VALIDITY AND RELIABILITY OF A NOVEL COMPUTER-ANIMATED SELF-REPORT PHYSICAL ACTIVITY INSTRUMENT IN OLDER ADULTS

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ABSTRACT

The purpose of this study was to investigate the reliability, construct validity and responsiveness to a physical activity intervention of the MAT-PA (Mobility Assessment Tool-Physical Activity) physical activity questionnaire (PAQ) for walking in older adults. The MAT-PA is a novel computer-animation assisted self-report questionnaire created for the assessment of physical activity in older adults. We recruited 185 older adults (67.0 ± 4.8yrs, 72% female) at risk for cardiovascular disease as part of the Cooperative Lifestyle Intervention Program-II (CLIP-II) study. Participants completed the MAT-PA with supervision on three occasions, twice at baseline (~14 days apart) and once at six-months. Gait speed at usual and fast pace was measured using a GAITRite instrumented carpet, and 7-day accelerometry were collected at baseline and 6-months. The 400m walk test and a modified version of the CHAMPS PAQ were both completed at baseline. The MAT-PA walking metrics displayed acceptable test-retest reliability ($r_s = 0.63, p<0.01$), good correlation with accelerometry moderate intensity physical activity minutes ($r_s=0.60, p<0.01$) and mCHAMPS5 ($r_s=0.54, p<0.01$), and was responsive to change from a physical activity intervention at 6-months when comparing the CLIP-II walking group with controls ($F(1,68)= 31.253, p<0.0001, \text{Eta}^2=0.32$). Older adults were able to discriminate between walking speed animations. These findings suggest that the MAT-PA has promising psychometric properties for the assessment of walking as a mode of physical activity training.
REVIEW OF THE LITERATURE

Aging Population

The aging population is fast becoming one of the critical issues for the healthcare system in the United States. In the 2010 census, 40.3 million Americans were aged over 65 accounting for 13% of the population (United States Census Bureau, 2011). There has been a steady increase in the population of older adults throughout the 20th century. However, with the ‘baby boomer’ generation now advancing into older age, an exponential rise in the number of older adults is predicted. By 2030, there will be 72.1 million Americans aged 65 and over, contributing to 19% of the US population (Federal Interagency Forum on Aging-Related Statistics, 2012). Of great concern is that a significant proportion of the population will be aged 85 and over, a group that is most likely to need health and long term care services. This trend of an aging population is not limited to the US, with projections suggesting that there will be 2 billion older adults worldwide by the year 2050, fully 20% of the total world population (National Institute of Aging, 2011).

Increases in the population of older individuals are important because of the increased prevalence of disability among older adults. Disability is one of the greatest burdens facing the older population. Higher disability rates among older adults reflect an accumulation of health risk across a lifespan of disease, injury and chronic illness (World Health Organization, 2011). Among the potential reasons for this trend are greater
morbidity accompanying better chronic disease survival rates, increasing obesity among midlife and older adults, and the effects of aging associated patterns of disuse and deconditioning – all of which are linked to functional limitations (King & Guralnik, 2010).

The pressing issues of an aging population are well understood, and it is clear that the health care system is facing an onslaught of older adults with functional limitations and disability. To counter this, focus needs to be placed on addressing the development and management of chronic diseases and comorbidities that can create impairments or disability with increasing age. Physical activity and/or a reduction in sedentary behavior have been proposed as key factors in stemming the tide and reducing the societal burden of an increasing number of older adults who are challenged to maintain their independence (Chodzko-Zajko et al., 2009).

Physical Activity

Physical activity, defined by the World Health Organization as any bodily movement produced by skeletal muscle that requires energy expenditure, has been suggested as a critical factor for the prevention and treatment of chronic disease and the consequences associated with the aging process (Chodzko-Zajko et al., 2009). The volume of physical activity is an important predictor of functional status in older adults, in turn affecting independence and quality of life (Morey et al., 2008). While lack of physical activity and/or energy expenditure is one of the leading causes of global mortality (Lim et al., 2012; Lee et al., 2012), more recently attention has been focused on
sedentary behavior which has also been identified as an independent risk factor for chronic diseases (Matthews et al., 2012).

