. Ethical approval for this study was obtained from Australian Catholic University's Human Research Ethics Committee (ACU HREC Ethics Register Number: 2016-276E) (Appendix 1).

A purposive sample of physiotherapists was recruited from experienced physiotherapists associated with the School of Physiotherapy, Australian Catholic University. Participants were included if they were registered physiotherapists and were experienced in working with stroke survivors. Physiotherapists across all years of experience were included, to have a diverse sample. People were excluded if they were undergraduate physiotherapy students or physiotherapy or allied health assistants.

A suitable date and time were arranged for those who volunteered to participate in focus group discussion. Participants were provided with the Participation Information sheet in advance and written Informed Consent was obtained prior to the focus group discussion.

4.2.2. Data collection

Three focus groups were conducted at the School of Physiotherapy, Australian Catholic University. A semi-structured interview guide was used, which included open-ended questions regarding physiotherapists' perspectives of community walking, and their perception of success and measurement of community walking in stroke survivors. The interview guide was pilot tested prior to commencement of the study.

Focus groups were conducted by the research candidate who was unknown to participants. Each focus group lasted approximately one hour. Focus group discussions were audio-recorded and transcribed verbatim after each session. Field notes were taken during all focus groups. After each focus group, a verbal summary was provided to participants to ensure clarity of content. Triangulation and credibility of data was enhanced by independent reviewing of transcripts, cross-checking audio-files and transcripts and maintaining a research diary.

4.2.3 Data Analysis

Data were analysed using an inductive thematic approach (Thomas, 2006). Transcripts were analysed independently by two members of the research team (NN, SK). Reading and re-reading of transcripts was undertaken, and important concepts were highlighted. Reviewers discussed and coded identified concepts. Codes were further discussed, and sub-themes were identified. These sub-themes were sorted, named and organised into relevant themes. Data collection was ceased when theme saturation was reached, based on the analysis of transcripts (Strauss & Corbin, 1998). Credibility of data analysis was ensured as two independent reviewers read and re-read transcripts and coded the data. Regular discussions on coding and themes were undertaken and agreed upon, before proceeding for final analysis. Both reviewers discussed and revised final themes.

4.3. Results

4.3.1. Participants

Eleven physiotherapists participated in the study. Participants' ages ranged between 27 and 34 years. All participants were experienced in working with stroke survivors and were from a range of work settings including inpatient, outpatient and community-based rehabilitation (Table 4.1). Additionally, participants were from a number of Australian states.

Table 4.1 Sample characteristics (n=11)

Characteristics	**Mean (SD)**
Age (yrs)	30.66 (±1.94)
Experience (yrs)	7.6 (±3.38)
Work setting	**Number, (%) participants**
Hospital outpatient	5 (45)
Inpatient rehabilitation	4 (36)
Community	2 (18)

4.3.2. Themes

Four themes were identified relating to community walking in stroke survivors: successful community walking is goal-dependant, physiotherapists lack consistency in measurement of community walking, current measurements don't reflect actual community walking, and measures of community walking should be multifactorial (Figure 4.1). The following section describes these themes with illustrative quotations from participants.

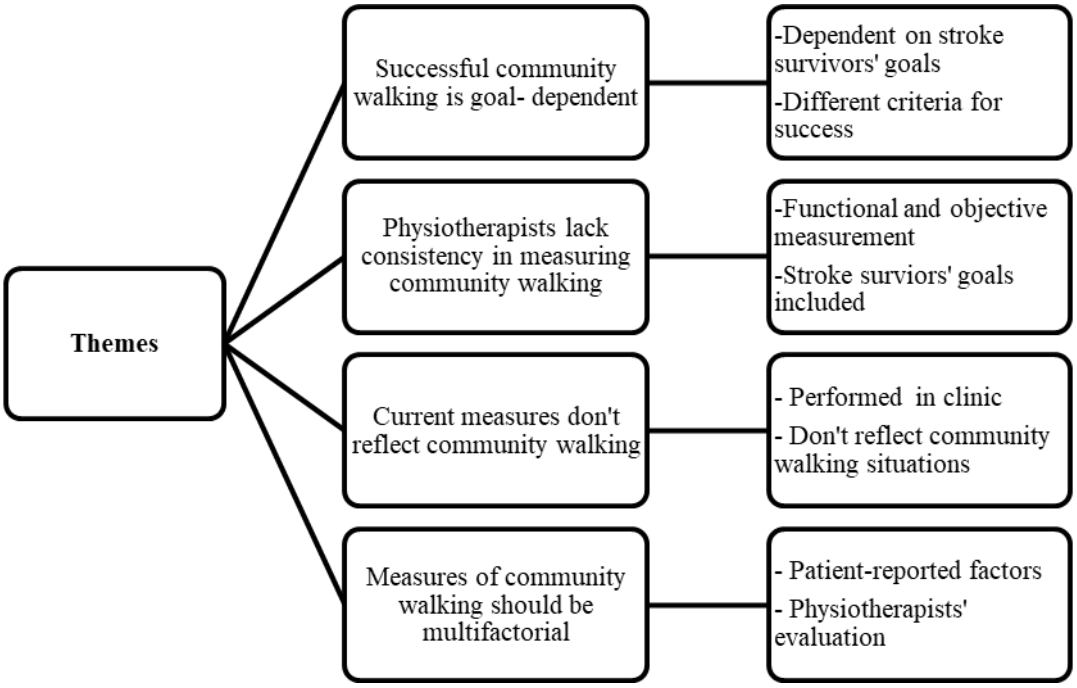

Figure 4.1 Summary of themes identified

Successful community walking is goal-dependent

All participants recognised that successful community walking after stroke is dependent on the goals set by a stroke survivor. For example, if the goal is to visit a supermarket, achieving that goal would be regarded as success in community walking by a stroke survivor.

> *"The definition of success in community ambulation I think that changes a little bit for each patient, depending on what their goals are."* Participant 3

Physiotherapists acknowledged the possibility that differences may exist in what might be regarded as successful community walking between stroke survivors and physiotherapists. For example, physiotherapists' definition of successful community walking was based on achieving a certain criterion for gait speed, walking distance and dual-tasking.

"If I think stereotypically about you know- from a therapist point of view- what makes successful community ambulating – you are looking at kind of distance being around 300-meter mark, your speed being around 1.2m/s and the patient having a cognitive ability to dual task" Participant 2

Participants also thought that it would be more meaningful for stroke survivors to fulfil tasks like walking to the park with their grandchildren or visiting a shop, than to improve their score on a specific measure.

"I mean the patient doesn't come to us to specifically improve their 6-Minute Walk time, they come to us – so that they can work towards going to the shop – or work towards going to the park with their grandchildren – that's what matters to them – that's what we should be focusing on" Participant 8

Physiotherapists use a range of measures to evaluate community walking

Physiotherapists reported using both functional and objective methods to measure community walking. There appeared to be some relationship between the setting in which the physiotherapists worked and the method of measuring community walking. For example, participants working in in-patient rehabilitation settings described measuring community walking using functional methods. The task of walking was observed, and walking function was described based on supervision needs and level of assistance required to complete the task. The approximate distance walked, and speed of walking were then estimated, based on this observation.

"We do try some form of community outdoor ambulation prior to discharge because it often part of their goal- hmm- but I often just estimate a distance."

Participant 6

Whereas physiotherapists working in outpatient and community rehabilitation settings indicated using objective measures relevant to community walking. These included inferring the level of community walking based on outcome measures such as the 6-Minute Walk Test, 10-Meter Timed Walk, Berg Balance Scale, Dynamic Gait Index, Functional Gait Assessment, Modified Falls Efficacy Scale, and Timed-up and Go test.

Physiotherapists also reported relying on measures to inform or evaluate treatment plans and predict the potential of stroke survivors to walk in the community.

"I will often use the Berg…not because I like it as a measure but because –that selection of tests give me lot of insight into what their impairments are going to be" Participant 7

"I guess choosing something like Activity Balance Confidence scale –would also be relevant for some patients if they are subjectively reporting that they are not confident performing a particular activity – then that would be a measure that you would choose – to give you some indication whether they are improving or not" Participant 11

All physiotherapists reported that stroke survivors' goals are taken into account when planning measurements and treatments, as the goals are relevant to stroke survivors for achieving community walking.

"... the (patient's) goal is to walk to the end of the street and depends on this, which one of those things - if speed is important, I will use that as a measure if it is distance- then that would be a measure." Participant 10

Physiotherapists were using gait speed as an indicator of community walking ability specifically for the task of crossing a road. However, there was variation in the gait speeds being used for road crossing with physiotherapists reporting gait speeds ranging from 0.70 m/s up to 1.8 m/s. Similarly, the physiotherapists reported a range of minimum distances required for community walking that varied from 200 to 1000 meters.

"We use 0.7m/s for normal traffic crossing." Participant 10

"It was 1.14 for normal traffic crossing." Participant 9

"We use 1.8, because we have a particularly wide road, our road is quite difficult cos it has a big crossing." Participant 7

"Distance-doesn't have to be more than one kilometre." Participant 2

Current measurements don't reflect community walking

Participants noted that many of the objective measures are completed in a clinical environment on a hard, level surface, in environments without crowds, obstacles and clutter, which do not reflect the environment of community walking. Thus, current measurement tools being used by the participants such as 6-Minute Walk Test, 10-Meter Timed Walk, Berg Balance Scale, Dynamic Gait Index, Functional Gait Assessment and Timed-up and Go test were regarded as inaccurate representations of community walking.

"There is a real lack that I think, we have identified in an outcome measure that does involve all of the– you know- situations you will encounter when you are ambulating in the community." Participant *5*

"I think the limitations with something like Dynamic Gait Index – is that it seems such a sterile environment on this flat ground." Participant 2

"I don't think they (measures) *give me a very accurate idea of community walking."* Participant 9

Measures of community walking should be multifactorial

Physiotherapists identified a range of factors that needed to be included in a measure of community walking. Factors identified included stroke survivors' goals, confidence, satisfaction with respect to community walking, dynamic balance, dual-tasking ability, gait speed and distance walked and taking into account environmental demands and safety awareness associated with community walking.

Participating physiotherapists recommended including a measure of confidence and satisfaction perceived by stroke survivors during activities that are deemed important for community walking. Such activities that were identified consisted of walking on uneven terrains, transferring oneself on different surfaces and walking distance. Patient-report was suggested as the type of measure required.

"On a self-report scale- so confidence in walking on uneven surfaces, uphill-downhill" Participant 6

"I would really love that- for there to be more things looking at patient's confidence in the community as well as you know their ability to participate because there is a very big gap there in my experience." Participant 11

Participating physiotherapists recommended including stroke survivors' goals and what motivates them to achieve that goal, in a measure of community walking.

".... trying to have a way of recording or documenting the different factors that are impacting (goals)– at least having (goals) recorded somewhere- I mean you could go as far as – having again some sort of list" Participant 1

"You could use a goal attainment scale or a patient-specific functional scale - I guess thinking that this is gonna be an outcome for them - I really want to get better at balancing cos I know it's important to my walking - but if you are just measuring stuff arbitrarily – it's not meaningful to the patient" Participant 3

Physiotherapists recommended evaluating components such as dual-tasking, combined with dynamic balance components including negotiating obstacles and stairs, in a measure of community walking. Gait speed and distance walked in a community situation were also suggested to be included in a measure of community walking.

"To bring in all the components of community ambulation – you need some kind of dual tasking." Participant 9

"You need to have a look at how they will deal with perturbations – often you will get knocked in the community." Participant 4

"Endurance -going to the shopping centre and be able to shop and be in different aisles – you gonna have to be able to walk that amount of time with that amount of distance – so that's one thing that I would like to measure or have it in a measure" Participant 6

Along with these components, physiotherapists identified that it is important for the physiotherapists to report on stroke survivors' safety and also to evaluate if stroke survivors have insight into their own safety.

> *"Comment on their safety when they do encounter an obstacle or a situation that's novel."* Participant 11

> *"For a stroke population - because insight has a very has a strong impact on safety."* Participant 2

> "*...having attention in variable places at the same time and to be aware of the environment and understand the safety concerns of your environment."* Participant 5

> *"...asking questions like -do you ever forget to look for cars- have you ever run into someone"* Participant 7

4.4. Discussion

This study identified four themes related to physiotherapists' perspectives of the measurement of community walking in stroke survivors. Themes identified were as follows; successful community walking is goal-dependent, physiotherapists use a range of measures to evaluate community walking, current measures don't reflect community walking, and measures of community walking should be multifactorial. Overall, physiotherapists appear to regard measurement of community walking in stroke survivors as important but acknowledged the complexity and challenges associated with measuring community walking in stroke survivors. Stroke survivors' self-report of their satisfaction and confidence in community walking, goals related to community walking and physiotherapists' evaluation of gait speed, distance, safety

awareness, balance and dual-tasking abilities were recommended to be included in a comprehensive measure.

In this study, physiotherapists identified that the stroke survivors' idea of successful community walking is likely to be related to the goals they have set. This supports previous studies that have shown that stroke survivors utilise goal-setting as a strategy to engage in community walking (Barclay, Ripat, & Mayo, 2015). Rehabilitation professionals have acknowledged that taking into account stroke survivors' goals has the potential to motivate stroke survivors and facilitate rehabilitation (Parsons, Plant, Slark, & Tyson, 2018).

Achievement of goals has been shown to be important for facilitating assessment, rehabilitation planning and measuring the progress of stroke survivors (Black, Brock, Kennedy, & Mackenzie, 2010; Brock et al., 2009). Therefore, it would appear reasonable for the inclusion of stroke survivors' goals when selecting a measure of community walking as recommended by participants in this current study. Goals meaningful to stroke survivors promote active engagement (Parsons et al., 2018) and improve satisfaction with rehabilitation (Black et al., 2010; Brock et al., 2009). Thus, physiotherapists setting goals relevant to community walking for stroke survivors and including these goals when selecting a measure, may enhance engagement in and success of community walking.

In addition to stroke survivors' goals, self-report of satisfaction and confidence in community walking and activities related to community walking were recommended by physiotherapists in the current study for inclusion in a measure of community walking. Stroke survivors have reported reduced satisfaction in walking after stroke (Robinson, Shumway-Cook, Ciol, et al.,

2011) as well as reduced confidence in balance activities (Torkia, Best, Miller, & Eng, 2016; Yiu, Miller, Eng, & Liu, 2012), which may influence functional mobility after stroke (Ng, 2011) including community walking. Patient-reported measures in health care have been well-recognised (Boyce, Browne, & Greenhalgh, 2014; Dawson, Doll, Fitzpatrick, Jenkinson, & Carr, 2010) and are frequently used in physiotherapy practice (Kyte et al., 2015). Patient-reported measures commonly used for community walking include questionnaires developed by Perry et al. (1995) and Lord et al. (2004). Both these measures classify stroke survivors into levels of community walking based on places visited in the community, but do not report on stroke survivors' level of satisfaction or confidence for community walking.

Physiotherapists in the current study suggested including objective evaluation in community walking measurement. Findings from the current study are similar to that of Corrigan and McBurney (2012) where physiotherapists from rural and regional Australia were asked about their perceptions of the abilities stroke survivors needed to walk in the community. Two of the abilities reported by Corrigan and McBurney (2012) are related to physical capacities of stroke survivors; being able to walk quickly with sufficient physical fitness as well as being able to negotiate environmental terrains. Physiotherapists in the current study similarly suggested including objective evaluation of distance walked, balance abilities and dual-tasking in a measure of community walking. Distance walked, as measured with 6MWT has been significantly associated with the potential to walk in the community after stroke (An et al., 2015; Bijleveld-Uitman et al., 2013). Impaired balance and cognitive dual- tasking has also been associated with community walking after stroke (Amatachaya, Chuadthong, Thaweewannaku, Srisim, & Phonthee, 2016; Durcan et al., 2016; Robinson, Shumway-Cook, Matsuda, et al., 2011).

Lord and Rochester (2005) more than a decade ago, identified limitations of measurement tools for community walking and suggested that a theoretical framework would be required to help facilitate the development of a comprehensive measure. Since that time emphasis has been placed on exploring factors affecting community walking as well as interventions to improve community walking (Barclay, Stevenson, et al., 2015). Only recently has a theoretical framework been proposed (Barclay, Ripat, et al., 2015). Despite this advancement in community walking research, it is perhaps surprising that physiotherapists in the current study highlighted ongoing challenges of measuring community walking.

One challenge identified by participating physiotherapists was the lack of specific tools for measuring community walking, compelling physiotherapists to rely on a range of measures that infer community walking such as tools to assess balance and gait. Even then physiotherapists were not consistent in which measures to use. The lack of what might be referred to as content validity of the measures used for community walking was also identified as a challenge. That is, many of the measures utilised by physiotherapists provided information about walking ability in a clinic as opposed to the actual environment that community walking occurs in.

For stroke survivors, walking outside the home is likely to be dependent on the environment; like facing diverse challenges such as navigating around people in public spaces, traffic and different surfaces (Nanninga et al., 2017; Robinson et al., 2013). Environmental challenges have also been associated with reduced frequency or avoidance of community walking in stroke survivors (Robinson et al., 2013). In addition, differences have been reported for gait

speed measured in different environments such as a shopping mall, clinic or a suburban street (Donovan et al., 2008). Physiotherapists in the current study recommended measuring community walking in an environmental context reflective of community walking. This may be of significance not only in measurement of community walking, but also for effective rehabilitation of community walking, as stroke survivors have been reported to have difficulty in applying skills learnt in clinic to their home environments (Nanninga et al., 2017).

Given the multifactorial nature of community walking, it would be helpful for physiotherapists to distinguish which components of community walking are being evaluated by their selected measurement tool. In addition, psychometric properties of commonly used measures have not yet been established specifically for community walking. Investigating the content of commonly used measures for community walking within an ICF framework and reviewing these measures for psychometric properties would provide better understanding about applicability of these measures and might make selecting a measure for community walking less challenging. This can also direct future research involving comprehensive measurement of community walking.

There are several limitations that need to be acknowledged pertaining to this study. Findings of this qualitative study are based on a purposive sample of eleven physiotherapists with an average experience of seven years, and therefore may not represent views of a broader population of physiotherapists. It is possible that physiotherapists with more extensive experience or specific experience in community-based settings may have provided differing information.

In conclusion, this study has presented a unique insight into physiotherapists' perspective of community walking of stroke survivors and the variability in what physiotherapists used as a marker of successful community walking. Comprehensive measurement of community walking remains an ongoing challenge owing to multiple contributing factors, ranging from personal factors such as confidence and satisfaction of community walking, physical performance factors such as dynamic balance and gait abilities, to the effect of myriad environmental situations of community walking.

