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Balance ability and cognitive impairment influence sustained walking in an assisted living facility

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ABSTRACT

Purpose of study: The purpose of this study was to determine the influence of cognitive impairment (CI),[1] gait quality, and balance ability on walking distance and speed in an assisted living facility.
Materials and methods: This was a longitudinal cohort study of institutionalized older adults (N = 26; 555 observations) followed for up to 8 months. Hierarchical linear modeling statistical techniques were used to examine the effects of gait quality and balance ability (using the Tinetti Gait and Balance Test) and cognitive status (using the Montreal Cognitive Assessment) on walking activity (distance, sustained distance, sustained speed). The latter were measured objectively and continuously by a real-time locating system (RTLS).
Results: A one-point increase in balance ability was associated with an 8% increase in sustained walking distance (p = 0.03) and a 4% increase in sustained gait speed (p = 0.00). Gait quality was associated with decreased sustained gait speed (p = 0.03). Residents with moderate (ERR = 2.34;p = 0.01) or severe CI (trend with an ERR = 1.62; p = 0.06) had longer sustained walking distances at slower speeds when compared to residents with no CI.
Conclusions: After accounting for cognitive status, it was balance ability, not gait quality, that was a determinant of sustained walking distances and speeds. Therefore, balance interventions for older adults in assisted living may enable sustained walking activity. Given that CI was associated with more sustained walking, limiting sustained walking in the form of wandering behavior, especially for those with balance impairments, may prevent adverse events, including fall-related injury.

1. Introduction

Long-term care residents experience declines in physical activity, largely due to chronic conditions, other health problems, and characteristics of the environment (e.g., ambient conditions, terrain characteristics) (Stewart, 2003). When transitioning to long-term care, more than 30% of individuals report a reduction in physical activity (Ruuskanen & Parkatti, 1994), resulting in a high prevalence of sedentary lifestyles (Resnick, Gruber-Baldini, & Perceptions, 2010). For these residents, over 80% of their waking hours are spent sitting or lying down (MacRae, Schnelle, Simmons, & Ouslander, 1996). As a result, few long-term care residents achieve the recommended 30 min of daily moderate activity (Resnick et al., 2010).

Physical activity is an important determinant of morbidity, mortality, independence, and quality of life in this population. Increased activity, including walking, is associated with decreased mortality risk in later life (Bijnen et al., 1998; Hakim, Petrovitch, & Burchfiel, 1998; Manini, Everhart, & Patel, 2006; Wannamethee, Shaper, & Walker, 1998). Even for those who do not participate in vigorous physical activities, walking four or more hours per week can reduce the risk of cardiovascular disease hospitalization (LaCroix et al., 1996). Achieving just minimal levels of activity can protect against functional decline and disability (Miller, Rejeski, Reboussin, Ten Have, & Ettinger, 2000). For older adults with limited mobility capabilities, physical activity is associated with maintaining independence (Hirvensalo, Rantanen, & Heikkinen, 2000). In addition, physical activities such as walking help prevent depression and/or slow the progression of cognitive decline (Abbott et al., 2004; DiPietro, Merrill, & Berkman, 1996; Lautenschlager, Cox, & Flicker, 2008; Strawbridge, Deleger, Roberts, & Kaplan, 2002; Weuve et al., 2004). Given the broad benefits of physical activity, it is not surprising that a sedentary lifestyle is also associated with poor health-related quality of life (Jenkins, Pienta, & Horgas,

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2002). Thus, it is important to identify the underlying factors that influence physical activity in long-term care – specifically focusing on the factors that influence walking, one of the most common forms of activity in this setting (Ruuskanen & Parkatti, 1994).

Walking activity is influenced by an individual's gait quality and balance ability. In a sample of sedentary older adults, clinical measures of balance ability were significantly correlated with self-reported physical activity levels (Washburn, McAuley, Katula, Mihalko, & Boileau, 1999). In community-dwelling older adults, self-reported activity levels were significantly correlated with balance (McAuley, Mihalko, & Rosengren, 1997) and walking capacity (Boulgarides, Mcginty, Willett, & Barnes, 2003). In a study of ambulatory long-term care residents, activity-monitor-based measures of physical activity were positively correlated with a combined measure of gait quality and balance ability using the Tinetti Gait and Balance Test (MacRae et al., 1996). This relationship between function and physical activity, however, did not persist when excluding residents with an ordered movement restraint. Gait quality and balance ability are logical targets for interventions to improve walking activity in long-term care facilities. The inconsistent relationship between these targets and reported physical activity, however, necessitates further study evaluating how gait and balance *independently* influence *objective* measures of walking activity.