Current guidelines on physical activity for adults in the US are; ≥150 mins per week of moderate intensity aerobic exercise, 75 mins per week of vigorous intensity aerobic exercise, or a relative combination of the two (US Department of Health and Human Services, 2008). It is also recommended that adults do muscle strengthening exercises that are of moderate to high intensity and involve all the major muscle groups on two or more days of the week. Increasing physical activity levels towards a goal of 300 mins per week of moderate intensity aerobic exercise provides additional health benefits (US Department of Health and Human Services, 2008).

An important caveat to the current guidelines is the application of the recommendations to older adults. Older persons have a wide range of ability in the performance of physical tasks due to the variation in decline due to aging that includes combinations of chronic conditions of varying severity. This variation in ability makes it difficult to provide a single physical activity guideline. The current recommendations are that healthy older adults perform the same physical activity as the general adult population albeit at lower absolute intensity. For those older adults unable to meet these guidelines because of chronic conditions, it is recommended that they are as physically active as their abilities allow (Chodzko-Zajko et al., 2009; US Department of Health and Human Services, 2008; Nelson et al., 2007).

Challenges remain in the quantification of physical activity at the population level, but there are two major factors that are widely agreed upon with physical activity rates in
the US population. First, staggeringly low numbers of individuals report meeting current physical activity guidelines. According to data from 2008-2010 (Schoenborn CA, 2013), only 45.8% of adults met the aerobic physical activity guidelines and only 19.1% met the overall physical activity guidelines incorporating both aerobic and muscle strengthening activities. Notably, 34.1% of adults engaged in no leisure time physical activity at all. Second, the proportion of the US population meeting physical activity guidelines declines with increasing age. In 2007, only 37.1% of adults in the US aged 65-75 years met the aerobic physical activity guidelines, a stepwise decrease with increasing age (Schoenborn CA, 2013). These two factors suggest that the prevalence rates and mortality of chronic disease in the US population will likely increase in future years driven by a lack of physical activity and increasing sedentary behaviour. It is therefore essential for research to address the lack of physical activity of older adults as they are currently the least physically active of any age group. Critically important to any research in this area is the identification of the activity types preferred by older people and the measurement and quantification of the volume of preferred activities.

Current data suggest that the most common physical activity performed by the US population is walking, likely due to its accessibility (Kruger, Ham, Berrigan, & Ballard-Barbash, 2008). In 2010, 53.7% of older adults (≥65 years) reported that they performed at least one bout of 10 mins or more of walking for transport or leisure in the past 7 days. Older adults who walked were 3.36 times more likely to meet current aerobic physical activity guidelines compared to those who did not walk (Center of Disease Control, 2012). These numbers are in stark contrast to the prevalence of other forms of physical activity in older adults. Current data suggests that muscle strengthening activity is performed by
less than 20% of older adults (Schoenborn CA, 2013). This highlights the importance of promoting walking activity as a method of helping older people meet their physical activity requirements.

Measurement of physical activity

Measurement of physical activity is important to researchers and clinicians for a number of reasons: measurement of population health behaviors; linking physical activity to risk and development of chronic disease; identifying dose-response relationships between physical activity and health outcomes; compiling data that informs physical activity guidelines; assessing whether populations are meeting current physical activity guidelines; and determining the effectiveness of interventions designed to increase physical activity. With these varying agendas, effective measurement of physical activity may need to consist of different formats, dependent on the setting.

Large degrees of complexity exist in the measurement of physical activity behaviors, with a primary issue being the measurement end-point. For example, energy expenditure, in kilojoules (kJ), is the physical activity measurement that perhaps best operationalizes the definition of physical activity, any energy expenditure created by the contraction of skeletal muscle. However, several problems exist in the interpretation of this end-point. First, it fails to provide contextual information about the type of activity performed, nor does it provide information about the intensity, frequency, and duration of the physical activity. These domains are potentially important, as they provide the basis for interpreting and prescribing physical activity behavior.
Another common method of reporting the energy cost of physical activity is the Metabolic Equivalents of Task (MET) value. One MET is equivalent to resting metabolic rate that is 3.5 ml/kg/min, with subsequent MET values being a multiple of this. Developed with the intention of standardizing the application of intensity from physical activity, the MET value provides a way to estimate energy expenditure. The Compendium of Physical Activities, updated in 2011, is an index of the energy cost of over 820 experimentally tested physical activities (Ainsworth et al., 2011). An example would be a MET value of 3.3 for walking at 3.0 mph (Ainsworth et al., 2011). This suggests that the energy cost of walking at this speed is 3.3 times that of resting levels. With this method of applying intensity, it allows the collection of information, such as the duration and frequency of physical activity performed, while still providing the ability to interpret physical activity relative to resting energy expenditure.