5. Study 2: Systematic review of measures of community walking in stroke survivors and content analysis using the ICF linking process

This chapter describes Study 2 of the thesis, which is a systematic review to identify and analyse the content of measurement tools used to evaluate community walking in stroke survivors. This study was conducted in two phases. Phase I consisted of identifying the tools used to measure community walking in stroke survivors. Phase II involved analysing these measures within the ICF framework to characterise the content covered by these measures. This chapter describes Study 2 including methods, detailed results and concludes with discussion of the findings.

5.1. Introduction

Measurement of community walking in stroke survivors remains problematic (Lord & Rochester, 2005) with a range of physical, environmental and personal factors possibly influencing stroke survivors' capacity to walk in the community. The choice of a measure may depend on the preference of physiotherapists as to which tool best represents community walking as identified in Study 1 of this thesis. Participating physiotherapists in Study 1 also reported challenges associated with current measures in capturing multifactorial community walking, with seemingly no consensus as to which measurement tool is better or preferable.

Physiotherapists tend to rely on proxy measures of community walking such as gait speed and walking distance, although there is some suggestion that these measures may not necessarily

reflect community walking. Gait speed (Bijleveld-Uitman et al., 2013; Taylor et al., 2006) and walking distance (Bijleveld-Uitman et al., 2013; Lord, McPherson, McNaughton, Rochester, & Weatherall, 2008) are reported to be associated with community walking in stroke survivors. However, these associations might not be an accurate indication of stroke survivors' ability to walk in the community. For instance, for those stroke survivors with fast gait speed (>0.66m/s), one third have reported not being able to walk unsupervised in the community (Lord et al., 2004). Walking distance, often measured clinically using the 6MWT, may overestimate community walking ability (Dean et al., 2001).

Physiotherapists may face additional challenges when choosing a measurement tool due to a number of contributing factors to community walking such as adapting to varying environmental situations (Shumway-Cook et al., 2002), balance confidence (Durcan et al., 2016), and walking in a range of locations (Lord et al., 2004). Measuring these factors seem equally important and adds to the complexity of measuring community walking.

When choosing a measure of community walking, it is also important to distinguish which components of community walking are being captured by the measurement tool. For example, the Activities-specific Balance Confidence scale, a tool to evaluate confidence in balance activities, includes items such as walking in a crowded mall and walking across a car park. These items are therefore representative of the person's confidence to walk in the community and navigate through obstacles and can provide physiotherapists with relevant information about community walking. Understanding the factors relevant to community walking being captured by a measurement tool, would be important for physiotherapists to help inform their

choice of measure. The ICF provides a framework to explore the multifactorial nature of community walking in stroke survivors.

The ICF is a framework that offers systematic classification of functioning that can be used for identifying different components of functioning evaluated by a measure (Cieza et al., 2016; Fayed et al., 2011).The ICF framework has previously been employed for exploring the content of outcome measures utilised in stroke survivors (Geyh et al., 2004; Schepers, Ketelaar, van de Port, Visser-Meily, & Lindeman, 2007). Data related to measurement of community walking may be collected for a range of purposes, for instance to predict the potential to walk in the community based on gait speed/distance or to characterize community walking based on the environments negotiated. Linking the current measures of community walking to the ICF may help in gaining better understanding of the purpose of the tool and what aspects of community walking the measurement tool specifically focuses on. This can be achieved by using the ICF linking process to identify the main and additional concepts covered by a measurement tool. In addition, linking measurement tools within ICF provides an opportunity to compare measurement data collected across a range of measures (Cieza, Fayed, Bickenbach, & Prodinger, 2016). Thus, linking measures of community walking may provide an opportunity to standardise information collected, while identifying the context and purpose of the tool, at the same time taking into consideration complexity of the measures in regard to what is covered.

A systematic review is needed to identify the measurement tools used for community walking in stroke survivors. Once the tools are known, the ICF framework can be used to evaluate the tools including individual items of the tools with regard to the components of community

walking. Therefore, the aims of this systematic review were to a) identify measures of community walking in stroke survivors, and b) analyse the content of identified measures using the ICF framework regarding the components of community walking. This will enable a sound understanding of the available measures and the components of community walking evaluated by these measures, which may help physiotherapists when choosing a measure of community walking.

5.2. Phase I

Phase I consisted of a systematic review to identify measurement tools for community walking in stroke survivors. The following section describes the methods, data extraction and results of this phase.

5.2.1 Method: Identification and selection of studies

Databases searched included CINAHL, EMBASE, PubMed, Scopus, and Web of Science. An electronic search strategy for each database was developed and comprised keywords relevant to the measurement of community walking (Appendix 2). These databases were selected as containing the most relevant literature. All databases were searched from date of creation to the month of search, which was June 2017.

All studies reporting measures of community walking in stroke survivors were included and no restrictions on type of study design were applied (Table 5.1). All studies measuring or reporting community walking in stroke survivors were included. The search strategy was limited to studies written in English and included human participants.

Studies were excluded if community walking was not measured or reported, if participants were under the age of 18 and if studies were in a language other than English. Studies assessing social participation and/or quality of life, and not community walking were excluded. Measurement of social participation generally reports on socializing inside and outside the home, and participating in recreation or leisure activities (Ballert et al., 2016). Quality of life measures report on general well-being and/or an individual's perception of how the health-condition influences well-being (Chen, Li, & Kochen, 2005). Community walking ability may influence social participation and quality of life; however, the current systematic review specifically focused on measurement of community walking. For this reason, studies reporting on social participation and/or quality of life measures - not including a component of community walking in the measurement, were excluded.

Following the removal of duplicates from the initial yield, two independent reviewers screened titles and abstracts against the eligibility criteria. Full-text articles were retrieved and read if there was uncertainty about inclusion of the study at this stage. Any disagreement was resolved by discussion and consensus was reached.

Table 5.1 Inclusion criteria

Design	All studies reporting measures of community walking in stroke survivors, irrespective of the type of study design. Studies in English language.
Participants	Adult human participants-males and females aged 18 or above. First or recurrent ischemic or hemorrhagic stroke.
Measurement of community walking	All studies measuring or reporting community walking in stroke survivors. All types of measures of community walking including self-report and performance based.

5.2.2. Data extraction

Data were extracted by the research candidate and included study details and participant characteristics. Study details extracted include author and journal details, year of publication and study setting of hospital outpatient department, in-patient rehabilitation or community setting. Participant characteristics extracted included number of participants, age, gender, post-stroke duration, and walking status. Data extracted regarding measurement of community walking consisted of name of the measure and description of procedure used for measurement. Other outcomes utilised in the study were noted. Data extraction was checked by the second investigator (SK).

5.2.3. Data analysis

Descriptive synthesis of included studies was undertaken, which involved study and participant characteristics, and measurement tools used. Identified measurement tools were categorised based on the mode of administration.

5.2.4. Results

Study selection

Database searches yielded 606 results (Figure 5.1). After initial screening of titles and abstracts and removing the duplicates, 418 articles were retrieved. After applying the inclusion criteria and reviewing abstracts, 77 articles were included for retrieval of full-texts and independently reviewed by two reviewers (NN, SK). Twenty-six papers were identified for inclusion following full-text review. Based on searches of the references of identified papers, one additional study was included, thus totaling 27 studies in the final synthesis.

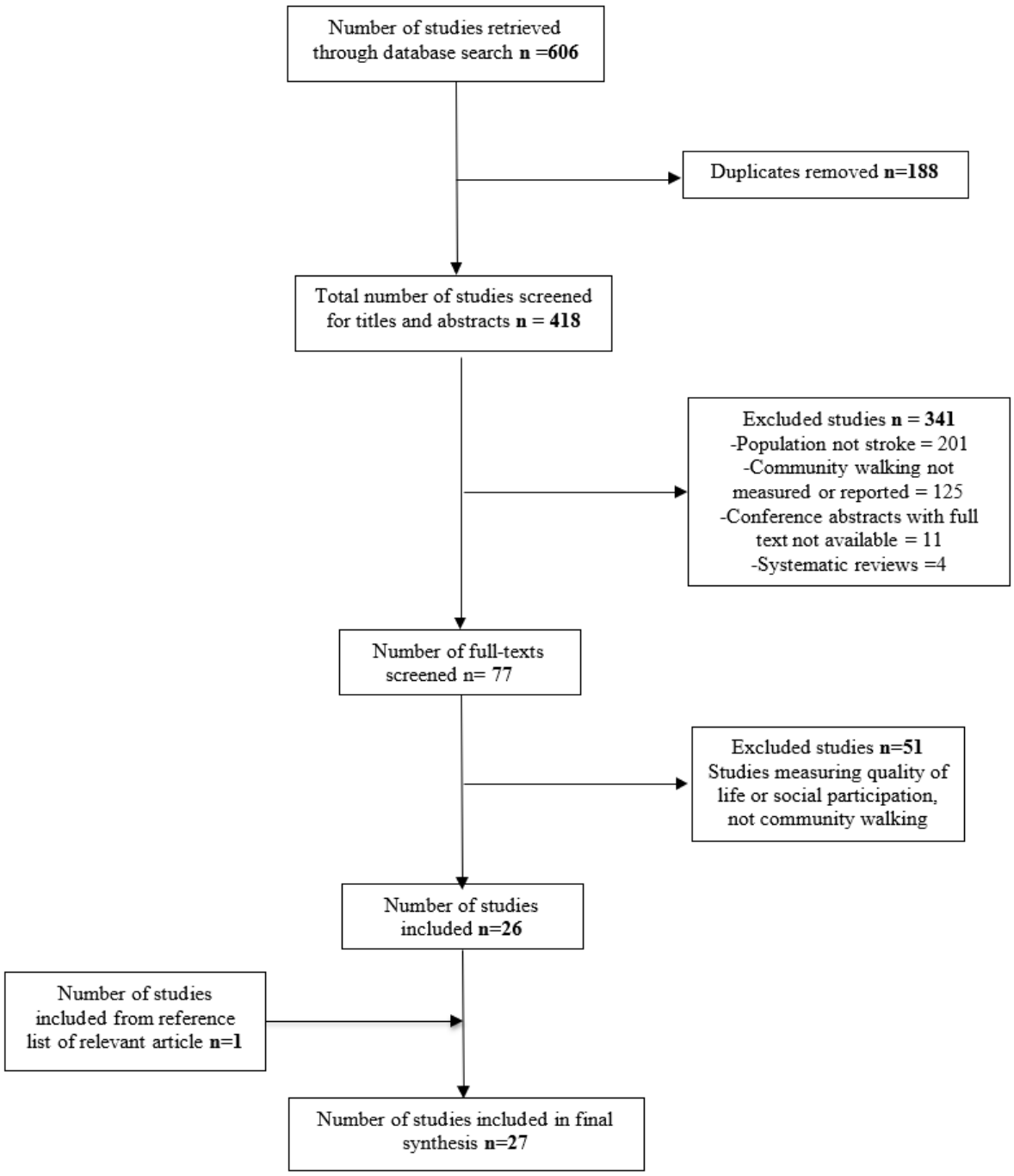

Figure 5.1 Flow of studies through the systematic review

Study and participant characteristics

Studies consisted of 12 cross-sectional studies (Amatachaya et al., 2016; An et al., 2015; Barak, Wu, Dai, Duncan, & Behrman, 2014; Bijleveld-Uitman et al., 2013; Durcan et al., 2016; Fulk et al., 2010; Joa et al., 2015; Lee, Kim, & Lee, 2015; Lee, Lim, et al., 2015; Michael, Allen, & Macko, 2006; Robinson, Shumway-Cook, Ciol, et al., 2011; van de Port et al., 2008), seven prospective observational studies (Donovan et al., 2008; Ferreira, Chamlian, França, & Massaro, 2015; Lord et al., 2004; Mahendran, Kuys, & Brauer, 2016; Mehrholz et al., 2007; Robinson et al., 2013; Taylor et al., 2006), four randomised controlled trials (RCTs) (Lord et al., 2008; Yang, Tsai, Chuang, Sung, & Wang, 2008) with two studies including secondary analysis from previous RCTs (Bethoux et al., 2015; Miller, Pollock, Brouwer, & Garland, 2016), two experimental designs (Kim, Cho, & Lee, 2014; Rosa et al., 2015), one case control (Robinson, Shumway-Cook, Matsuda, et al., 2011) and one cross- over study (Dickstein et al., 2013).

Total number of participants across all studies was 2436. Mean age of the participants was 60 (+14.57) years, 42% of the participants were female and 58% were male. Post-stroke duration was 15.57 (+32.91) months. Appendix 4 presents details of data extracted for this study.

Identified measures of community walking

Twenty measurement tools were identified from included studies consisting of Activities-specific Balance Confidence scale, Community Balance and Mobility scale, Community walking session, Community walk test, Environmental Analysis of Mobility Questionnaire, Functional Ambulation Categories, Functional walking categories, Global Positioning

System devices and accelerometers-ActivPALTM, Hoffer Classification, ICF-oriented "mobility", "self-care" and "domestic life" questionnaire, Modified Emory Functional Ambulation Profile, Step activity monitor and pedometers, Subjective Index of Physical and Social Outcome, Trip activity log and activity diary, and Walking Ability Questionnaire (Table 5.2).

Several measurement tools identified were questions or criteria developed within the study by respective authors. These included a community ambulation self-report questionnaire comprising six items (Lord et al., 2004), a single question on community walking difficulty (Rosa et al., 2015) and ability to meet a number of nominated criteria such as minimum gait speed, distance and ability to negotiate curbs and stairs (Mehrholz et al., 2007). For the purpose of this systematic review, the measurement tools are referred to as Lord's community ambulation self-report questionnaire, question on community walking and nominated criteria, respectively.

One of the identified measures, 6MWT was conducted in a range of settings for measurement of community walking (Donovan et al., 2008). The test was performed in three settings – clinic, suburban street and a shopping mall. The most common measure used among all included studies was Lord's community ambulation self-report questionnaire (n = 8), followed by the Step activity monitor and pedometers (n = 6).

Table 5.2 Identified measures of community walking

Measures of community walking	Studies
Activities-specific Balance Confidence scale	Lord et al. (2008)
Community Balance and Mobility scale	Miller et al. (2016)
Community walking session	Taylor et al. (2006)
Community walk test	Kim et al. (2014); Yang et al. (2008)
Environmental Analysis of Mobility Questionnaire	Robinson et al. (2013)
Functional Ambulation Categories	Barak et al. (2014); Lord et al. (2004)
Functional walking categories	Barak et al. (2014); Bethoux et al. (2015); Joa et al. (2015)
Global Positioning System and accelerometer devices- ActivPAL™	Mahendran, Kuys, and Brauer (2016)
Hoffer Classification	Ferreira et al. (2015)
ICF-oriented "mobility", "self-care" and "domestic life" questionnaire	Robinson, Shumway-Cook, Ciol, et al. (2011)
Lord's community ambulation self-report questionnaire	Amatachaya et al. (2016); An et al. (2015); Bijleveld-Uitman et al. (2013); Durcan et al. (2016); Lee, Kim, et al. (2015); Lee, Lim, et al. (2015); Lord et al. (2004); van de Port et al. (2008)
Modified Emory Functional Ambulation Profile	Bethoux et al. (2015)
Nominated criteria	Mehrholz et al. (2007)
Question on community walking	Rosa et al. (2015)
Step activity monitor/pedometer	Barak et al. (2014); Dickstein et al. (2013); Donovan et al. (2008); Fulk et al. (2010); Michael et al. (2006); Robinson, Shumway-Cook, Ciol, et al. (2011)
Subjective Index of Physical and Social Outcome	Lord et al. (2008)
Trip activity log and activity diary	Mahendran, Kuys, and Brauer (2016); Robinson et al. (2013); Robinson, Shumway- Cook, Matsuda, et al. (2011); (Robinson, Shumway-Cook, Ciol, et al., 2011)
Walking Ability Questionnaire	Fulk et al. (2010); Yang et al. (2008)
10-Meter Timed Walk in the clinic	Lord et al. (2008)
6-Minute Walk test in the clinic, street and mall	Donovan et al. (2008)

Note: ICF: International Classification of Functioning, Disability and Health

5.2.5. Descriptive synthesis

Measures of community walking

Identified measures were categorised into three groups based on mode of administration - instrumented measures, patient-reported measures and therapist-reported measures (Table 5.3). Measures quantifying gait parameters and utilising devices were classified as instrumented. Measures where mode of administration comprised stroke survivors self- report were classified as patient-reported measures. Measures based on therapist's evaluation were classified as therapist-reported measures.

Table 5.3 Categories of identified measures of community walking

Instrumented measures	**Patient-reported measures**	**Therapist-reported measures**
Community walking session	Activities-specific Balance Confidence scale	Community Balance and Mobility scale
Global Positioning System and accelerometer devices- ActivPAL^{TM}	Environmental Analysis of Mobility Questionnaire	Community walk test
Step activity monitor /pedometer	ICF-oriented "mobility", "self-care" and "domestic life" questionnaire	Functional Ambulation Categories
10-Meter Timed Walk in the clinic	Lord's community ambulation self-report questionnaire	Functional walking categories
6-Minute Walk Test in the clinic, street and mall	Question on community walking	Hoffer Classification
	Subjective Index of Physical and Social Outcome	Modified Emory Functional Ambulation Profile
	Trip activity log and activity diary	Nominated criteria
	Walking Ability Questionnaire	

Instrumented measures

Five instrumented measurement tools were identified including devices such as global positioning systems, accelerometers, and timed walking tests such as 10MTW, 6MWT and community walking session. The timed walking tests were quantified using an accelerometer and are categorised as instrumented measures. The following section describes each of these measures and reports on how they were utilised in the included studies identified in this review.

- ***Community walking session***

Taylor et al. (2006) implemented Community walking session, that consisted of a pre- planned community walking route to measure gait speed while walking in the community. Approximately 300 meters long, this route was planned in and around a shopping mall to include various environmental dimensions proposed by Patla and Shumway-Cook (1999). Walking in a car park, supermarket, walking over a slope and crossing a road were incorporated in this route. Gait speeds recorded using 10MTW while walking along a route in the community and in a clinical setting were compared.

- ***Global positioning system devices, accelerometers and pedometers***

Global positioning system (GPS) devices provide information about location and duration of trips. Accelerometers and pedometers are devices which measure accelerations of an object in motion, thus providing information about velocity, step counts and/or duration (S. Moore et al., 2017). One study used an accelerometer and a GPS device to quantify community walking in terms of number of steps, duration and location of walking (Mahendran, Kuys, & Brauer, 2016).