The relationships between walking activity, gait quality and balance ability may be affected by cognitive impairment (CI). Compared to nursing home residents with no or mild/moderate CI, residents with severe CI demonstrate 20% more independent travel events, 26% of which are characterized as "lapping" behaviors, a type of wandering (Martino-Saltzman, Blasch, Morris, & McNeal, 1991). The prevalence of wandering (e.g., excessive walking with little/no breaks) among populations with severe CI has been reported to be between 38% (Cohen-Mansfield & Wirtz, 2007) and 80% (Hope et al., 2001). In long-term care facilities, wandering is a behavioral symptom of dementia to be managed by health care staff, as it is associated with a variety of adverse health outcomes such as injurious falls, accidents, weight loss, fatigue, sleep disturbances, getting lost, and death (Beattie, Song, & LaGore, 2005).

The walking activity of older adults in an assisted living environment is not well-understood. This may be, in part, because the population is heterogeneous (with varying cognitive levels, health conditions, and so forth) and a valid measure of activity in this population has been difficult to record. Self-report methods of activity, especially of walking, are vulnerable to floor effects and recall bias, and continuous observation over the long-term can be time-consuming and expensive (Bowen, Wingrave, Klanchar, & Craighead, 2013; Bowen & Rowe, 2016). Real-time locating system (RTLS) technologies have previously been implemented to objectively and continuously track and measure the walking activity of institutionalized patients with CI over time with a high degree of accuracy (Bowen & Rowe, 2016; Jeong, Bychkov, & Hiser, 2017; Kearns, Jasiewicz, & Fozard, 2013). This technology, then, is ideal for understanding walking activity among older adults in an assisted living setting.

Using a RTLS, the purpose of this study was to determine the influence of CI, gait quality, and balance ability on walking distance and speed in an assisted living facility. We hypothesized that poor gait quality and balance ability would be associated with shorter walking distances and slower walking speeds. Because older adults with CI may walk more (e.g., wandering) despite reduced physical capacity, we also hypothesized that increased CI would be associated with longer walking distances. Given that increased gait speeds are associated with better health and functioning, and because sustained walking is associated with fatigue (Bowen & Rowe, 2016), we expected residents with CI to also walk at slower gait speeds than their counterparts (Buracchio, Dodge, Howieson, Wasserman, & Kaye, 2010; Studenski, Perera, & Patel, 2011). We captured walking activity using three indices: walking distance (average total number of meters walked per week), sustained walking distance (average number of continuous meters walked per week calculated when the resident travels for at least 60 s with a stop not exceeding 30 s) and sustained gait speed (average meters per second/week calculated during sustained walking only).

2. Methods

This study was approved by the University of South Florida Institutional Review Board and VA Research and Development office (IRB#01455). An observational study monitoring board was established at the beginning of the study for human subject protection. The board met at study onset and every 6 months or if an adverse event occurred. Study staff also met weekly to document and report any adverse events which were to be reported to the IRB within 5 days.

Twenty-six residents of a 116-bed residential care facility participated in this study. To recruit residents, the facility administrator contacted the resident to determine interest and the study team provided explanations of procedures, aims and consent document contents. If a legally authorized representative (LAR) was indicated in the resident's medical chart the LAR determined consent to participate and the resident provided assent. A similar process was followed for residents known to have dementia or CI–either from a note in their medical chart or a score of < 26 on the Montreal Cognitive Assessment (MoCA). To participate in this longitudinal study, residents were required to be ambulatory (with or without an assistive device) at study start and living in the residential care facility. Exclusion criteria included an acute health event (e.g., stroke) in the previous 30 days which may affect gait/balance and/or a diagnosis of traumatic brain injury within 1 year of study enrollment.

To continuously monitor walking activity, residents wore a tag (e.g., around their wrist) embedded with ultra-wideband real-time locating device continuously for up to eight months (see Fig. 1). These tags emit an ultra-wideband signal that is triangulated by multiple sensors in the environment, based on x and y coordinates, recording resident location in real-time several times a second, time of day, and storing this information for later graphical and other analyses (Bowen et al., 2013; Bowen, Craighead, Wingrave, & Kearns, 2010; Kearns, Nams, & Fozard, 2010). To calculate average walking distance, sustained walking distance and sustained gait speed, each resident's time and change in location were averaged over the course of the week. The number of samples available to calculate these measures for each resident varied based on their level of activity. For example, residents who were largely sedentary had several hundred data points/day; residents who were more active had several thousand data points/day. There were 50 active Ubisense sensors mounted in the upper corners of all common rooms and hallways in the residential care facility to triangulate the

Fig. 1. Real-time locating sensor (mounted in the corners of ceilings) and two tags used in the study (a wrist "compact tag" and "hang tag" which can be worn around the neck). The tags emit an ultra-wide band radio signal that is triangulated by multiple sensors in the environment. The tags are worn by residents to track their location and movement in real-time.