MET values and the Compendium of Physical Activities were designed to evaluate physical activity at a population level. Therefore, limitations exist when trying to make inferences from this information at the individual level. This is particularly evident for older adults when we consider that the resting MET value is based upon a healthy 40 year old, 70 kg male. Large individual variation in the energy cost of activities may exist due to a range of factors such as sex, age, body composition and health status. A recent study by Hall and colleagues investigated the energy cost of walking in older adults (Hall, Howe, Rana, Martin, & Morey, 2013). The measured MET values for their sample at various levels of walking were significantly higher than compendium reported MET’s, suggesting that the compendium and self-report questionnaires are likely underestimating the energy cost of walking for this group (Hall et al., 2013). Despite this, the lack of a
viable alternative means that MET values and the Compendium of Physical Activities still serve an important purpose for the interpretation of self-reported physical activity information.

Several methods are available to measure physical activity within a research setting. The choice of a tool will vary based on a range of factors including cost, participant burden, number of participants, demographic and health characteristics of participants and the research question. Measurement tools in physical activity are commonly referred to as either objective or subjective measurement tools. Objective methods include the Doubly Labeled Water protocol (DLW) and various forms of activity monitors (accelerometers, pedometers). Subjective measurement tools for physical activity consist of self-report questionnaires, either interview based or self-administered.

For the various reasons presented earlier, the measurement of physical activity in older adults is of high importance. However, it is not appropriate to utilize the same measurement tools to assess physical activity in older adults as is used in the wider adult population. Numerous factors must be considered when assessing the appropriateness of a tool for older adults including: the types of activities commonly performed by older adults; the burden on the participant; and physical or cognitive limitations that could affect the integrity of results. The following sections will review the physical activity measurement tools commonly used in studies of older adults.
Objective Measurement of Physical Activity

The doubly labeled water (DLW) technique is considered the gold standard to estimate total free living energy expenditure (Starling, Matthews, Ades, & Poehlman, 1999; Colbert, Matthews, Havighurst, Kim, & Schoeller, 2011). The DLW method measures total energy expenditure determined from CO₂ production through the use of labeled isotopes (Schoeller, 1999). The doubly labeled water method is expensive, difficult to administer in larger studies, and does not differentiate between different types of physical activity. Therefore, the primary application of this technique is as the comparison measure to evaluate the validity of other physical activity measurement tools (Bonnefoy et al., 2001; Mahabir et al., 2006; Plasqui & Westerterp, 2007).

Activity monitors such as accelerometers and pedometers have become increasingly popular over the past two decades for the measurement of physical activity in research settings as well as in consumer devices. Pedometers are small, relatively inexpensive devices that use a horizontal spring suspended lever arm to detect vertical motion at the hip and calculate a person’s steps (Berlin, Storti, & Brach, 2006). Modern pedometers are made up of inertial sensors, a more advanced and accurate way of measuring this vertical motion and have been incorporated into a range of personal consumer devices. Presently, the term pedometer refers to any device that counts a person’s steps, as opposed to being a reference to the mechanical structure of the device. Through calibration of an individual’s usual step length, the distance walked can also be derived. Pedometers appear to be accurate for healthy individuals walking at normal speeds (Shepherd, Toloza, McClung, & Schmalzried, 1999) and they are a good method to estimate walking distance when compared to a calibrated measuring wheel (Bassett, Jr.
et al., 2000). With step counts commonly used in public health recommendations, pedometers appear useful for monitoring walking behavior. However, they are not accurate for activities that do not include footfalls such as cycling or resistance training, and because they are not equipped with internal clocks, they provide no context as to when or how the counts occurred (Van et al., 2012).