Two types of accelerometers or pedometers were identified in the included studies; Step activity monitor and ActivPALTM. Accelerometers record number of steps taken over a period of time. Recorded step data can be downloaded, and output is normally expressed as stride/step counts per unit time. Five studies described using Step activity monitor to measure community walking (Barak et al., 2014; Dickstein et al., 2013; Donovan et al., 2008; Fulk et al., 2010; Michael et al., 2006). Step activity monitor was used for time intervals ranging from 48 hours (Barak et al., 2014; Michael et al., 2006) to one week (Fulk et al., 2010) and expressed as step count over this period of time to quantify home and community walking. One study implemented Step activity monitor to exclusively evaluate gait parameters including speed, step length and number of steps, while walking in the environment during a 6MWT (Donovan et al., 2008). Pilot study to ensure reliability and validity of Step activity monitor to evaluate these gait parameters was undertaken in stroke survivors walking in the community, with intraclass correlation coefficients values ranging from r =0.89 to 0.99 for speed, step length and number of steps. The ActivPALTM was used in one study with data collected over four days (Mahendran, Kuys, & Brauer, 2016) and reported according to duration, frequency and intensity of steps.

- ***10-meter timed walk and 6-minute walk test***

Gait speed can be evaluated with a 10MTW, where the participant is instructed to walk on a 10-meter pathway at a self-paced, comfortable speed (J. Green, Forster, & Young, 2002). One study described the 10MTW as a primary outcome measure to evaluate the effect of community-based physiotherapy intervention on community walking (Lord et al., 2008).

Average gait speed for these participants was 0.80 m/s, which was considered the minimal speed needed for community walking.

The 6MWT is a measure used to evaluate endurance and aerobic capacity where people are instructed to walk as far as possible on a pathway for 6 minutes. Donovan et al. (2008) employed 6MWT in three different environments; clinic, shopping mall and suburban street, to determine if outcomes derived from these commonly used measures changed according to the environment. Participants were instructed to walk at a comfortable speed and gait parameters during these tests were recorded using an accelerometer (Donovan et al., 2008).

Patient-reported measures

Patient-reported measures are defined as a direct report of patient's health condition that comes from the patient, without interpretation by a clinician or anyone else (Kyte et al., 2015). Patient-reported measures are generally questionnaires and represent patient's perspective of consequences of a disease or condition on their functioning.

Eight patient-reported measures used for measuring community walking in stroke survivors were identified, namely Activities-specific Balance Confidence scale, Subjective Index of Physical and Social Outcome, Environmental Analysis of Mobility Questionnaire, ICF-oriented "mobility", "self-care" and "domestic life" questionnaire, Lord's community ambulation self-report questionnaire, Question on community walking, Trip activity log and activity diary, and Walking Ability Questionnaire. The following section describes each of these measures and reports on how they were utilised in selected studies of this review.

- ***Activities-specific Balance Confidence scale and Subjective Index of Physical and Social Outcome***

The Activities-specific Balance Confidence (ABC) scale is a measure that subjectively rates balance confidence in 16 mobility tasks, ranging from activities in the home and outside including household tasks, walking in a mall and parking lot (Botner, Miller, & Eng, 2005). Participants rate their confidence on a scale of 0-100, where 0 means no confidence and 100 represents complete confidence in the task. Subjective Index of Physical and Social Outcome (SIPSO) is a subjective measure of social integration after stroke, consisting of 10 items (Kersten, Ashburn, George, & Low, 2010). Some SIPSO items focus on mobility in and around home, the neighbourhood and shopping. Responses are rated on a five-point ordinal scale.

Selected items related to mobility outside home from both these measures (6 ABC scale items, 2 SIPSO items) were used to infer community walking in stroke survivors (Lord et al., 2008). Items from the ABC scale used in the study by Lord et al. (2008) were not specified. The ABC scale items that may relate to community walking include confidence in walking outside the house, getting in and out of a car and walking across a parking lot. The two items on SIPSO utilised in this study (Lord et al., 2008) were related to perceived difficulty while shopping and carrying bags when shopping, and independence in moving around local neighbourhood (Lord et al., 2008).

- ***Environmental Analysis of Mobility Questionnaire***

The Environmental Analysis of Mobility Questionnaire (EAMQ) was used to report on the environmental features affecting community walking in a group of 30 chronic stroke survivors

(Robinson et al., 2013). This self-reported questionnaire comprises 21 items to examine physical environmental dimensions, and whether stroke survivors encounter or avoid these dimensions while walking in the community. Physical environmental dimensions comprise terrain characteristics, distance, attentional demands, ambient conditions, temporal factors, physical load, postural transitions, and traffic levels (Robinson et al., 2013). This measurement tool was used to understand stroke survivor's avoidance and encounter with environmental dimensions and how this affects number of trips taken in the community and the number of walking activities undertaken during community trips (Robinson et al., 2013).

The ICF-oriented mobility, self-care and domestic life (MOSES) questionnaire is a subjective measure based on relevant ICF chapters, consisting of 58 items on 12 scales corresponding to the ICF chapters (Farin, Fleitz, & Frey, 2007). For example, the scale based on ICF category of walking consists of 8 items including walking long and short distances and walking on uneven surfaces. Robinson, Shumway-Cook, Ciol, et al. (2011) used two of these 12 scales, namely walking without equipment (8 items) and moving about using equipment (7 items) to evaluate stroke survivors' perceived difficulty in community walking. Stroke survivors' perceived satisfaction while participating in community walking was also evaluated using the same two scales (Robinson, Shumway-Cook, Ciol, et al., 2011). Satisfaction was recorded using a five-point scale, where 1 indicated being dissatisfied and 4 indicated being very satisfied. Additionally, the same walking items from the MOSES were utilised to measure stroke survivors perceived importance for walking. Perceived importance of walking was rated using a similar five-point ordinal scale with a score of 1 indicating not important to a score of 4 indicating very important (Robinson, Shumway- Cook, Ciol, et al., 2011).

- ***Lord's community ambulation self-report questionnaire***

Lord et al. (2004) developed a self-reported questionnaire to understand the importance of community walking as perceived by stroke survivors as well as to assess community walking with regards to supervision needed. This questionnaire consists of six questions focusing on the importance of community walking for stroke survivors, choice of places they like to visit, and level of supervision needed. Based on the responses, stroke survivors are categorised into four levels of community walking. First level implies inability to walk outside the home; second level consists of being able to walk as far as the letterbox; level three consists of being able to walk in the immediate environment; and level four indicates being able to walk in a shopping centre and/or place of special interest (Lord et al., 2004).

Seven other studies identified in this review reported community walking using Lord's community ambulation self-report questionnaire (Amatachaya et al., 2016; An et al., 2015; Bijleveld-Uitman et al., 2013; Durcan et al., 2016; Lee, Kim, et al., 2015; Lee, Lim, et al., 2015; van de Port et al., 2008). Most of these studies reported the association between level of community walking and other mobility variables including gait speed, walking distance and motor function (Amatachaya et al., 2016; An et al., 2015; Bijleveld-Uitman et al., 2013; Durcan et al., 2016; Lee, Lim, et al., 2015; van de Port et al., 2008). One study (Lee, Kim, et al., 2015), established the association between motor recovery and gait velocity.

- ***Question on community walking***

Community walking ability was inferred from a self-reported question regarding the level of difficulty stroke survivors experienced when walking outside the home (Rosa et al., 2015). Five responses were possible; having no difficulty in community walking and physical

assistance or supervision not needed, having mild difficulty in community walking with supervision needed to walk far away from home, having moderate difficulty with required supervision to walk near and far away from the home, having severe difficulty in community walking with always requiring physical assistance from another person, and being unable to walk outside of the home (Rosa et al., 2015). Participants who responded to the first option were categorised as independent community walkers; and those responding to the remaining options were categorised as non-independent community walkers (Rosa et al., 2015).

- ***Trip activity log and activity diary***

Several studies reported stroke survivors' participation in community walking using a trip activity log or activity diary, which details the number of trips in the community and activities undertaken during a trip (Robinson et al., 2013; Robinson, Shumway-Cook, Ciol, et al., 2011; Robinson, Shumway-Cook, Matsuda, et al., 2011). A trip has been defined as leaving the person's property and activity during a trip has been described as exiting one's property and walking to a destination. Trip activity log was maintained over a period of seven (Robinson, Shumway-Cook, Ciol, et al., 2011) to twelve days (Robinson et al., 2013; Robinson, Shumway-Cook, Matsuda, et al., 2011).

In one study (Mahendran, Kuys, & Brauer, 2016), an activity diary was utilised by stroke survivors to report on time and location of the trip, approximate time spent walking, choice of transport, and purpose of trips. The activity diary was used as an adjunct to GPS and accelerometer data. The purpose of trips in this study was grouped as work, social, recreation, essential errands and roles, and religious and spiritual purpose, based on the participation domain of the Stroke Impact Scale (Mahendran, Kuys, & Brauer, 2016).

- ***Walking Ability Questionnaire***

The Walking Ability Questionnaire (WAQ) comprises 19 questions pertaining to walking activities in the home (8 questions) and in the community (11 questions) (Perry et al., 1995). Yang et al. (2008) used the WAQ as an outcome measure to investigate the effect of virtual reality training on community walking. A second study utilised the WAQ to categorise stroke survivors based on their self-reported community walking (Fulk et al., 2010). Only 7 of the 19 questions were used by this latter study, with the specific questions used not reported by Fulk et al. (2010).

Therapist-reported outcome measures

- ***Community Balance and Mobility scale***

The Community Balance and Mobility (CB&M) scale is a 13-item scale to evaluate walking balance and consists of tasks including forward to backward walking, walking and looking, crouch and walk, and running with controlled stop (Howe, Inness, Venturini, Williams, & Verrier, 2006). Each item is graded separately on a 6-point scale. All tasks are performed without assistive devices, with exception of descending stairs. Originally designed for clients with traumatic brain injury (Howe et al., 2006), the CB&M scale has also been used to assess balance in community-dwelling stroke survivors (Knorr, Brouwer, & Garland, 2010). The study identified in the current systematic review (Miller et al., 2016) aimed to explore structural validity of CB&M scale for stroke survivors, who were able to walk in the community.

- ***Community walk test***

Community walk test was described by Kim et al. (2014) and covered 300 meters including a 150 meters pedestrian walkway, 100 meters park trail, a 20° slope, 10 stairs, and a visit to a convenience store. Yang et al. (2008) used a Community walk test with a 400 meters route that included crossing a street, negotiating curbs or ramps and stepping over obstacle. The time taken to complete this route was recorded and multiplied by a factor corresponding to the level of walking aid used.

- ***Functional Ambulation Categories***

The Functional Ambulation Categories (FAC) classifies ambulation ability into six levels based on the physical assistance required and surface able to be negotiated (Holden et al., 1984). Level 0 indicates non-functional ambulation and scores of 4 and above represents independent ambulation.

In one study (Barak et al., 2014), FAC were implemented as an additional measure to ensure adherence to the Step activity monitor. For example, for a participant with a score of FAC >4, meaning an independent ambulator, if no step activity was recorded, it would be attributed to non-use or malfunctioning of the step activity monitor. The FAC were not directly used in this study to quantify community walking step activity.

Lord et al. (2004) used FAC as one of the mobility outcomes for quantifying mobility of stroke survivors across the four levels of community walking; unable to walk outside the home, walk as far as the letter box, walk in the immediate environment and walk in a shopping centre and/or place of special interest. The FAC scores were utilised to assess the relationship

with self-reported community walking. The highest FAC score of 6, indicating independent walking on non-level and level surfaces, inclines, and stairs was achieved by 94 (72.3%) of the stroke survivors.

- ***Functional walking categories***

The Functional walking categories were originally proposed by Perry et al. (1995) to differentiate community walkers (unlimited, least, and most limited community walker) and household walkers (unlimited or limited household walker, physiological walker).

Barak et al. (2014) used these categories to define two groups of stroke survivors based on gait speed assessment. In a study to investigate stroke survivor's adherence to accelerometry measurement, participants with gait speed < 0.4 m/s were classified as household walkers and those with gait speed between 0.4 to < 0.8 m/s were classified as limited community walkers (Barak et al., 2014).

In a 12-month follow up study to investigate the effect of functional electrical stimulation and ankle foot orthosis on stroke survivors gait quality (Bethoux et al., 2015), all six functional walking categories were used to report if stroke survivors changed category during the data collection period (Bethoux et al., 2015).

In one study, stroke survivors were asked to self-report their community walking ability from one of the six functional walking categories (Joa et al., 2015). Significant association was reported between the Berg Balance Scale and gait speed with the functional walking categories of community walkers (Joa et al., 2015). A cut score of 42 on the Berg Balance

scale was reported for dividing household versus community walkers. Gait speed of 0.80 m/s was reported as the cut score for determining community walkers (Joa et al., 2015).

- ***Hoffer Classification***

The Hoffer classification categorises ambulation in four levels, where level zero means no ambulation and level 4 indicates community ambulation. One study used the Hoffer classification to categorise walking as non-ambulatory, non-functional, household, and community walking (Ferreira et al., 2015). This study investigated non-motor factors predictive of community walking in people with chronic stroke. The classification was used at the end of the rehabilitation program to evaluate achievement of independent community walking (Ferreira et al., 2015).

- ***Modified Emory Functional Ambulation Profile***

The Modified Emory Functional Ambulation Profile (mEFAP) evaluates ability to negotiate different types of terrain. The mEFAP consists of five individually timed tasks, which include walking on hard floor, carpet, obstacles, stair climbing and timed-up and go test (S. Wolf et al., 1999). Total score is calculated as sum of the time recorded for these tasks. The time taken to complete these tasks is recorded and multiplied by a corresponding level of assistance needed (no aid x 1, ankle foot orthosis x 2, cane x 3, quadruped cane x 4, ankle foot orthosis + cane x 5, ankle foot orthosis + quadruped cane x6) (S. Wolf et al., 1999).

One study used mEFAP as a measure of functional walking over a l2-month follow up following an intervention comparing functional electrical stimulation and the use of ankle foot orthosis on gait (Bethoux et al., 2015). All tasks were multiplied by 2 to account for the use

of the ankle foot orthosis. Yang et al. (2008) utilised the scoring system of mEFAP for quantifying the time taken and the level of assistance needed for a Community walking test.

- ***Nominated Criteria***

In a study reporting on the psychometric properties of FAC, Mehrholz et al. (2007) nominated three criteria for defining community walking. Stroke survivors walking faster than 1.21 m/s, able to walk further than 332 meters, and having the ability to climb stairs and curbs were regarded as community walkers (Mehrholz et al., 2007). Cut-off scores of the FAC were reported to predict independent community walking at 6 months post-stroke rehabilitation follow-up.

5.3. Phase II

Phase II comprised a linking process to identify the content of the tools within the ICF framework. The following section describes the procedure, data extraction and descriptive synthesis for this phase.

5.3.1. Procedure

The ICF linking process was undertaken based on the established ICF linking rules (Cieza et al., 2016). Linking is a process that involves identification of the main concept for each item of a measure. Identification of main concept indicates what the item is actually about, taking into account the overall context of the measure. Additional concept/s, if any, are also noted. These identified concepts are then linked to the most appropriate ICF category (Cieza et al., 2016). For example, in ABC scale, the item “How confident are you that you will not lose

your balance/become unsteady when you walk around the house?" can be linked to the ICF category 'd4600 Moving around within the home', as the main concept for this item is walking around the house. In addition, as the item covers confidence in the given activity, a second category that can be linked is 'b1266 confidence'.

The next step in the process consists of documenting the perspective or purpose for which the information is collected (Cieza et al., 2016). For example, in the above-mentioned example of ABC scale item, the perspective taken is that of appraisal, as the item asks about perceived confidence in an activity.

When a measure has several response options, such as a rating scale or Likert scale, these responses are also considered in the linking process. The ICF linking process involves noting the response options or rating system used in the measurement tools and categorising the response options (Cieza et al., 2016). For example, in ABC scale, a person is asked to respond on a scale ranging from 0 to 100. In this example, the response option can be categorised as that of intensity, as it takes into account how (much) confident a person feels when performing an activity.

5.3.2. Data extraction

Based on the linking rules (Cieza et al., 2016), extracted data comprised name of the measure, verbatim items or questions that comprised each measure, and response options of the measures. Main and additional concepts were identified, and perspectives and category of response noted. Each measure was independently assessed by three reviewers (BB, NN, SK) and linked with the most precise ICF category. All reviewers discussed coding and

consensus was reached. Any disagreement was resolved by detailed discussion and further analysis of the ICF coding structure. Descriptive synthesis was undertaken to report each measure according to ICF category.

5.3.3. Results and descriptive synthesis

All 20 identified measures were included in the ICF linking process. A total of 232 items were extracted across all the measurement tools. Figure 5.2 gives an illustrative example for the linking process, using the main concept identified in the item 'most-limited community walker' within the Functional walking categories.

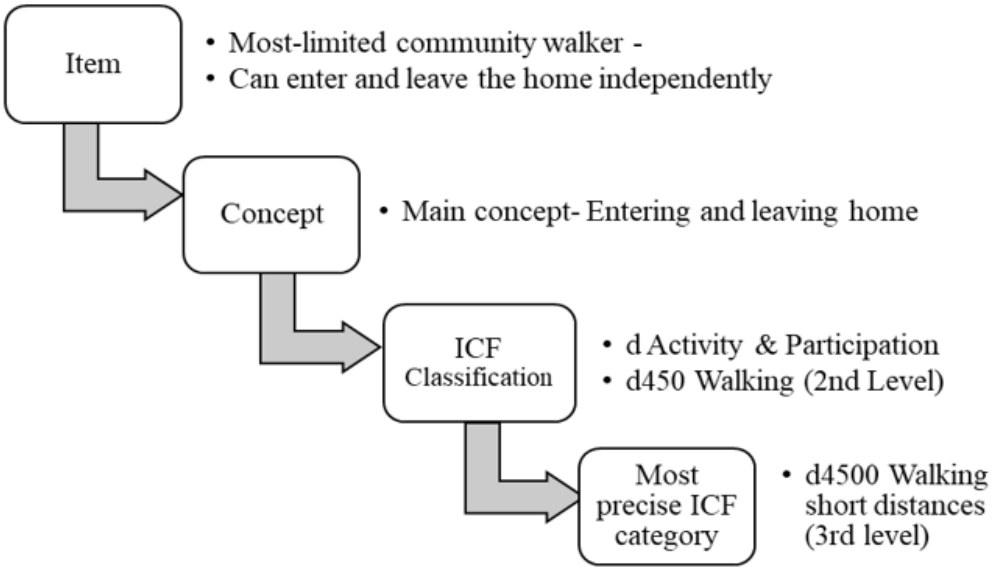

Figure 5.2 Example of linking process for an item in the Functional walking categories
Note: ICF: International Classification of Functioning, Disability and Health

The following section describes the results linking the measure item with the identified concept/s and the most precise ICF category, regardless of level.