In contrast, accelerometers provide increased utility over pedometers through the measurement of body accelerations (Berlin et al., 2006). Based on the force and frequency of the displacement, these accelerations are processed to create movement counts, which are dimensionless units specific to the brand of monitor. Through the use of an internal clock, counts are aggregated over specified periods of time, called epochs, a timeframe which is dependent on the proprietary software of the specific device. This method of accumulating counts in reference to time allows determination of activity intensity. Counts are stored, and the software interprets the data to obtain information such as the time spent at certain physical activity levels, usually aligning with MET cut points. Accelerometers therefore, allow for the determination of the quantity and the intensity of movements (Plasqui & Westerterp, 2007). These devices have been widely used in research to assess physical activity in a range of settings. Accelerometers have also played a major role in the assessment of activity in the National Health and Nutritional Examination Survey (NHANES), a survey research program conducted by the National Center for Health Statistics to assess the health and nutritional status of adults and children in the United States, and to track changes over time (Troiano et al., 2008; Tudor-Locke, Camhi, & Troiano, 2012).
Accelerometers have been validated in healthy older adults (Copeland & Esliger, 2009) and those with chronic disease (Van Remoortel et al., 2012). Evidence suggests they have good validity when compared with DLW, indirect calorimetry and self-report methods. (Kowalski, Rhodes, Naylor, Tuokko, & MacDonald, 2012). Despite providing a good option for the measurement of physical activity, limitations still exist. Accelerometers are somewhat expensive with high levels of burden placed on the researcher to prepare the device and on the participant to remember to wear and attach it correctly. Collection of data requires extended periods of time with a minimum of 4 days of accelerometer wear time to provide reliable physical activity information in older adults (Matthews, Ainsworth, Thompson, & Bassett, Jr., 2002). Due to the sensitivity of the accelerometers and their cut-points, there is difficulty in measuring individuals with slow walking speeds and/or chronic disease (Van et al., 2012). This complicates the use of accelerometers in older adults, a group that is prone to these conditions. Similar to pedometers, these devices do not accurately capture resistance training and other predominantly upper body or seated exercise. This is due to the device only measuring accelerations due to movement of the attachment location, usually at the hip. To address this problem, some companies have begun to incorporate multi sensor devices, worn at different points on the body, to capture a wider variety of movements with limited success (Swartz et al., 2000). The feasibility of this approach for older adults in free living conditions is questionable due to the burden of attaching multiple sensors to the body.
Self-Report Questionnaires

Several limitations of objective physical activity measurement instrument necessitate the need for additional methods to assess physical activity behaviors. Primary limitations include difficulty in assessing large cohorts, due to cost and availability, and the inability to capture descriptive information such as the type and the setting of the activity. The alternative is to use self-report physical activity questionnaires (PAQs). PAQ’s provide an instrument that can independently collect physical activity information in addition to being a supplementary tool to further enrich the information gathered from objective measurement. Provided a PAQ measures the correct construct, it may remove the need for devices such as accelerometers in some cases. PAQ’s are often referred to as self-report questionnaires, where individuals are either interviewed or complete a questionnaire on their own (self-administered). This latter version reduces the need for trained staff, allowing the questionnaire to be administered at a time or place convenient to the individual and increases the feasibility of using the questionnaire in larger scale studies. Self-administered questionnaires also remove the potential for issues due to inter-tester reliability, which is measurement error created from having different test administrators. For these reasons, this review will predominantly focus on self-administered questionnaires.
Measurement Properties of Self-Report Questionnaires

To determine appropriate ways to measure physical activity using self-report physical activity questionnaires, it is important to understand the principles of reliability and validity of measurement. The following is a guide to the reliability and validity concepts that are important when considering the selection of a questionnaire.