Concepts

A total of 259 concepts, including 177 main and 82 additional concepts were identified. Of the 259 concepts identified, 256 were able to be linked to ICF categories. Three concepts could not be linked in the ICF and were identified as ‘not definable’(nd) and ‘personal factors - not definable’ (pf-nd). Table 5.4 illustrates the number of main and additional concepts identified for all measures.

Concepts were linked to the ICF components of Activity and Participation, Environmental factors and Body functions. No measurement tool contained concepts related to Body structures. The EAMQ consisted of the highest number of concepts (n=41) and the Step activity monitor/pedometer the lowest (n=1).

Table 5.4 Number of items, concepts, ICF categories and ICF hierarchy level for community walking measures

		Instrumented measures					**Patient-reported measures**								**Therapist-reported measures**						
	Total	10MTW	6MWT	GPS	SAM	CWS	ABC	EAMQ	Lord's	MOSES	SIPSO	TAL	Question	WAQ	CB&M	CWT	FAC	FWC	Hoffer	mEFAP	Criteria
Number of items	230	3	6	2	2	5	16	41	6	58	10	3	2	23	13	6	6	16	4	5	3
Concepts																					
Number of total concepts	259																				
Number of main concepts	177	3	2	2	1	7	16	41	6	9	10	3	2	23	13	5	6	16	4	5	3
Number of additional concepts	82					6	11	12	3		9			6	11	1	6	8	3	4	2
Concepts not linked	3							2			1										
ICF categories linked																					
Total (number)	169	3	7	3	1	9	13	15	4	43	10	3	2	18	10	5	2	9	4	5	3
Body functions	4						1				1			2							
Activity and Participation	147	2	6	3	1	8	11	10	2	41	9	3	2	13	10	4	2	9	3	5	3
Environmental factors	18	1	1			1	1	5	2	2				3		1			1		
Level of ICF hierarchy																					
1st level																					
2nd level	18	1	1	1				1	2	2	1	2	1	5		1					
3rd level	151	2	6	2	1	9	13	14	2	41	9	1	1	13	10	4	2	9	4	5	3

Note: 10MTW:10-Meter Timed Walk, 6MWT: 6-Minute Walk Test, ABC: Activities-specific Balance Confidence scale, CB&M :Community Balance and Mobility scale, CWS: Community walking session, CWT: Community walk test, EAMQ: Environmental Analysis of Mobility Questionnaire, FAC: Functional Ambulation Categories, FWC: Functional walking categories, GPS: Global Positioning System devices and ActivPAL™, Hoffer: Hoffer Classification, ICF: International Classification of Functioning, Disability and Health, Lord's: Lord's community ambulation self-report questionnaire, mEFAP: Modified Emory Functional Ambulation Profile, MOSES: ICF- oriented “mobility”, “self-care” and “domestic life” questionnaire, Criteria: Nominated criteria, Question: Question on community walking, SAM: Step Activity Monitor and pedometers, SIPSO: Subjective Index of Physical and Social Outcome, TAL: Trip activity log and activity diary, WAQ: Walking Ability Questionnaire

ICF categories

Across the 20 measures, 169 unique ICF categories were linked. Figure 5.3 shows the distribution of these categories across the ICF. The most common component was Activity and Participation, which was linked to 147 (88%) categories. Environmental factors were linked to 18 (10%) categories, followed by Body functions component which was linked to 4 (2%) categories.

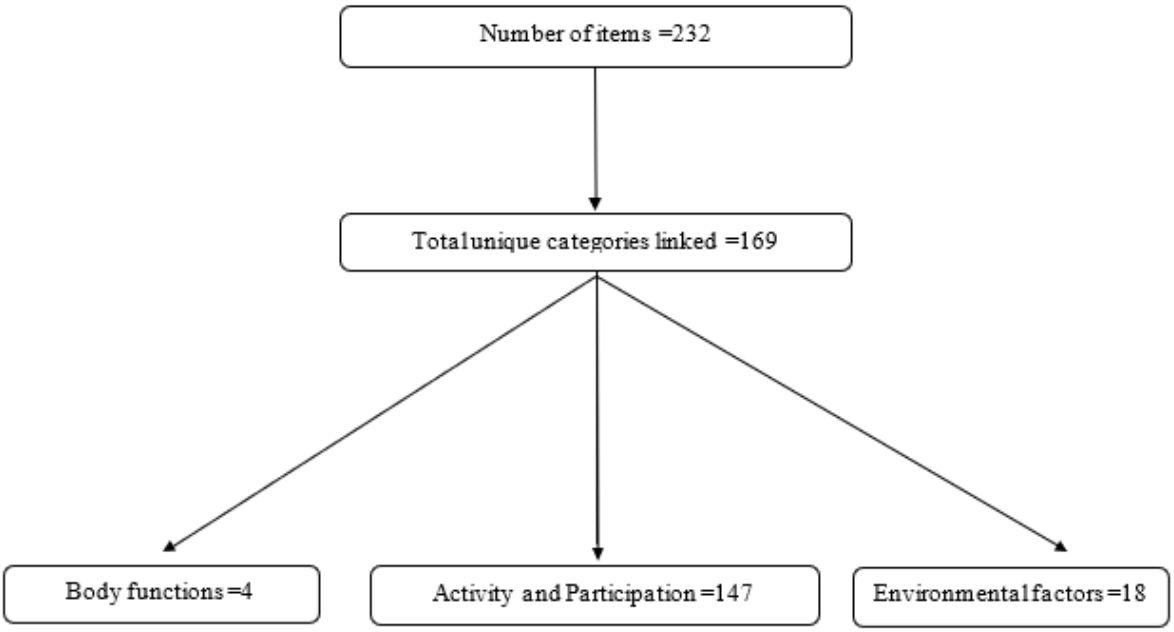

Figure 5.3 Distribution of the International Classification of Functioning, Disability and Health categories across 20 identified measures

The MOSES questionnaire included the highest number of overall categories (n=43) and step activity monitor/pedometer the lowest (n=1). The highest number of Activity and Participation categories were attributed to the MOSES (n=41) questionnaire and EAMQ had highest number of Environmental categories (n=5). Categories most frequently belonged to third-level (n=151) classification, followed by second-level (n=18) (Table 5.4).

Distribution of measures based on ICF components

Activity and Participation was the most common component covered and was linked across all 20 measures. Within this component, the highest number of categories were attributed to the Mobility domain. The distribution of the ICF categories linked to the ICF components, Activity and Participation, Environmental factors and Body functions are elaborated below.

Activity and Participation

Within the component of Activity and Participation, all measures were linked to the Mobility domain (d4). Table 5.5 outlines the categories linked to Activity and Participation component for all measures. The number of categories covered by each measure varied. The highest number of Mobility categories were covered by the MOSES questionnaire (n=27) and the Step activity monitor and Lord's community ambulation self-report questionnaire covered the lowest number (n=1).

Within the Mobility domain, 'Walking and moving' (d450-d469) was the most commonly utilised second-level category. The most frequently used third-level subcategory was 'd4502 Walking on different surfaces' (n=25), followed by 'd4551 Climbing' (n=20) and 'd4503 Walking around obstacles' (n=19).

Table 5.6 illustrates walking and moving categories linked in the community walking measures. The common third-level categories will be discussed further below.

Table 5.5 Number of ICF categories linked to Activity and Participation component for community walking measures

ICF Category	Instrumented measures					Patient-reported measures								Therapist-reported measures						
	6MWT	10MTW	GPS	SAM	CWS	ABC	EAMQ	Lord's	MOSES	SIPSO	TAL	Question	WAQ	CB&M	CWT	FAC	FWC	Hoffer	mEFAP	Criteria
d1 Learning and applying knowledge																				
d2 General tasks and demands										1										
d3 Communication										1										
d4 Mobility	6	2	3	1	8	10	10	1	27	2	3	2	9	10	4	2	8	3	5	3
d5 Self-care									7	2										
d6 Domestic life						1			7	2			1				1			
d7 Interpersonal interactions and relationships								1												
d8 Major life areas																				
d9 Community, social and civic life										1			3							

Note: 10MTW:10-Meter Timed Walk, 6MWT: 6-Minute Walk Test, ABC: Activities-specific Balance Confidence scale, CB&M :Community Balance and Mobility scale, CWS: Community walking session, CWT: Community walk test, EAMQ: Environmental Analysis of Mobility Questionnaire, FAC: Functional Ambulation Categories, FWC: Functional walking categories, GPS: Global Positioning System devices and ActivPAL™, Hoffer: Hoffer Classification, ICF: International Classification of Functioning, Disability and Health, Lord's: Lord's community ambulation self-report questionnaire, mEFAP: Modified Emory Functional Ambulation Profile, MOSES: ICF-oriented "mobility", "self-care" and "domestic life" questionnaire, Criteria: Nominated criteria, Question: Question on community walking, SAM: Step Activity Monitor and pedometers, SIPSO: Subjective Index of Physical and Social Outcome, TAL: Trip activity log and activity diary, WAQ: Walking Ability Questionnaire

Table 5.6 Walking and moving categories covered in community walking measures

ICF category	Instrumented measures					Patient-reported measures								Therapist-reported measures						
	10MTW	6MWT	GPS	SAM	CWS	ABC	EAMQ	Lord's	MOSES	SIPSO	TAL	Question	WAQ	CB&M	CWT	FAC	FWC	Hoffer	mEFAP	Criteria
d4500 Walking short distances	Y	Y			Y	Y			Y				Y		Y		Y		Y	Y
d4501 Walking long distances									Y											
d4502 Walking on different surfaces		Y			Y	Y	Y		Y				Y		Y	Y	Y		Y	
d4503 Walking around obstacles		Y			Y	Y	Y						Y		Y		Y		Y	
d4508 Walking, other specified			Y	Y	Y									Y		Y	Y	Y		Y
d4509 Walking, unspecified													Y				Y	Y		
d4551 Climbing						Y	Y		Y				Y	Y			Y		Y	Y
d4552 Running									Y					Y						
d4553 Jumping														Y						
d4558 Moving around, other specified														Y						
d4600 Moving around within the home						Y			Y	Y			Y				Y	Y		
d4601 Moving around within buildings other than home		Y			Y		Y						Y							
d4602 Moving around outside the home and other buildings		Y					Y			Y			Y				Y			
d4609 Moving around in different locations, unspecified			Y					Y			Y	Y								
d465 Moving around using equipment	Y	Y											Y		Y					
d469 Walking and moving, other specified and unspecified			Y																	

Note: 10MTW:10-Meter Timed Walk, 6MWT: 6-Minute Walk Test, ABC: Activities-specific Balance Confidence scale, CB&M :Community Balance and Mobility scale, CWS: Community walking session, CWT: Community walk test, EAMQ: Environmental Analysis of Mobility Questionnaire, FAC: Functional Ambulation Categories, FWC: Functional walking categories, GPS: Global Positioning System devices and ActivPALTM, ICF: International Classification of Functioning, Disability and Health, Hoffer: Hoffer Classification, Lord's: Lord's community ambulation self-report questionnaire, mEFAP: Modified Emory Functional Ambulation Profile, MOSES: ICF-oriented "mobility", "self-care" and "domestic life" questionnaire, Criteria: Nominated criteria, Question: Question on community walking, SAM: Step Activity Monitor and pedometers, SIPSO: Subjective Index of Physical and Social Outcome, TAL: Trip activity log and activity diary, WAQ: Walking Ability Questionnaire

- ***Walking on different surfaces and around obstacles***

Nearly half of the measures covered walking on different surfaces and walking around obstacles (Table 5.6). The ICF describes different surfaces as slopes, uneven or moving surfaces, such as on grass, ice and snow, or aboard vehicles including ship, train and others (WHO, 2001). Walking around obstacles implies walking around or through traffic or other crowded areas, marketplace or shops.

One instrumented measure (6MWT) and three patient-reported measures (ABC scale, EAMQ and WAQ) covered walking on different surfaces such as slopes and icy sidewalks (ABC scale) and walking in crowded places. Therapist-reported measures (Community walk test and Functional walking categories) encompassed walking on uneven surfaces and mEFAP consisted of walking on carpeted and hard floors. These measures also contained navigating shopping malls and crowded places. Functional Ambulation Categories and MOSES questionnaire included walking on slopes and uneven surface.

- ***Climbing***

The ICF describes climbing as moving the whole body upwards or downwards and includes climbing steps, curbs or rocks, and ladders or stairs (WHO, 2001). Two patient-reported measures, EAMQ and WAQ, covered stair climbing and navigating curbs. An additional two patient-reported measures, ABC scale and MOSES questionnaire, included stair climbing. One therapist reported measure, FAC, included stair climbing and navigating curbs with three measures (CB&M, mEFAP, and nominated criteria) including stair climbing. None of the instrumented measures included climbing.

- ***Distance walked***

Walking long distances is described in the ICF as walking more than a kilometre (WHO, 2001). The MOSES questionnaire was the only measure that linked to walking long distances, involving walking more than two kilometres.

Walking short distances is described in the ICF as walking less than a kilometre, such as across rooms or hallways (WHO, 2001). Measures covering walking short distances included mEFAP which involved three meters and five meters walks, the MOSES questionnaire consisting of 20 meters to 200 meters walk and nominated criteria which included a distance of 332 meters. The Community walk test and Community walking session involved walking distances of 400 meters and 600 meters respectively. Functional walking categories included entering and leaving home and walking within the home, implying short distances. Instrumented measures namely 10MTW and 6MWT also covered walking short distances. One patient-reported measure, the ABC scale involved walking outside the house to the drive-way.

Some of the items in the included measures were categorised into 'walking, other specified'(d4508) category. For example, the CB&M scale includes tandem walking where a person is asked to walk on a straight line with heel touching the toe was classified as 'walking, other specified'. 'Walking, other unspecified'(d4509) category was utilised where details of walking were not given in a measure. For example, in the Functional walking categories, the item 'independent in at least two other moderate community activities' was categorised as 'walking other, unspecified'.

Environmental factors

Environmental factors are a component of ICF classification, and takes into consideration products and technology, natural and man-made environment and support and relationships (WHO, 2001). Table 5.7 illustrates the environmental factors included across the community walking measures.

Measures such as the Hoffer's classification, Lord's community ambulation self-report questionnaire, WAQ, 10MTW and 6MWT contained environmental factors that included use of assistive devices such as canes and crutches for personal indoor and outdoor mobility. Additionally, the WAQ and Community walk test covered specific assistive devices needed for community walking, such as a wheelchair or ankle foot orthosis. The EAMQ covered environmental factors that involved the use of products and technology for gaining access to facilities inside buildings such as ramps, lifts or escalators, climate factors of precipitation, and light and sound intensity. The MOSES questionnaire consisted of two items which included walking outdoors in winter on an icy path and walking up a hill. One component of the Community walking session involved walking in low light intensity and one item on the ABC scale involved stepping on and off an escalator. Lord's community ambulation self-report questionnaire comprised one item that covers individual attitudes of immediate family members.

Table 5.7 Environmental factors covered by measures

	Instrumented measures					Patient-reported measures								Therapist-reported measures						
ICF category	10MTW	6MWT	GPS	SAM	CWS	ABC	EAMQ	Lord's	MOSES	SIPSO	TAL	Question	WAQ	CB&M	CWT	FAC	FWC	Hoffer	mEFP	Criteria
e120 Products and technology for personal indoor and outdoor mobility and transportation													Y							
e1201 Assistive products and technology for personal indoor and outdoor mobility and transportation	Y	Y						Y					Y					Y		
e1208 Products and technology for personal indoor and outdoor mobility and transportation, other specified													Y		Y					
e1500 Design, construction and building products and technology for entering and exiting buildings for public use							Y													
e1501 Design, construction and building products and technology for gaining access to facilities inside buildings for public use						Y	Y													
e2100 Land forms									Y											
e2250 Temperature									Y											
e2253 Precipitation							Y													
e2400 Light intensity					Y		Y													
e2500 Sound intensity							Y													
e410 Individual attitudes of immediate family members								Y												

Note: 10MTW:10-Meter Timed Walk, 6MWT: 6-Minute Walk Test, ABC: Activities-specific Balance Confidence scale, CB&M :Community Balance and Mobility scale, CWS: Community walking session, CWT: Community walk test, EAMQ: Environmental Analysis of Mobility Questionnaire, FAC: Functional Ambulation Categories, FWC: Functional walking categories, GPS: Global Positioning System devices and ActivPALTM, Hoffer: Hoffer Classification, Lord's: Lord's community ambulation self-report questionnaire, mEFAP: Modified Emory Functional Ambulation Profile, MOSES: ICF-oriented “mobility”, “self-care” and “domestic life” questionnaire, Criteria: Nominated criteria, Question: Question on community walking, SAM: Step Activity Monitor and pedometers, SIPSO: Subjective Index of Physical and Social Outcome, TAL: Trip activity log and activity diary, WAQ: Walking Ability Questionnaire

Body functions

The ICF component of Body functions covers physiological functions of body systems, including psychological functions (WHO, 2001). The ABC scale evaluates confidence in various activities, which was linked to the ICF category ‘b1266 confidence’. Two items on the WAQ include assessment of proprioception and movement control and were linked to ‘b260 proprioception’ and ‘b798 neuromusculoskeletal and movement function other specified’, respectively. One of the items on SIPSO was linked to ‘b1801 body image’.

Perspectives and categories of response options covered in the measures

Among all the measures, the most commonly adopted perspective was descriptive (either evaluating capacity or performance in a task), adopted by 12 measures (Table 5.8). All instrumented measures and four therapist-reported measures (CB&M scale, Community walk test, mEFAP and Nominated criteria) also adopted descriptive perspective. Patient-reported measures adopting the descriptive perspective included the EAMQ, MOSES, and Trip activity log and activity diary.

The most common response options were confirmation or agreement included in seven measures (Table 5.8). Four patient-reported measures (ABC scale, Lord's community ambulation self-report questionnaire, Question on community walking and SIPSO) had response options regarding intensity. Additionally, Lord’s community ambulation self- report questionnaire and SIPSO had questions, with a qualitative response option. For example, a question on SIPSO – ‘Since your stroke, how do you feel about your appearance when out in public?’ has response options as happy and self-conscious.

Table 5.8 Perspectives and categories of response covered in the identified measures

Measure	**Perspective**	**Category of response**
10-Meter Timed Walk	Descriptive	Not applicable
6-Minute Walk Test	Descriptive	Not applicable
Activities-specific Balance Confidence scale	Appraisal	Intensity
Community Balance and Mobility Scale	Descriptive	Confirmation or agreement
Community walking session	Descriptive	Not applicable
Community walk test	Descriptive	Not applicable
Environmental Analysis of Mobility Questionnaire	Descriptive	Frequency
Functional Ambulation Categories	Need/dependency	Confirmation or agreement
Functional walking categories	Need/dependency	Confirmation or agreement
Global Positioning System devices and accelerometers	Descriptive	Not applicable
Hoffer Classification	Need/dependency	Confirmation or agreement
Lord's community ambulation self-report questionnaire	Appraisal,Need/dependency	Intensity, qualitative attributes
Modified Emory Functional Ambulation Profile	Descriptive	Confirmation or agreement
ICF-oriented “mobility”, “self-care” and “domestic life” questionnaire	Descriptive	Confirmation or agreement
Nominated criteria	Descriptive	Not applicable
Question on community walking	Need/dependency	Intensity
Step Activity Monitor and pedometers	Descriptive	Not applicable
Subjective Index of Physical and Social Outcome	Appraisal	Intensity, qualitative attributes
Trip activity log and activity diary	Descriptive	Not applicable
Walking Ability Questionnaire	Need/dependency	Confirmation or agreement

5.4. Discussion

This is the first systematic review to identify measures of community walking in stroke survivors and analyse content of these identified measures within the ICF framework. Twenty measurement tools were identified and categorised as instrumented, patient- reported and therapist-reported measures. This chapter discusses the findings from Phase I and Phase II in the sections below.

5.4.1. Phase I

From the 27 included studies, 20 measurement tools of community walking of stroke survivors were identified. Instrumented measures and therapists-reported measures appeared to be largely focused on quantifying community walking performance. Patient-reported measures were well represented and were largely focused on reporting locations visited, and confidence and difficulty experienced during community walking activities. Surprisingly, only a few of the identified measures were specifically developed to evaluate community walking in stroke survivors and seemed to focus on specific factors contributing to community walking, such as places visited in the community.

Instrumented measures identified in this study were GPS devices and accelerometers such as ActivPAL^{TM}, Step activity monitor and pedometer, community walking session and 10MTW and 6MWT. Instrumented measures potentially have the benefit of providing objective and quantitative measures of community walking. Accelerometers, for example, provide direct measurement of ambulatory activity and are reported to be accurate measures of ambulatory activity within the home and in the community for stroke survivors (Haeuber et al., 2004; Macko et al., 2002). Similarly, GPS devices are reported to be valid for objectively determining

ambulatory activity and locations visited after stroke (McCluskey et al., 2012). In contrast, it appears pedometers should be used with consideration. Although pedometers have been reported to show good validity to measure the number of steps taken by stroke survivors (Vanroy et al., 2014) pedometers often undercount number of steps when negotiating stairs (Vanroy et al., 2014). In addition, pedometers appear to valid only for specific walking conditions such as walking at normal intensity and not at higher walking intensities (Vanroy et al., 2014).

A number of other limitations have also been associated with instrumented measures. Data from devices can be limited by device malfunction or people forgetting to don the device. Adherence rates for wearing a device, may also be an issue, and may worsen the longer the device needs to be worn. Adherence rates have been inferred for wearing the Step activity monitor based on data collection rates in a large group of more than 400 stroke survivors (Barak et al., 2014). Over the first day the Step activity monitor was worn adherence rates of 68% were inferred (Barak et al., 2014). Adherence reduced to 61% and 53% respectively across the second and third days (Barak et al., 2014). One strategy that has been used to overcome these limitations is the use of activity diaries. Activity diaries have been recommended to be used simultaneously, particularly with GPS devices (McCluskey et al., 2012) to obtain specific and comprehensive information about community walking, such as the purpose of the trip (Mahendran, Kuys, & Brauer, 2016), number of trips and activities undertaken during the trip (Robinson, Shumway-Cook, Ciol, et al., 2011).

Several patient-reported measures were identified in this review which were used to classify stroke survivors' community walking capacity based on their self-reported performance. The most commonly used, Lord's community ambulation self- reported questionnaire and the

WAQ, categorised stroke survivors based on the places visited. Both these measures utilised stroke survivors' report on their ability to visit specified places outside the home as well as the level of supervision or assistance needed.

Interestingly, only selective components of some of the patient-reported measures were used to infer community walking status. It was unclear from the authors of studies that selected specific components from previously validated measures why this was done. There also appeared to be no consistency in the content or attribute/s relevant to community walking that were selected. Lord et al. (2008) reported utilising two questions from SIPSO and six questions from the ABC scale relevant to community walking. Questions utilised from SIPSO asked about difficulty in the activity of shopping and carrying bags and perception of independence in walking in local neighbourhood. Questions selected from the ABC scale asked about perception of confidence in balance. Similarly, community walking was inferred in one study based on selective items of MOSES questionnaire relevant to community walking (Robinson, Shumway-Cook, Ciol, et al., 2011). Walking items from MOSES were combined with a stem question to understand stroke survivors perceived difficulty, satisfaction and importance in these items related to walking.

Patient-reported measures identified in this review considered some of the important contributing factors to community walking. The places visited after stroke play an important role in successful reintegration in the community and thus should be considered (Nanninga et al., 2015). Similarly, balance self-efficacy as measured with a self-reported confidence plays an important role in achieving community walking and is important to measure as it has

predictive abilities for independent community walking in stroke survivors (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011).

Most of the therapist-reported measures such as the Hoffer classification, FAC and Functional walking categories provide a classification system based on performance of gait speed and assistance needed. Some of the measures such as CB&M scale and mEFAP are structured measures for evaluating balance, dual-tasking and walking performance, whereas Nominated criteria employed by Mehrholz et al. (2007) takes into account minimum gait speed and distance walked. The use of these measures suggests an effort to quantify community walking, either by classifying into levels based on evaluated performance or by using a combination of performance variables. Other measures such as Community walking session and Community walk test evaluated walking performance in an environment resembling community walking and recognised the influence of environment while walking in the community.

Of all the measures identified in this systematic review, only two were specifically developed to measure community walking. Lord's community ambulation self-reported questionnaire (Lord et al., 2004) was first implemented in a sample of 130 community- dwelling stroke survivors to identify the level of self-reported community walking. Four levels of community walking were identified in this study ranging from not being ambulant outside home (Level 1) to being ambulant in places of choice or shopping centres (Level 4). Since the publication of this study in 2004, Lord's community ambulation self-reported questionnaire has been widely used to classify stroke survivors into levels of community walking. Seven of the studies from this systematic review have used this questionnaire to measure community walking in stroke survivors (Amatachaya et al., 2016; An et al., 2015; Bijleveld-Uitman et al., 2013; Durcan et al., 2016; Lee, Kim, et al., 2015; Lee, Lim, et al., 2015; van de Port et al., 2008). The

questionnaire was pilot-tested on an unspecified number of stroke survivors in the same study (Lord et al., 2004) and though most commonly used, the validity of this measurement tool has not been reported in any of the included studies.

The second specifically developed measure of community walking is the EAMQ; a self-reported questionnaire originally developed to evaluate mobility in older adults (Shumway-Cook et al., 2003). This measure reports on the frequency of avoidance (i.e. How often do you avoid …?) and encounter (i.e. How often do you . . .?) with environmental challenges, such as distance walked, light and weather conditions and terrain characteristics (Shumway- Cook et al., 2003). Despite its focus on an important contributor of community walking – environmental factors, EAMQ has not been used frequently with stroke survivors, with only one study included in this review using this tool (Robinson et al., 2013).

Some of the identified measures were modified from their original procedure to measure community walking. One study compared 6MWT (distance walked) and 10MTW (gait speed) findings in three environments of a clinic, a suburban street and a shopping mall (Donovan et al., 2008). Similarly, Taylor et al. (2006) implemented a 10MTW during a community walking route, while Yang et al. (2008) measured time to complete a similar community route. Kim et al. (2014) used a community walking route that consisted of a walking in a pedestrian walkway, park trail and a visit to a convenience store. These findings underline the importance researchers attribute to gait speed and distance walked in the measurement of community walking as well as acknowledging the need to implement these measures in an environment resembling community walking. In order to comprehensively measure community walking, it would be reasonable to understand what relevant factors are covered by these measures.

5.4.2. Phase II

Findings from Phase II, which focused on analysing content of identified measures of community walking within the ICF framework suggested diversity in content of these measures. More than 200 concepts were identified, covering 169 unique ICF categories. Content across the measures varied with the majority belonging to the Activity and Participation component. Environmental factors were covered by half of the identified measures of community walking with only a few covering Body functions.

Current measures of community walking seem to focus on walking as a mobility activity

Within the component of Activity and Participation, the ICF domain of Mobility was covered by all 20 measures. Measures of community walking covered diverse categories in this domain and included walking on short distances, climbing and walking on different surfaces.

Walking short distances (d4500), as indicated within the ICF implies walking less than a kilometre, such as across rooms or hallways (WHO, 2001). The identified measures of community walking seem to be diverse in the distance covered, despite being included in the same category of walking short distances. Distances covered in these measures ranged from walking three meters (mEFAP) to walking up to 600 meters (Community walking session). Short distances were also covered by some measures referring to specific destinations such as within the home and outside to the drive-way (Functional walking categories and ABC scale). A similar diversity could be observed within the category of climbing (d4551) with measures linked to this category covering ascending and descending a curb as well as negotiating stairs. Some measures specified the number of stairs, for example, ascending and

descending five stairs (mEFAP) and two or more flight of stairs (EAMQ, MOSES), whereas some measures covered the ability to climb stairs and curbs without indicating a number (Functional walking categories, Nominated criteria). Ability to climb up a steep slope (e.g. hill) was covered in the MOSES questionnaire.

The diversity observed in walking and climbing categories may be related to the definitions of community walking reported in the literature. Lerner-Frankiel et al. (1986) proposed that walking sufficient distance and being able to negotiate curbs were requirements for walking in the community. Distances up to 600 meters were required by stroke survivors to walk to their desired destinations (Lerner-Frankiel et al., 1986). On the other hand, Perry et al. (1995) proposed a classification system for community walking which was based on the level of assistance required to walk in various location. The ability to independently negotiate stairs and curbs was one factor included in the classification system. These definitions may influence the way community walking is measured.

Interestingly, only one measure (MOSES) covered the category walking long distances (d4501). Walking more than a kilometre is indicated as long distance in the ICF, which may seem more relevant to community walking. One of the commonly utilised measures for distance walked (6MWT) is performed within the clinical setting, and even for able-bodied people being able to walk at least one kilometre in six minutes is unrealistic, thus the 6MWT may remain restricted to measuring short distances. On the contrary, MOSES is an ICF oriented, patient-reported questionnaire and walking more than a kilometre seems reasonable to include.

Overall, community walking is a combination of walking as an activity and participation in community situations, including a range of environments. The content of the identified measures seems to focus mainly on walking as a mobility activity. Additionally, current measures of community walking appear to cover a range of ICF mobility categories relevant to community walking.

Environmental factors are partially covered by measures of community walking

Half of the identified measures of community walking covered environmental factors contributing to community walking. The most comprehensive of these measures was the EAMQ which reports on avoidance and encounter in a range of environmental situations including accessing ramps, lifts or escalators; weather conditions consisting of precipitation, light and sound intensity. Items of the ABC scale and WAQ also report on accessing escalators and ramps.

Within the ICF, Environmental factors are described as physical, social and attitudinal environment in which people live and conduct their lives (WHO, 2001). Along with physical features of the environment like different terrains and weather, social features including contact with family, peers and acquaintances, and attitudinal features such as attitudes of caretakers, health-care professionals and family members are also important to the overall functioning of an individual (WHO, 2001).

A range of physical features of the environment are reported to be important contributors of community walking (Shumway-Cook et al., 2002) and are covered in the EAMQ. However, none of the identified measures covered categories associated with social and attitudinal

features of the ICF component of environment. One item from Lord's questionnaire 'Does the assistance you require to get out and about cause any problems to you or your carers?'(Lord et al., 2004) was linked to the category related to attitudinal feature (e410) within environmental component. However, this question is not taken into account when classifying stroke survivors into levels of community walking based on Lord's questionnaire (Lord et al., 2004). These findings suggest that other environmental contributors within the ICF are not extensively considered in the measures identified from this review.

Factors such as stroke survivors' confidence in walking activities and perceived satisfaction related to community walking has been acknowledged as contributors to community walking (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011). Within the ICF framework, personal factors are not classified; however, some of the measures identified in this review seem to cover personal factors relevant to community walking. The ABC scale consists of items reporting on perceived confidence in walking activities, which may be relevant to community walking. Lord et al. (2008) used some of the items on ABC to infer stroke survivors' community walking. Robinson, Shumway-Cook, Ciol, et al. (2011) utilised walking items on MOSES questionnaire to understand stroke survivors' perceived satisfaction with walking in the community.

This systematic review has identified measures of community walking in stroke survivors. Numerous measures with diverse contents have been used in the scientific literature to measure community walking. Most of these measures covered the activity of walking with approximately half of the identified measures covering environmental factors. None of the measure comprehensively covered multiple factors that are contributors of community

walking. These findings point towards a lack of consensus in the literature about measuring community walking, in terms of what is being measured to infer community walking. It is also possible that gaining clarity regarding the content of measures of community walking is important for physiotherapists to select the most appropriate measure both in research and in clinical practice.

6. Discussion

This thesis explored measurement of community walking in stroke survivors from the perspective of physiotherapists and within the ICF framework. Study 1 comprised a qualitative exploration of physiotherapists' perspectives of what is successful community walking for stroke survivors, how community walking in stroke survivors is measured, and challenges associated with measurement. Study 2 consisted of a systematic review to identify measures of community walking in stroke survivors and analyse content of identified measures within the ICF framework. Chapter 6 presents a summary of the findings of both studies, followed by a discussion of the clinical implications of research findings and the limitations of the research. Chapter 6 concludes with recommendations on future directions of research regarding measurement of community walking in stroke survivors.

6.1. Summary of research

6.1.1. Study 1

Eleven physiotherapists were interviewed to understand their perspectives on community walking in stoke survivors. Four themes were identified from this study related to the topics discussed in the focus groups; successful community walking is goal-dependant, Physiotherapists use a range of measures to evaluate community walking, current measurements don't reflect actual community walking, and measures of community walking should be multifactorial.

Successful community walking is goal-dependent

Physiotherapists perceived that stroke survivors' goals related to community walking played a vital role in achieving success in community walking. Physiotherapists took into account stroke survivors' goals when selecting a measure of community walking and planning rehabilitation of community walking. However, for the participating physiotherapists, successful community walking meant stroke survivors satisfying specific criteria for gait speed, distance walked and ability to perform dual-task while walking. Physiotherapists recognised that these criteria may be different from what successful community walking means for stroke survivors.

Physiotherapists use a range of measures to evaluate community walking

Physiotherapists measured community walking in a range of ways and there appeared to be some differences in how community walking was measured based on the work-setting. For physiotherapists working in hospitals, measuring community walking often consisted of observing the task of walking within the clinic or hospital inpatient department and estimating gait speed, distance walked, and supervision needed during community walking tasks. Physiotherapists working in hospital outpatient and community services reported using more objective measures to infer community walking which comprised walking tests such as 10MTW, 6MWT and Dynamic Gait Index, along with tests of balance such as Berg Balance Scale and Modified Falls Efficacy Scale. Inference of community walking based on these measures was also used to evaluate the effect of treatment on community walking ability. Additionally, even when common measures were identified as being used by the participating physiotherapists, different values or cut-off scores were used as representative of the minimum requirements for community walking. For example, physiotherapists used gait speeds ranging

from 0.70 m/s up to 1.8 m/s as the indicator for community walking. Distances required to be walked for community walking ranged from 200 meters up to 1000 meters.

Current measurements don't reflect actual community walking

Participants noted that current measures of community walking were performed in a clinical environment which does not necessarily involve the situations encountered while community walking. For example, tests such as 10MTW and 6MWT are typically performed in an uncluttered clinic environment and do not reflect demands of community walking including navigating crowds, slopes and obstacles while walking outside. Thus, participants regarded current measures as an inaccurate representations of community walking.

Measures of community walking should be multifactorial

Physiotherapists identified a range of factors that were important to be measured. Physiotherapists suggested patient-reported goals related to community walking as well as satisfaction and confidence in activities related to community walking be included in a measure of community walking. Therapist-report of gait parameters in an environment reflecting community walking, dual tasking, dynamic balance ability and stroke survivor's safety awareness were suggested to be included in a measure of community walking.

6.1.2. Study 2

Study 2 comprised a systematic review to identify measures of community walking in stroke survivors and analysed the content of identified measures using the ICF linking process.

Identified measures of community walking

Twenty measures to evaluate community walking in stroke survivors were identified from 27 included studies in the review. These tools were categorised based on the mode of administration as instrumented, patient-reported and therapist-reported measures. Five instrumented measures were identified and comprised community walking session, global positioning system devices, accelerometers, pedometers and the 10MTW and 6MWT. Eight patient-reported measures were identified and comprised questionnaires including ABC scale, EAMQ and Lord's community ambulation self-report questionnaire. Seven therapist-reported measures were identified and included structured classification measures such as the FAC, Functional walking categories and Hoffer classification.

Only two of the identified measures, the EAMQ and Lord's community ambulation self- report questionnaire, both patient-reported measures, were designed specifically to measure community walking. A number of identified measures were designed to measure walking as a broad construct and comprised a small number of items within these measures that were utilised to infer community walking status. Lord et al. (2008) reported utilising two questions from SIPSO and six questions from ABC scale relevant to community walking. Similarly, satisfaction with community walking was inferred in one of the studies based on selective items of the MOSES questionnaire that were relevant to community walking (Robinson, Shumway-Cook, Ciol, et al., 2011).

Content of identified measures

Identified measures of community walking covered a diverse range of content within the ICF framework with the majority (99%) linked to ICF categories. Activity and Participation was

the most frequently covered component, with the number of categories included in measures ranging from one (Step activity monitor) to 43 for the MOSES questionnaire. Half of the identified measures covered Environmental factors and only three measures covered Body functions.

All identified measures covered the ICF domain of Mobility. Walking on different surfaces, climbing, and walking around obstacles were the most frequently covered ICF categories. Ten identified measures covered walking short distances and one measure included an item pertaining to walking long distances.

6.2. Clinical implications

Clinical implications of the research findings from both studies are discussed in the following section, with regard to measurement of community walking in stroke survivors. The clinical implications include – there is little consensus in measuring community walking, what drives physiotherapists' choice of a measure, using the ICF to select the right measure of community walking and collaborative goal-setting.

6.2.1. Knowledge translation and measures of community walking

Different measures of community walking were reported by physiotherapists compared to those identified in the systematic review. Participating physiotherapists in Study 1 reported using measures including the Berg Balance Scale, Dynamic Gait Index, Functional Gait Assessment and Modified Falls Efficacy Scale to infer community walking in stroke survivors. This contrasts with the systematic review findings, in which Lord's community ambulation

self-report questionnaire was the most frequently utilised, followed by accelerometers. Some of the plausible explanation of discrepancy in measures used could be the difference in the purpose of the measurement and the intended use of the results. For example, measures such as Lord's community ambulation self-report questionnaire may well describe limitations in the activity, however it may not necessarily identify the underlying impairments and help inform treatment planning. Some measures may be intended to identify areas of impairment or activity limitation, or describe the stroke survivors current level of community ambulation while others may be used to predict the capacity to walk in the community. A clinician may be using a measure to identify impairments with the intent of using those results to direct treatment. Thus, it is possible that different measures would be selected depending on the purpose, which may explain the of discrepancy in measures used as identified in this research program.

Another explanation for the discrepancy in the measures identified could be attributed to a gap in knowledge translation. Knowledge translation framework (Straus, Tetroe, & Graham, 2011), consists of knowledge creation and knowledge application. Knowledge creation implies inquiry, creation and synthesis of knowledge through research (Straus et al., 2011). Knowledge application includes processes needed to implement knowledge in health care such as identification, selection and adaptation of knowledge to local context (Straus et al., 2011). It is integral for the knowledge translation framework, that users of the knowledge (clinicians/physiotherapists) are involved in the entire process to warrant that the knowledge and its implementation are relevant to their needs (Bowen & Graham, 2013; Straus et al., 2011). The discrepancy in identified measures of community walking in the literature and those used by physiotherapists may indicate a problem in knowledge translation. The problem may exist at both the stages of knowledge creation (researchers) and application (physiotherapists). The

research community may not be well-informed about measures of community walking that are most applicable in clinical settings. For example, tools commonly used in research, such as Lord's community ambulation self-report questionnaire and accelerometers offer information relevant to research parameters but may be limited in measuring community walking ability in clinical practice. Therefore, researchers may not be using measures that have clinical relevance. Additionally, it may also be a reasonable expectation that researchers need to communicate better with therapists to identify how best to measure community walking. A range of factors may play a role in the choice physiotherapists make when implementing measures of community walking, including infrastructure and health care policies e.g., lack of equipment such as accelerometers or local standards of practice recommending specific measures. Furthermore, feasibility and utility of the measures may also influence how the measures are implemented in clinical practice.

Such issues of knowledge translation can be addressed via integrated knowledge translation, where research is designed to be a collaborative venture between researchers and knowledge users (Bowen & Graham, 2013). Thus, researchers and clinicians collaborating may help identify and implement measurement tools that are more relevant and useful for community walking for both researchers and clinicians alike.

The scientific literature has suggested a range of measures of community walking which are being utilised in clinical practice. Physiotherapists identified that current measures are limited in their accuracy to comprehensively measure community walking. These issues may make it challenging for physiotherapists to choose a relevant measure of community walking to use in

clinical practice. Findings from this research program therefore highlight a gap in the evidence related to measurement of community walking in stroke survivors.

6.2.2. What drives physiotherapists' choice of a measure?

This lack of consensus appears to lead physiotherapists to choose a measure based on factors they think best represents community walking. Factors such as stroke survivors' goals, perceived important contributors to community walking, routine practices in the local work-setting and knowledge of guideline recommendations may be some of the drivers for physiotherapists' selection of measures.

As identified in Study 1, physiotherapists may select a measure that reflects stroke survivors' goals regarding community walking. For example, if a stroke survivor's goal was to go to the park with their grandchildren, physiotherapists may choose a measure of community walking that reflects being able walk on grass or other terrains. Alternatively, if the stroke survivor's goal was to walk in the neighbourhood the physiotherapists may choose walking distance as a measure of community walking.

Another factor driving the choice of a measure for community walking may be physiotherapists' perspective of important contributors of community walking or what constitutes community walking. Gait speed has long been identified as an important contributor of community walking by physiotherapists and the scientific literature (Corrigan & McBurney, 2012; Lord & Rochester, 2005) and is probably the most utilised proxy measure of community walking.

There is also a possibility that physiotherapists' work-setting plays a role in choosing a measure of community walking. Participating physiotherapists in Study 1 working in in- patient rehabilitation relied on observing walking and estimating gait speed, distance walked, and supervision needed for community walking based on their observations. Physiotherapists working in outpatient services and community rehabilitation utilised more objective measures including 6MWT or the Functional Gait Assessment to infer community walking. The choice of measure may also depend to some extent on routine practices followed in the work-settings. Feasibility of the measurement tools in terms of resources needed in the clinical setting and time taken to administer may also contribute to selecting a measure.

Another important factor driving physiotherapists' choice of a measure may be the recommendations within stroke clinical guidelines. For example, the recently published American clinical practice guidelines recommend a core set of outcome measures for neurological physiotherapy (J. Moore et al., 2018). Recommended balance and gait outcome measures were Functional Gait Assessment, ABC scale, 10MTW and 6MWT (J. Moore et al., 2018). The 10MTW and 6MWT were recommended as measures to indicate community walking ability. Gait speed and distance were also recommended to be included as core measures in stroke recovery research (Kwakkel et al., 2017); suggesting that if clinicians and researchers at the very least used these two measures consistently, this could facilitate a bridging of the clinical research divide.

6.2.3. Using the ICF to select the right measure of community walking

Selecting the right outcome measure reflects good clinical practice, helping physiotherapists to identify and quantify observations (Potter et al., 2011) and enhances the efficiency of practice

(Andrews, Folger, Norbet, & Swift, 2008). The ICF framework can provide a basis for selecting an outcome measure (WHO, 2001) supporting physiotherapists' decision making regarding identification and selection of the right outcome measure (Potter et al., 2011).

Selecting measures reflecting components of the ICF enables researchers and clinicians to include measures that are clinically relevant (Potter et al., 2011). For community walking, this would imply choosing a measure that covers important contributing factors from relevant ICF components. This is likely to be a challenging task for two reasons – first, given the multifactorial nature of community walking, a decision would need to be made regarding what factors need to be included in a measure and second, currently no measure seems to evaluate comprehensively a combination of factors.

Physiotherapists may wish to measure only a selective factor or use a combination of tests that measure relevant factors contributing to community walking, such as gait speed and walking distance in different environments reflective of community walking. However, for both these choices, it is vital to take into consideration the impact of broader domains of participation (Doyle, 2002; Lord & Rochester, 2005) and personal factors on community walking such as confidence in balance and satisfaction with community walking (Durcan et al., 2016; Robinson, Shumway-Cook, Ciol, et al., 2011). A feasible choice in this scenario seems to be a measure that is inclusive of stroke survivors' goals in adjunct to physiotherapists' evaluation of community walking. Acknowledging stroke survivors' goals may guide physiotherapists to choose what factors are important to measure. Collaborative goal-setting may also be useful in capturing broader domains such as participation in community walking.

6.2.4. Collaborative goal-setting

Collaborative goal-setting might also be feasible to inform measurement of community walking for stroke survivors. Recently updated Australian clinical guidelines recommend individualised goal-setting for stroke survivors having difficulty in community walking (Stroke Foundation, 2017a). The guidelines also recommend physiotherapists and stroke survivors work collaboratively on goal-setting to inform the plan of care (Stroke Foundation, 2017a).

Goal-setting also facilitates recovery and improves performance in stroke survivors (Sugavanam et al., 2013). Clinicians working with stroke survivors have identified that inclusion of stroke survivor goals facilitates better engagement in rehabilitation (Parsons et al., 2018). Goals meaningful to stroke survivors enhance motivation and active involvement in rehabilitation (Parsons et al., 2018). Participating physiotherapists in Study 1 took into account stroke survivors' goals when selecting a measure of community walking. Participants also acknowledged possible differences between physiotherapists' and stroke survivors' interpretation of successful community walking. Therefore, clear communication between clinicians and stroke survivors collaborating on goal-setting is required and has been recommended as best practice in stroke rehabilitation (Sugavanam et al., 2013).

Collaborative goal-setting should occur regardless of clinical setting or time post stroke. Participating physiotherapists in Study 1 from different work-settings ranging from acute care services to community services identified the importance of stroke survivors' goals in determining success of community walking. Benefits of goal-setting are acknowledged by clinicians and neurological clients across the spectrum of care from acute to community rehabilitation (Young, Manmathan, & Ward, 2008). Goal-setting should occur for both short-

term and long-term goals. Short-term goal-setting is reported to be an indicator of progress in inpatient neuro-rehabilitation (Black et al., 2010). Longer-term goal-setting is also important as stroke survivors achieving their goals six months after inpatient rehabilitation have more positive perceptions of their participation in the community (Brock et al., 2009). More than a year after stroke, stroke survivors identified walking in the community as an area of priority in goal-setting (Heinemann et al., 2010).

Goal-setting and goal attainment have both been reported to be valid outcome measures in neurological rehabilitation (Hurn, Kneebone, & Cropley, 2006). Additionally, the recent American neurological rehabilitation clinical guidelines (J. Moore et al., 2018) recommended that clinicians should document goals set by the patient and monitor the progress of rehabilitation, using an outcome measure such as the Goal Attainment Scale (Turner-Stokes, Williams, & Johnson, 2009). The guidelines also recommend reporting the goal-related tasks, the time to complete the tasks or patient's stated level of independence. Documenting patient goals is recommended to be undertaken at least twice, at admission and discharge, and, when feasible, between these periods (J. Moore et al., 2018). Collaborative goal-setting with stroke survivors in addition to physiotherapist's evaluation of relevant impairments, may inform the measurement of community walking.

6.3. Study Limitations

The following section includes a discussion of the limitations of the studies included in the research program.

6.3.1. Study 1

Methods

Qualitative research acknowledges the importance of data collection from multiple sources to fully explore the topic of interest (Corbin & Strauss, 2008; Denzin, 2017). Purposive sample of physiotherapists working in a range of clinical settings and with diverse clinical experience, was employed in this study to ensure rich information was obtained. However, within this sample, there was a limited range in the participants' age (range 27 to 34 years) and a mean experience of 8 years. It is possible that a more diverse sample in terms of clinical experience may have added additional perspectives to those reported in Study 1.

Although a sample size of 11 physiotherapists proved to be sufficient to reach thematic saturation, a more diverse sample may have added strength to the obtained data. It is acknowledged that the views of occupational therapists, clinical exercise physiologists and rehabilitation physicians may differ from physiotherapists and their perspectives could be explored in future studies.

Analysis

An inductive approach to thematic analysis was used to analyse Study 1 data, without determining apriori codes. Inductive thematic analysis offers a flexible approach that can be modified for the aim of the study and provides a detailed, yet intricate account of data (Braun & Clarke, 2006; Thomas, 2006). Inductive thematic analysis is an effective method for investigating the perspectives of a range of participants, emphasising similarities and differences, and generating unanticipated insights (Braun & Clarke, 2006; Thomas, 2006;

Vaismoradi, Turunen, & Bondas, 2013). While thematic analysis offers flexibility, this may lead to inconsistency when generating themes derived from the data (Holloway & Todres, 2003). There is a possibility that reviewers in the current study may have conceptualised qualitative findings differently owing to professional backgrounds and experiences. Interpretive bias and inconsistency in conceptualising findings were minimised in this study by triangulation of data analysis by independently reviewing and discussing themes.

Applicability of results

The applicability of the findings from this study may be limited, as the participants represent a specific group of physiotherapists within a defined number of years of experience and work-setting, they were not representative of broader cohort of physiotherapists. However, themes identified in this study related to current measures of community walking may be relevant to other physiotherapists.

6.3.2. Study 2

Phase I of the Systematic Review

A number of limitations pertaining to methods must be acknowledged. First, the focus of the systematic review was restricted to stroke survivors' community walking. It is possible that measures of community walking used in other populations or people with other health conditions may not have been identified. Second, only those studies published in English were included, thus identifying measurement tools available only in English. Third, the research questions for this systematic review were broad, as the aim was to identify all possible measures of community walking in stroke survivors. The studies included presented a wide

range of designs, as no restriction was applied for specific types of study. This resulted in a lack of homogeneity in the included studies. Additionally, meta-analysis was not possible given the research aims. A descriptive synthesis of findings from included studies was conducted which may have been influenced by investigator experiences.

Quality assessment of the included studies was not undertaken in this systematic review. As the aim was to identify measures of community walking, all eligible studies were included to extract possible measures of community walking. This may have impacted the number of included studies; as studies of any design and quality were included. Quality assessment of included studies has not been undertaken in previous studies on content analysis of measures using an ICF linking process (Ballert et al., 2016; Fayed et al., 2011; Geyh et al., 2007; Geyh et al., 2004). A lack of quality assessment is unlikely to have influenced the identification of relevant measures nor the ICF linking process.

Unlike traditional systematic reviews, this review aimed to analyse content of the identified measures, and not evaluate psychometric properties of the identified measures. An investigation of psychometric properties of the included measures was beyond the scope of this thesis. Future investigation of psychometric properties of the included measures would however require a quality assessment.

Phase II of the Systematic Review

The ICF framework and the linking process are valuable resources for content analysis of measures; however, some limitations should be acknowledged.

Within the ICF linking process, identifying the main and additional concepts in a measure is an interpretative process. There is a chance that researcher's experience may influence identification of concepts. However, regular discussions within the research team were held and consensus was reached throughout the linking process.

The ICF framework consists of more than 1400 categories (WHO, 2001). Some of the categories which were linked in this study seem to be ambiguous for community walking items. For example, walking on different surfaces (d4502) is categorised under the domain of Mobility (Activity and Participation) and not in the Environmental factors component of ICF; however, the task of walking on different surfaces also represents an environmental aspect of community walking. Similarly, the task of shopping (d6200), which is covered in a few measures of community walking is categorised under Domestic life (Activity and Participation). Whereas within the context of community walking, shopping would seem to be a combination of walking certain distances and dual-tasking while walking.

Some ICF categories seem to be embedded within the other categories. For example, the category of socialising (d9205) which describes engaging in informal gatherings such as visiting friends or relatives, is similar to the d750 categories of informal relationships, and seem to cover socialising as well.

Lastly, though the ICF acknowledges personal factors, they are not classified within the ICF. The linking process rules recommend that if the identified concept is not contained in the ICF but is clearly a personal factor as mentioned in the ICF, the concept could be coded as pf (personal factors)(Cieza et al., 2016). Despite this provision in the linking process, it seems

challenging to code personal factors. For example, confidence is classified in ICF as a Body function (b1266), whereas within the measures of community walking confidence seems to link to a personal factor that could affect certain activities related to walking in the community.

Limitations mentioned in this section were addressed by researcher agreement and consensus reached throughout the process. Given the limitations within the ICF framework and the complexity of ICF linking process, the results of the content analysis of identified measures should be interpreted only within the context of community walking.

6.4. Future directions

Research findings of both studies provide directions and scope for future research. Both studies included in this research program highlight the need to further investigate measurement of community walking in stroke survivors. The following section discusses future directions of research based on findings of Study 1 and Study 2 of this research program. Recommended future directions include - investigating the psychometric properties of identified measures, understanding stroke survivors' perspective of community walking and possible options for the future measurement of community walking.

6.4.1. Investigating the psychometric properties of identified measures

Before selecting a measurement tool, it is essential to evaluate its performance in terms of psychometric properties such as validity, reliability and sensitivity to change (Portney, 2015; White & van den Broek, 2004). Reviewing psychometric properties has been recommended and remains central to the process of selecting a measure in neurological physiotherapy practice

(Potter et al., 2011; Sullivan et al., 2011). Only two of the measurement tools identified in Study 2, Lord's community ambulation self-report questionnaire and the EAMQ were specifically designed for evaluating stroke survivors' community walking; however, the validity of these tools remains unclear and has not been reported in the included studies. Similarly, the psychometric properties of the other identified measures for measuring community walking were not necessarily reported in the included studies.

All identified measures covered a range of factors relevant to community walking; however, it is not clear if these measures are suitable to measure the relevant factors covered (validity), whether the measures can be implemented with minimal error (reliability) and if the measure can ascertain that treatment results in a change in the status of community walking (sensitivity to change). Future studies could focus on reviewing the literature on psychometric properties of the measures for evaluating community walking in stroke survivors. This could involve appraising the reported validity, reliability and sensitivity to change with respect to use of the tools to measure community walking. Even measures such as the 10MTW and 6MWT with good psychometric properties, have not been psychometrically evaluated for measuring community walking in stroke survivors. For this purpose, COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) check-list may be used to assess the quality of studies reporting on psychometric properties of the identified measures (Terwee, 2012).

6.4.2. Stroke survivors' perspectives

Understanding patient's perspectives is a key element of evidence-based physiotherapy practice (Gibson & Martin, 2003). Exploring patient's perspectives using qualitative research

can augment quantitative research in providing a valuable contribution to the development of measures and interventions that are relevant to stroke survivors (Barclay, Ripat, et al., 2015; Gibson & Martin, 2003; Salter, Hellings, Foley, & Teasell, 2008).

Stroke survivors have reported walking in the community has a positive impact on physical and emotional well-being (Barclay, Ripat, et al., 2015). Stroke survivors have also reported that walking outside home in the community is influenced by a range of factors in the environment, including traffic rules, negotiating various surfaces and support from family and friends (Barclay, Ripat, et al., 2015; Nanninga et al., 2017). Walking in the community is identified as an important goal to achieve by stroke survivors and thus understanding community walking and measurement of community walking from a stroke survivor's perspective may provide valuable insights.

Physiotherapists in Study 1 acknowledged that stroke survivors' goals can play an important role in achieving community walking. Based on this, physiotherapists also reported taking into account stroke survivors' goals when selecting a measure of community walking and designing treatments likely to be effective in helping the patient achieve the goals. Future research can explore stroke survivors' perspectives of community walking to determine what factors stroke survivors perceive contribute to their success of community walking. Understanding stroke survivors' perspective may also help understand the impact of personal factors including motivation, confidence and satisfaction with their capacity to walk in the community. In addition, exploring stroke survivors' perspectives can further inform measurement, by physiotherapists and stroke survivors collaborating on goals related to community walking and measuring what is important.

6.4.3. Measurement of community walking

Future research is needed regarding the measurement of community walking. This thesis has highlighted a research practice gap as there appears to be no consensus either within clinical practice or in the scientific literature regarding measurement of community walking. There is certainly little bridging of the evidence between researcher and clinicians regarding measurement of community walking. Overall, findings of both studies from this research program identified challenges associated with current measures evaluating community walking in stroke survivors. No measures covered important contributors consistent with community walking, and participating physiotherapists found it challenging to measure community walking comprehensively. Given this, possible options to bridge the gap in measurement of stroke survivors' community walking may include either using a battery of measures or creating a new comprehensive tool to measure community walking in stroke survivors.

Battery of measures or a comprehensive new measure

One possible solution to the problem of measuring community walking could be for future studies to focus on achieving a consensus between researchers and clinicians on what measure/s should be used to evaluate stroke survivors' community walking. With current measures largely being unidimensional, it is reasonable to suggest that assessment might involve utilising a battery of measures, based on the factors contributing to community walking. This battery may include relevant measures that are informed by expert review and scientific evidence but could include the 10MTW to measure gait speed, 6MWT for distance walked, and the Berg Balance Scale or similar measures to reflect balance components. A battery of measures may be expected to characterise and quantify community walking, and

also be implemented to measure community walking as an outcome in intervention studies targeted at improving community walking. The clinical utility of such a battery will need to be established.

Alternatively, it is also reasonable to suggest that a new comprehensive measure of community walking is required. In recent years, considerable research has been undertaken to understand the concept of community walking (Barclay, Ripat, et al., 2015; Nanninga et al., 2017; Robinson et al., 2013) and factors contributing to community walking in stroke survivors (Bijleveld-Uitman et al., 2013; Corrigan & McBurney, 2012; Durcan et al., 2016; Fulk et al., 2010; Lee, Lim, et al., 2015; Robinson, Shumway-Cook, Matsuda, et al., 2011; Rosa et al., 2015). This body of evidence may guide the selection of relevant items that need to be considered such as gait speed, distance walked, balance self-efficacy and environmental features for inclusion in a new comprehensive measure. Participating physiotherapists in Study 1 of this research program also identified important factors to be considered for inclusion in a measure of community walking such as gait speed and endurance performed in a community situation, balance and dynamic components of balance, stroke survivors' safety awareness, and stroke survivors' perceived confidence and satisfaction in community walking tasks (Figure 6.1.).

Figure 6.1 Factors identified by physiotherapists to be considered for inclusion in a measure of community walking

The selection of items for both a battery of measures or a new comprehensive measure would need to be confirmed, possibly by an expert review or a Delphi study. A comprehensive measure of community walking seems to be reasonable at least theoretically. Regardless of the type, the measure would need to be feasible, practical, resource efficient, and applicable to community walking reflecting the contributing factors. In the absence of a gold-standard measure of community walking and due to the lack of consistency in available measures, consideration must be given to how a test battery would be validated.

Format of a new measure of community walking

If a new measure or a battery of measures of community walking is to be developed or agreed upon, the format (or mode of administration) needs consideration. Findings from the studies in this research program suggest a patient-reported measure may be feasible for measuring community walking. In Study 1, physiotherapists identified factors such as stroke survivors' confidence and satisfaction related to community walking, as important to be measured Figure 6.1. Patient-reported measures may be a suitable format for these items. At the same time, findings from this research program highlight a lack of a suitable patient- reported measure that looks at factors specific to community walking in stroke survivors. For some of the measures identified in the systematic review, researchers had modified existing patient-reported measures in order to make them relevant for community walking or used selected relevant items from these measures to infer community walking.

Patient-reported measures are of the utmost importance when offering patient-centred health care (Kingsley & Patel, 2017). For community walking, a patient-reported measure may be more relevant than other types of measure to understand and measure personal factors contributing to community walking. Patient-reported measures may also provide an insight into the impact of rehabilitation targeted at improving community walking.

Developing a patient-reported measure for community walking may be less time-consuming than an inclusive comprehensive measure; however, a range of steps would be involved in developing a patient-reported measure. The pre-requisite to developing a patient-reported measure will be conceptual framework construction by reviewing relevant literature on stroke survivors' community walking. Item generation will need to be informed by taking into

consideration stroke survivors' and physiotherapists' perspective of community walking. Thus, a study exploring stroke survivors' perspectives would need to precede item generation. Generated items can be narrowed down using a Delphi process and literature review (Streiner, Streiner, Norman, & Norman, 2008). The pre-test items will then need to be reviewed for comprehensibility, skew and refining or modifying items accordingly (Streiner et al., 2008). The next steps would involve testing the pilot measure on a large sample size, examining psychometric properties and removing items that performed poorly in statistical analysis. Once the final measure is developed, further testing will be needed to ascertain reliability and construct validity and to re-evaluate the impact of confounding factors (Streiner et al., 2008).

Patient-reported measure may be useful in developing treatment plans based on stroke survivors' concerns and goals; however, some of the limitations need to be considered. Comparability of outcomes between individuals, using patient-report measures may be limited. Additionally, patient-reported data may not provide direct quantification of community walking.

Use of technology in measuring community walking

Advances in technology may also provide a possible measure of community walking. Accelerometers and GPS devices can quantify community walking in terms of number of steps taken, distance walked, and location/s visited (Fini et al., 2015). The devices offer a direct recording of ambulatory activity and may be utilised easily when stroke survivors walk in the community.

Global positioning system devices provide a means to identify places navigated to and time taken for navigation and have been utilised to establish if a stroke survivor navigates to meaningful places for social, and occupational goals (Evans et al., 2012). Global positioning system devices offer integrated information about distance walked and places visited, including places meaningful for stroke survivors, which is relevant to community walking (Evans et al., 2012; Mahendran, Kuys, & Brauer, 2016). Using the stroke survivors' report as an adjunct to GPS devices may help capture community walking. For example, stroke survivors' purpose for visiting places and the related participation goals can provide important information in addition to navigation data (Evans et al., 2012; Mahendran, Kuys, & Brauer, 2016; McCluskey et al., 2012).

Global positioning system devices are reported to be valid, reliable and feasible for measuring community walking in stroke survivors (Mahendran, Kuys, Downie, et al., 2016). Accuracy of GPS is reported for measuring gait speeds > 0.42 m/s, number of steps and time spent walking. However, in the study by Mahendran, Kuys, Downie, et al. (2016), GPS was not reported to be accurate for the distance walked. Distance walked in this study was short (200 meters). In addition, during the short distance walked, stroke survivors navigated between buildings which may have interrupted the satellite signals (Mahendran, Kuys, Downie, et al., 2016), and may have influenced the accuracy for distance. Accuracy of GPS has been shown to improve with longer distances walked (Le Faucheur et al., 2008; Paz- Soldan et al., 2014). The effect of environmental variations when walking in the community on GPS accuracy requires further investigation.

Some of the limitations of using GPS devices relate to environmental or technical issues. Global positioning system devices may not work accurately in city areas with tall buildings, for example (Paz-Soldan et al., 2014). Loss of data may also occur due to malfunctioning, reduced battery life and difficulty in switching on and off the device (Evans et al., 2012; Mahendran, Kuys, & Brauer, 2016; McCluskey et al., 2012; Paz-Soldan et al., 2014). Another possible issue associated with the use of GPS devices is emerging ethical concerns. Some of these concerns relate to third party access to location data and privacy. There are currently no guidelines on the measurement and use of GPS data that monitors activity (McNamee, 2005). Additionally, the use of devices may offer limited information about impact of social, environmental and personal factors on community walking. However, future research into use of GPS technology within smart phones and phone applications using the technology, may provide further directions for measuring community walking. Phone applications could be developed to record community walking in terms of distance walked and places visited and could also record patient-report of personal and environmental factors associated with community walking. The advent in technology may have the potential to simplify measuring community walking and offer further avenues to be explored by clinicians and researchers.

6.5. Conclusion

Results of Study 1 and Study 2 have successfully achieved the aims and objectives outlined for this research program. Study 1 explored physiotherapists' perspective about stroke survivors' community walking and Study 2 of this program has identified measures of community walking in stroke survivors and has analysed the contents of these measures within ICF framework.

Findings from both studies highlight that there is a lack of a comprehensive measurement tool of community walking in stroke survivors, as no single tool measures all of the important factors contributing to community walking. Community walking is mostly inferred based on some components of these measurement tools. Physiotherapists take into account stroke survivors' goals when selecting a measure of community walking and choose measures that they think best represent community walking.

Findings from this research program informs the literature on measures currently being used to evaluate stroke survivors' community walking and the content of these measures. Collectively, this research furthers our understanding of measurement of community walking in stroke survivors. As for the wide range of measures of community walking with a diverse content, the findings of this research program signal a need to decide on what should be measured. In the interim, investigating the psychometric properties of identified measures of community walking is recommended to ascertain applicability of the identified measures.

7. References

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8. Research Portfolio Appendices

8.1 Appendix 1: Ethics Approval

Principal Investigator: Dr Suzanne Kuys
Co-Investigator: Prof Nancy Low Choy,
Student Researcher: Neelam Nayak (HDR Student)
Ethics Register Number: 2016-276E
Project Title: Stroke survivor and physiotherapist perspectives of community walking: a qualitative study Risk Level: Low Risk
Date Approved: 14/02/2017
Ethics Clearance End Date: 30/06/2018

This email is to advise that your application has been approved by the Australian Catholic University's Human Research Ethics Committee and confirmed as meeting the requirements of the National Statement on Ethical Conduct in Human Research. This approval will be ratified at the next available meeting and is subject to the following:

. satisfactory validation of Working with Children Checks;
. receipt of outstanding permission letters/other approvals;
. ratification of any outstanding items (eg: interview/survey questions).

You will be contacted should the Committee raise any issues in relation to the above matters.

Failure to provide outstanding documents to the ACU HREC before data collection commences is in breach of the National Statement on Ethical Conduct in Human Research and the Australian Code for the Responsible Conduct of Research. ACU HREC approval is only valid as long as approved procedures are followed.

If you require a formal approval certificate, please respond via reply email and one will be issued. Researchers who fail to submit a progress report may have their ethical clearance revoked and/or the ethical clearances of other projects suspended. When your project has been completed a progress/final report form must be submitted. The information researchers provide on the security of records, compliance with approval consent procedures and documentation and responses to special conditions is reported to the NHMRC on an annual basis. In accordance with NHMRC the ACU HREC may undertake annual audits of any projects considered to be of more than low risk. Clinical Trials - Researchers should refer to the Australian New Zealand Clinical Trials Registry http://www.anzctr.org.au/) for information.

It is the Principal Investigators / Supervisors responsibility to ensure that:

1. All serious and unexpected adverse events (or any matter that might affect the ethical acceptability of the protocol) should be reported to the HREC with 72 hours.
2. Any changes to the protocol must be reviewed by the HREC by submitting a Modification/Change to Protocol Form prior to the research commencing or continuing. http://research.acu.edu.au/researcher-support/integrity-and-ethics/

3. Progress reports are to be submitted on an annual basis.
   http://research.acu.edu.au/researcher-support/integrity-and-ethics/
4. Protocols can be extended for a maximum of five (5) years after which a new application must be submitted. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).
   Please do not hesitate to contact the office if you have any queries.

   Kind regards,
   Kylie Pashley
   on behalf of ACU HREC Chair, Dr Nadia Crittenden Ethics
   Officer | Research Services
   Office of the Deputy Vice Chancellor (Research) Australian Catholic University

8.2 Appendix 2: Search strategy for the Systematic Review

1.CINAHL

CINAHL Keyword Search String
(Stroke OR “Cerebrovascular accident” OR CVA OR “brain hemorrhage” OR “brain attack”) AND (measure* OR scale* OR instrument* OR assessment) AND (“community walking” OR “community ambulation” OR “social participation”)

CINAHL Subject Headings Search String
(((MH "Stroke+") OR (MH "Stroke Patients")) AND ((MH “Outcome Assessment+”) OR (MH “Research Measurement+”)) AND ((MH "Walking") AND ((MH “Community Living+”))

2.PubMed

PubMed Keyword Search String
(Stroke OR “Cerebrovascular accident” OR CVA OR “brain hemorrhage” OR “brain attack”) AND (measure* OR scale* OR instrument* OR assessment) AND (“community walking” OR "community walkers" OR “community ambulation”)

PubMed MeSH & Keyword Search String
(("Stroke"[Mesh]) OR Stroke OR “Cerebrovascular accident” OR CVA OR “brain hemorrhage” OR “brain attack”) AND (("Patient Outcome Assessment"[Mesh]) OR ("Outcome Assessment (Health Care)"[Mesh]) OR (“Exercise Test”[Mesh]) OR measure* OR scale* OR instrument* OR assessment) AND (“community walking” OR “community walkers” OR “community ambulation”)

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3. Embase

Embase Keyword & Emtree Headings Search
(exp cerebrovascular accident/ or (Stroke or CVA or brain hemorrhage or brain attack).tw.) AND (exp outcome assessment/ or exp patient assessment/ or exp measurement/ or exp exercise test/ or (measure* or scale* or instrument* or assessment).tw.) AND (((exp walking/ or exp mobilization/) and exp community/) or (community walking or community walker or community ambulation).tw.)

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4. Scopus Keyword Search String
TITLE-ABS-KEY((Stroke OR {Cerebrovascular accident} OR CVA OR {brain hemorrhage} OR {brain attack}) AND (measure* OR scale* OR instrument* OR assessment) AND ({community walking} OR {community walkers} OR {community ambulation}))

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5. Web of Science Search String
(Stroke OR “Cerebrovascular accident” OR CVA OR “brain hemorrhage” OR “brain attack”) AND (measure* OR scale* OR instrument* OR assessment) AND (“community walking” OR “community walkers” OR “community ambulation”)

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6. PsycInfo keyword search
Stroke OR “Cerebrovascular accident” OR CVA OR “brain hemorrhage” OR “brain attack”) AND (measure* OR scale* OR instrument* OR assessment) AND (“community walking” OR "community walker" OR “community ambulation”)

8.3 Appendix 3: Registered Systematic Review protocol on PROSPERO

PROSPERO
International prospective register of systematic reviews

NHS National Institute for Health Research

Measurement of community walking in stroke survivors

Neelam Nayak, Nancy Low Choy, Belinda Bilney, Suzanne Kuys

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Review question

What measures are available to evaluate community walking in stroke survivors? What is the content included in these measures, and how does the content link within the International Classification of Functioning, Disability and Health framework?

What are the psychometric properties of measures for evaluating community walking in stroke survivors?

Searches

The following databases will be searched from database inception to the present day: CINAHL, EMBASE, PEDro, PubMed, PsycINFO, Scopus, and Web of Science

Studies in the English language will be included.
The bibliography of included studies will be scanned for further relevant articles. Additional details about the search strategy can be found in the attached PDF document.

Types of study to be included

There will be no restrictions on the types of study design eligible for inclusion.

Condition or domain being studied

Community walking in stroke survivors.

Participants/population

Inclusion: adults aged 18 years or over with stroke, type of stroke - ischemic/hemorrhagic. Exclusion: people under 18 years of age, people with traumatic brain injury, neurodegenerative or neurosurgical disorders.

Intervention(s), exposure(s)

All studies measuring or reporting community walking as a primary or secondary outcome measure will be included.

Comparator(s)/control

Not applicable.

Context

There will be no restrictions on the context/settings to be included.

Main outcome(s)

A descriptive synthesis of measures of community walking.

Additional outcome(s)
Descriptive syntheses of identified measures, content of the measures and psychometric properties of the measures (validity, reliability, predictive ability, accuracy).

Data extraction (selection and coding)
Titles and abstracts from preliminary searches will be screened by two reviewers (SK, NN), and the full texts of relevant studies will be retrieved. Any disagreements will be resolved by consensus.
Data to be extracted:

Participant characteristics: number, age, gender, and post-stroke duration.

Measurement of community walking: name of the measure, mode of administration, content of the measures within the International Classification of Functioning, Disability and Health framework, and psychometric properties

Risk of bias (quality) assessment
One of the aims of this systematic review is to identify measures and explore content of the identified measures within the International Classification of Functioning, Disability and Health (ICF) framework. Standardised guidelines (Cieza et al., 2016) will be utilised to report on content of the identified measures of community walking for stroke survivors. According to the standardised guidelines assessing the quality of studies is not required and will not be undertaken. This will not influence the planned synthesis of identified measures and content of the measures.

For the aim of reporting on psychometric properties of the identified measures, COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) check-list will be used to assess the quality of studies.

Strategy for data synthesis
A descriptive synthesis of measures of community walking will be carried out.

Analysis of subgroups or subsets
Measurement tools used for community walking will be grouped where possible based on mode of administration of the measures.

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Details of any existing review of the same topic by the same authors Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes
Formal screening of search results against eligibility criteria	Yes	Yes
Data extraction	Yes	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

Versions
16 June 2016

8.4 Appendix 4: Data extracted for Study 2

Author & Journal	Study design	Setting	n	Age yrs (SD)	Gender (F:M Ratio)	Post stroke duration-Months (SD)	Walking status for inclusion in the study		Measure of community walking
Amatachaya, S., et al. (2016). "Levels of community ambulation ability in patients with stroke who live in a rural area." Malaysian Journal of Medical Sciences 23(1): 56-62.	Cross sectional	Home	95	62.1 (8.3) Age range 40-75 yrs	50% Males (n=53)	73.8 (62.0)	Needed to be able to walk independently over at least 10 m with or without a walking device	Ability to walk independently for at least 10 m with or without a walking device	Lord's Community Ambulation Questionnaire
An, S., et al. (2015). "Gait velocity and walking distance to predict community walking after stroke." Nursing & Health Sciences 17(4): 533-538.	Cross sectional	IPD	103	A=60 (9.01) B=56.86 (10.39) C=57.78 (6.75)	60 males /103	A=8.20 (1.84) B=9.22 (4.20) C=9.68 (4.68)	Patients who could independently walk 10 meters without external support	FAC ≥ 3 points	Lord's Community Ambulation Questionnaire
Barak, S., et al. (2014). "Adherence to	Cross-sectional	IPD	408	62.02 (12.74)	224 males/408	Two months	All participants had gait speed of <0.8 m/s	Not reported	1.Perry's FWC to classify as household walkers as 0.4 m/s and limited community ambulators: 0.4 to to 0.8 m/s

accelerometry measurement of community ambulation poststroke." Phys Ther 94(1): 101-110.									2. Habitual ambulatory activity was assessed with the Step Activity Monitor. The SAM was programmed to be worn for 5 days, with the goal of collecting 2 days of data. An additional step that was con-ducted in an effort to ensure that the adherence definition provides valid information for both active and nonactive individuals involved the determination of the Functional Ambulation Classification (FAC) of individuals with nonactive days (x20 steps per day). A comparison of the FAC and SAM step activity enabled the discovery of inconsistencies between functional ambulation level and step activity caused by nonadherence or SAM malfunctioning.
Bethoux, F., et al. (2015). "Long-Term Follow-up to a Randomized Controlled Trial Comparing Peroneal Nerve Functional Electrical Stimulation to an Ankle Foot Orthosis for Patients With Chronic Stroke." Neurorehabilitation & Neural Repair 29(10): 911-922.	RCT	IPD-Community	384 (follow-up)	FES= 63.87 (11.33) AFO= 64.30 (12.01)	Females=191 Males= 304	FES= 6.90 (6.43) AFO=6.86 (6.64)	Ability to ambulate at least 10 meters at a speed >0.0 m/s and <0.8 m/s	Not reported	. Modified Emory Functional Ambulation Profile (mEFAP) for the ability to perform functional ambulation tasks : . The mEFAP consisted of 5 subtasks: (a) a 5-m walk on a hard floor, (b) a 5-m walk on carpet, (c) a Timed Up and Go, (d) the navigation of a standardized obstacle course, and (e)the ascent and descent of 4 stairs. The total mEFAP was calculated using the sum of the 5 subtasks.The mEFAP measures ambulatory ability in functional, real-world environments commonly encountered in household and community ambulation. . Perry's FWC to demonstrate changed in gait speed
Bijleveld-Uitman, M., et al. (2013). "Is	Cross-sectional data from	IPD-Home	241	58.1 (10.3)	158 males	8.7 (1.5)	Ability to walk a minimum of 10 m without physical	FAC ≥ 3	Lord's Community Ambulation Questionnaire

gait speed or walking distance a better predictor for community walking after stroke?" Journal of rehabilitation medicine: official journal of the UEMS European Board of Physical and Rehabilitation Medicine 45(6): 535-540.	ongoing RCT				out of 241		assistance from a therapist.		
Dickstein, R., et al. (2013). "Effects of integrated motor imagery practice on gait of individuals with chronic stroke: a half-crossover randomized study." Arch Phys Med Rehabil 94(11): 2119-2125.	Experimental-crossover	Community	23	72(6.9)	16 males /23	76.5(46) weeks	Not reported	Not reported	Community ambulation was determined by data collected via the step activity monitors (SAM) which was donned by each participant during wake time in the 60 hours after each assessment.
Donovan, K., et al. (2008). "Mobility beyond the clinic: the	Prospective, observational	OPD and Community	30	61.3(11.1)	21 males/30	46.5(32.9)	Home-dwelling, walking independently in the community for at least 6 minutes (self-	10MTW in a clinic environment - baseline assessment	The 6MWT was used in each of the three environments, clinic, street and mall. Gait parameters were collected using the Step-Watch Step Activity Monitor (SAM).Prior to this study a reliability study was undertaken

effect of environment on gait and its measurement in community-ambulant stroke survivors." Clinical Rehabilitation 22(6): 556-563.							reported) and had a baseline gait speed between 20–50 m/min		on this device for 10 community ambulant stroke survivors and was found to be a reliable and valid tool, with intraclass correlation coefficients values for step length, cadence and speed ranging from r=0.89 to 0.99.15.
Durcan, S., et al. (2016). "Factors associated with community ambulation in chronic stroke." Disability & Rehabilitation 38(3): 245-249.	Cross sectional	Community rehabilitation outpatient	40	66 (13.4)	22 males out of (55)	22.3 (6.9)	Independent, with or without walking aid	10-meter walk	Lord's Community Ambulation Questionnaire
Ferreira, M. S., et al. (2015). "Non-motor factors associated with the attainment of community ambulation after stroke." Clinical Medicine and Research 13(2): 58-64.	Prospective cohort, follow-up after 6 months rehab.	OPD	201	56.9	49% male	> 6 months of rehab, duration not mentioned	Not reported	Not reported	The Hoffer classification is categorized as absent/nonambulatory [0], therapeutic [1], household [2], and community ambulation [3]. Therapeutic ambulation is characterized as the ability to walk only with assistance from other people and/or therapeutic splint features like canvas, parallel bars, and ante-brachial walker support, for example. Household is characterized as the ability to walk independently inside the house, and community is the ability to ambulate out of the home independently or with the use mobility aids such as canes.
Fulk, G. D., et al. (2010). "Predicting	Cross sectional	OPD	Stroke=19 Age	65.7(11.9)	Not reported	42.1(36.1)	Ability to ambulate on level surfaces independently with	FAC 4 or 5	1. Number of steps taken per day using StepWatch Activity Monitor (SAM): Participants instructed to wear

home and community walking activity in people with stroke." Arch Phys Med Rehabil 91(10): 1582-1586.			matched =13				or without an assistive device Gait speed > 0.40m/s		SAM on their least affected LE for 1 week during all waking hours, except while bathing. 2. Walking ability Questionnaire (WAQ) for mobility, includes evaluation component
Joa, K. L., et al. (2015). "Classification of walking ability of household walkers versus community walkers based on K-BBS, gait velocity and upright motor control." Eur J Phys Rehabil Med 51(5): 619-625.	Cross sectional	OPD	124	53.9(15.4)	68 males/124	> 3 months	Not reported	Not reported	Perry's Functional walking categories: Patients were asked to choose one of six walking categories which describe their functional walking ability at home or community.
Kim, M., et al. (2014). "Community walking training program improves walking function and social participation in chronic stroke patients." Tohoku Journal of Experimental	Pre-post, experimental	IPD	22	50.45	13 males	231.64 days	Walk 10 m independently without an assistive device	Gait speed < 0.8 m/s	Community gai assessment route- 300 metersThe community gait assessment route was 300 m, including a 150-m pedestrian walkway, 100-m park trail, a 20° slope, 10 stairs, and a visit to a convenience store. Assessment was conducted at a comfortable gait speed, and the subjects could take a rest when they wanted. The community gait assessment was performed in a new place to exclude the learning effect of training.

Medicine 234(4): 281-286.									
Lee, K. B., et al. (2015). "The relationship between motor recovery and gait velocity during dual tasks in patients with chronic stroke." Journal of Physical Therapy Science 27(4): 1173-1176.	Cross sectional	OPD	33 stroke 12 Healthy	A=52.6 (10.4) B=49.0(13.4) Healthy=54.7(7.6)	18 males/33	5.9 (6.9)years for limited CW 4.2 (2.6) for CW	Walk at least 15 m without help	Not reported	Lord's Community Ambulation Questionnaire
Lee, K. B., et al. (2015). "Factors related to community ambulation in patients with chronic stroke." Top Stroke Rehabil 22(1): 63-71.	Cross sectional	OPD	46	A=54.77(13.08) B=53.53(14.75) C=49.78(11.15)	28 males	A=5.22(3.00) B=4.06(3.08) C=5.52(7.17)	Included if able to walk independently with no assistance or device for a least 15 m	Not reported	Lord's Community Ambulation Questionnaire
Lord, S., et al. (2008). "How feasible is the attainment of community ambulation after stroke? A pilot randomized controlled trial to evaluate	RCT	IPD-OPD-Home	30	64.2 (14.8) Group 1 60.7 (17.6) Group 2	18 males/30	83.1(29.8) days for Group 1 80.3(33) days for Group 2	Identification of independent community ambulation as a primary rehabilitation goal	Ability to walk to their letterbox and no further	Gait speed, as measured with 10 MTW Community ambulation status was further inferred from responses given to six items on the Activities-specific Balance Confidence Scale pertaining to community mobility and Q4 and Q5 on SIPSO

community-based physiotherapy in subacute stroke." Clin Rehabil 22(3): 215-225.									
Lord, S. E., et al. (2004). "Community ambulation after stroke: how important and obtainable is it and what measures appear predictive?" Archives of Physical Medicine & Rehabilitation 85(2): 234-239.	Observational	Home-1- & 2-weeks post IPD	130	68.8(11.3)	71 male/130	16.3(11.5) weeks	Not reported	Not reported	Self-reported levels of community ambulation ascertained by questionnaire: Questionnaire developed and pilot tested on several people with stroke before the study-was used to identify community ambulation by self-report according to the level of unsupervised mobility. Participants were allocated to 1 of 4 community ambulation groups based on this self-report: Group 1: Not ambulant outside the home Group 2: Ambulant as far as the letterbox Group 3 : Ambulant in the immediate environment Group 4 : Ambulant in a shopping center and/or places of special interest. The 4 categories were used to discern different levels of community ambulation and community participation and were based on the responses participants gave to question 2, which related to the types of places people liked to visit before they had a stroke.
Mahendran, N., et al. (2016). "Accelerometer and Global Positioning System	Observational	Community	34	71.6(13.8)	Not reported	23.6(21.3) Rehab stay	Excluded if were unable to walk indoors for 10m	Not reported	Community ambulation was measured by an accelerometer, Global Positioning System, and activity diary. In addition, participants documented details of each community trip via an activity diary.Participants completed an activity diary that detailed trip time, location, estimated time spent walking,

Measurement of Recovery of Community Ambulation Across the First 6 Months After Stroke: An Exploratory Prospective Study." Archives of Physical Medicine & Rehabilitation 97(9): 1465-1472.									transport choice, purpose of community trips, and any issues encountered during trips. The activity diary was used during GPS and accelerometer data cleaning and analysis and to obtain purpose of trips into the community.
Mehrholz, J., et al. (2007). "Predictive validity and responsiveness of the Functional Ambulation Category in hemiparetic patients after stroke." Archives of Physical Medicine & Rehabilitation 88(10): 1314-1319.	Prospective cohort, follow-up after 6 months rehab.	IPD	55	62.8(10.2)	40 males /55	30.6 (15.5) days	Patients were all able to sit without holding on to any support and were either completely non-ambulatory or required the assistance of 1 or 2 therapists to walk irrespective of the use of an ankle-foot orthosis or a walking aid	Not reported	To measure predictive validity, functional community ambulation was used as a target outcome at 6 months after the study onset. The term “community ambulation” was used according to previous publications and was defined as the ability to walk faster than 73m/min, ability to walk longer than 332m,and ability to climb stairs and If patients met all 3 predefined conditions, patients’ ability to walk was graded as “community ambulation.”
Michael, K. M., et al. (2006). "Fatigue after stroke: relationship to mobility, fitness, ambulatory	Cross sectional	OPD	53	66	31 males	Mean 10.3 Range 6-166	Some preserved capacity for ambulation, with an assistive device or standby assistance, and could ambulate for a sufficient duration to allow	Timed 10-m walks were obtained during the initial visit to evaluate gait and to set parameters for subsequent treadmill testing.	Total daily step activity derived from microprocessor-linked Step Activity Monitors

activity, social support, and falls efficacy." Rehabilitation Nursing 31(5): 210-217.							treadmill testing at a minimal speed of 0.2 mph (0.42 mps).		
Miller, K. J., et al. (2016). "Use of Rasch Analysis to Evaluate and Refine the Community Balance and Mobility Scale for Use in Ambulatory Community-Dwelling Adults Following Stroke." Physical Therapy 96(10): 1648-1657.	RCT-secondary Rasch analysis	IPD-OPD-Home	100	62.8 (12.5)	57 males	3.5(2.5)	Ambulatory Community-dwelling	Not reported	The Community Balance and Mobility Scale (CB&M) is a 19-item ordinal scale scored out of 96 points, with higher scores representing better walking balance performance. Each test item is scored from 0 to 5 (with the exception of item 12: descending stairs, rated from 0 to 6) to reflect a hierarchy of task difficulty based on established criteria such as time, distance, and quality of performance.
Robinson, C. A., et al. (2013). "Participation in community walking following stroke: the influence of self-perceived environmental barriers." Phys Ther 93(5): 620-627.	Cross sectional	Community	30 stroke, 30 age matched	68.0 (8.5)	46.7 % Females	39.6 (26.3)	Ability to walk in the community without the physical assistance of another person and making at least 1 trip into the community each week.	Not reported	Trip activity log: Participants completed four trip activity logs, in which they recorded the number of trips and walking-related activities performed on every trip into the community during the previous 3-day period EAMQ::Examines 21 features of the physical environment grouped into 8 dimensions

Robinson, C. A., et al. (2011). "Participation in community walking following stroke: subjective versus objective measures and the impact of personal factors." Physical Therapy 91(12): 1865-1876.	Cross sectional	Community	50	65.0 (8.4)	46.7 % Females	85.0 (89.9)	Reported the ability towalk without physical assistance for a minimum of 3.048 m (10 ft) within their residence with or without the use of an assistive device such as a cane and or an ankle-foot orthosis.	Not reported	Trip Activity Log, and total number of steps-using twin pedometer. Two of 12 scales of MOSES questionnaire were used to rate self-perceived degree of difficulty walking without equipment (8 items) and moving about using equipment (7 items) using a 5-point ordinal scale (1“no difficulty” to 5“impossible”). Difficulty, satisfaction, importance of participating in Community walking was inferred from the items from the MOSES
Robinson, C. A., et al. (2011). "Understanding physical factors associated with participation in community ambulation following stroke." Disability & Rehabilitation 33(12): 1033-1042.	Case control	Community	30 stroke, 30 age matched	68.0 (8.5) Stroke group 68.6 (10.1) Age matched	46.7 % Females 56.7 % Females	39.6 (26.3)	Ability to walk in the community without the physical assistance of another person and making at least one trip into the community each week.	Not reported	Trip activity log
Rosa, M. C., et al. (2015). "Fast gait speed and self-perceived balance as	Longitudinal-follow up after 6 months	IPD	35	69.3(11.2)	23 males/35	45.5(22.1)	Able to walk 5m without a walking device but with human assistance, if needed	Not reported	The ability to walk in the community was assessed at using a self-reported question about difficulties in walking out of home after the stroke. Five responses were provided: (1) have no difficulty in walking in the community and do not require physical

valid predictors and discriminators of independent community walking at 6 months post-stroke - a preliminary study." Disability & Rehabilitation 37(2): 129-134.									assistance or supervision; (2) mild difficulty in walking in the community, requiring supervision to walk far away from home; (3) moderate difficulty, needing supervision to walk near and far away from the home; (4) severe difficulty in walking in the community, always requiring physical assistance from another person; (5) does not walk outside of the home. Subjects who responded to the first category were categorized as ''Independent Community Walkers (ICW)''; those responding with categories 2–5 were categorized as ''Non-Independent Community Walkers (NICW)''
Taylor, D., et al. (2006). "Does clinic-measured gait speed differ from gait speed measured in the community in people with stroke?" Clinical Rehabilitation 20(5): 438-444.	Cross sectional	Community	28	A=65.2(16.6) B=64.8 (10.6)	17 males	>6 months	The participants were placed into one of two groups: group A, people with gait velocity lower than 0.8 m/s and group B, people with gait velocity of 0.8 m/s or faster	Perry's FWC Walk in the community at least once per week;	Community walking session: It aimed to mimic a community outing to purchase simple supplies and to visit the pharmacy. This route included a variety of environmental dimensions and took place in and around a local shopping mall. Attempts were made to ensure the environment in which the velocity was recorded could be classified according to the key dimensions of community ambulation described by Patla and Shumway-Cook. The total length of the route was approximately 300 m from start to finish. Along the route, five predetermined 10-m sections were marked out which included the following conditions: Car park: Walking from a disabled car park in an underground car park to a lift with low lighting levels. * Mall: Walking from the lift to supermarket situated in the local shopping mall with medium to high density of foot traffic. * Supermarket: Walking up an aisle in a supermarket with the instruction to pick up a loaf of bread, which increased the attentional demand due to the task. * Slope: Walking down a slope to exit the shopping mall with altered terrain. * Crossing: Walking across a pedestrian

									crossing, which required increased attention and included a time pressure.
van de Port, I. G., et al. (2008). "Community ambulation in patients with chronic stroke: how is it related to gait speed?" Journal of Rehabilitation Medicine (Stiftelsen Rehabiliterings information) 40(1): 23-27.	Cross sectional	Community/Home	72	59 (10)	46 males /72	3 years post-stroke	Not reported	Not reported	Lord's Community Ambulation Questionnaire
Yang, Y. R., et al. (2008). "Virtual reality-based training improves community ambulation in individuals with stroke: A randomized controlled trial." Gait & Posture 28(2): 201-206.	RCT	Community	20	Control= 60.89 (9.25) Exp= 5.45(12.15)	10 males/20	Control= 6.10(10.32) yrs Experimental= 5.93(4.17) yrs	limited household walker, unlimited household walker, or most-limited community walker	Perry's FWC	1.Community walk test Subjects were instructed to walk at a comfortable pace for 400 m in a nearby community from our department. It comprised cross street, up and down the ramp/curb, and stepping over obstacle. The time to complete community walking was recorded and multiplied by a factor corresponding to the level of walking aid used 2.Walking ability questionnaire (WAQ)

8.5. Appendix 5: Selective examples: Identified measures of community walking

8.5. 1 Modified Emory Functional Ambulation Profile (mFEAP) (Baer and Wolf, 2001)

Allows for manual assistance to be provided. Manual assistance is recorded separately from the timed data in accordance with an ordinal scale.

Sub-tasks:

(1) a 5-meter walk on a hard floor;

(2) a 5-meter walk on a carpeted surface;

(3) rising from a chair, a 3-meter walk, and return to a seated position

(the "timed up-and-go" test);

(4) traversing a standardized obstacle course

(5) ascending and descending 5 stairs.

- Time each subtask and multiply that time by the appropriate factor according to the level of assistive device used during the task:

  1) No assistance x 1

  2) AFO x 2

  3) Single point cane x 3

  4) Hemi-walker or quad cane x 4

  5) AFO + single point cane x 5

  6) AFO + hemi-walker or AFO + quad cane x 6

  The totals for each of the 5 subtasks are then summed.

8.5. 2 Lord's community ambulation self-report questionnaire (Lord et al.,2004)

1. How important is it for you to be able to get out of the home?

Not important - Mildly important - Important -Very important - Essential

2. Which places outside the home did you like to get to before your stroke?

(Please list a maximum of 3 types of places, in order of preference.)

3. Are you able to get out and about, by yourself, without physical assistance or supervision from anyone?

Outdoors (eg, as far as the letterbox) but no farther- (go to question 5.)

Yes - (Give up to 3 examples.) No - (Go to question 5.)

4. Do you require special equipment to achieve this? (If yes, please state type of equipment, for example, wheelchair, scooter, and type of walking aid.) Yes/ No

5. Does the assistance you require to get out and about cause any problems to you or your carers? (If yes, please identify.) Yes/ No

6. Do you have any other comments you would like to make regarding getting out of the home?

8.5.3 Functional community walking categories (Perry et al.,1995)

Functional walking category	Description
Most-limited community walker	Independent (without supervision) in either entering/exiting the home or managing curbs.
	Can manage both entering/exiting the home and curbs without assistance.
	Requires some assistance in both local store and uncrowded shopping centres.
Least-limited community walker	Can perform all moderate community activities without use of wheelchair.
	Needs at least some assistance with a crowded shopping centre.
	Can perform without assistance (but may need supervision) in local stores or uncrowded shopping centres.
Community walker	Independent in all home and moderate community activities.
	Can accept uneven terrain.
	Can negotiate a crowded shopping centre with supervision only.