Reliability: A measure has high reliability if it produces similar results under consistent conditions. Test-retest reliability is a commonly used method to assess reliability, where the same test is administered on two separate occasions to the same group of individuals (DeVon et al., 2007). The results of these tests are then correlated to evaluate reliability. By definition, reliability is the degree to which the measurement is free from measurement error. When assessing the reliability of PAQs, the two test administrations should be performed under the same conditions. The period of time between tests should be long enough to prevent the recollection of previous responses, yet short enough to ensure the characteristic under study would not have changed (Terwee et al., 2010). The recall period of the PAQ is a critical factor in determining the appropriate time frame between tests. For example, if a PAQ aims to assess the physical activity performed over the past 7 days, it would not be appropriate to assess the test-retest reliability with 1 month between test administrations. This would increase the likelihood that the difference between test results may reflect a real difference in the physical activity performed not just measurement error. Most studies looking at self-
reported physical activity will use a test-retest window of 7-14 days, however it has been suggested that anywhere from 3 days to 3 months could be appropriate (Masse & de Niet, 2012; Forsen et al., 2010). Intraclass correlations are the statistical method suggested to assess the test-retest reliability of an instrument, where possible.

Validity: Validity refers to how well a test measures what it is purported to measure. There are many different ways of assessing the validity of a tool, with some being more appropriate for self-report PAQ’s.

Face validity is the degree to which items of an instrument appear to reflect the construct being assessed. This is the ‘eye test’. Because face validity is subjective in nature and cannot be measured statistically, it is often ignored. Despite this, it is still an important concept as it may affect people’s attitude towards the test. One approach to assess face validity is to ask respondents what they think the questionnaire is trying to measure.

Content validity is the next step in the ‘validation process’ and refers to the relevance and comprehensiveness of questionnaire items (Nunnally, 1978). Self-report questionnaires need to find balance between the degree of detail collected and the time burden on the participant to complete it. However, when attempting to assess energy expenditure, it is crucial that the type, intensity, frequency and duration of all activities are determined. The framing of questions is also important for content validity (Terwee et al., 2010). This relates to the style of questioning and the method of gathering responses. Common formats include free fields where responders can input any response, and others with lists of available options for selection. One important consideration for items that
have a predetermined series of possible responses is that there needs to be enough
sensitivity to correctly identify the variable. For example, if the desire is to assess the
total time spent walking during a day, having possible responses that are based on the
number of hours is likely not appropriate as there is no ability to differentiate between
those who completed 0 mins and those that completed 25 mins. Whether this is
acceptable will depend on the purpose of the questionnaire. Similar to face validity,
content validity is another subjective evaluation and is usually determined through expert
opinion in the form of a focus group, or more commonly that the developers of the tool
are well versed in the area of concern.

Construct validity is used to identify how well a PAQ actually measures the
domain of interest (Nunnally, 1978). Physical activity itself can be made up of a series of
different constructs including, energy expenditure, walking, moderate/vigorous activity,
resistance training, leisure time PA and transport PA. The ideal way to assess construct
validity would be to compare it to a gold standard, a direct measure of the domain of
interest. This is called criterion validity (DeVon et al., 2007). Unfortunately, there is no
gold standard for the measurement of physical activity (Terwee et al., 2010). When
assessing the construct validity of PAQ’s, one must rely on comparisons with other
previously validated instruments that measure closely related constructs. This is done by
testing a predefined hypothesis about expected relationships between these measures
(Terwee et al., 2010; Nunnally, 1978). Two important and opposing concepts when
making a case for the construct validity of an instrument are convergent and discriminant
validity (DeVon et al., 2007). Convergent validity means that the instrument displays a
relationship with other measures that it theoretically should share a relationship with,
whilst discriminant validity demonstrates the instruments ability to differentiate between constructs that are theoretically different (DeVon et al., 2007). In physical activity measurement, research centers mainly on convergent validity. The optimal instrument to use as a comparison measure is dependent on the construct that the PAQ is intending to assess. The DLW method is sometimes used for the validation of PAQ’s, however this method is rather impractical in larger scale studies and it is only a measurement of free-living energy expenditure which does not provide physical activity context or type (Washburn, 2000). The process of assessing construct validity therefore relies heavily on the use of activity monitors for comparison measures (Forsen et al., 2010; Masse & de Niet, 2012). Depending on what physical activity construct they are intending to assess, studies will use different pieces of information from these devices such as moderate intensity activity durations, steps, or energy expenditures (Forsen et al., 2010). An issue that further complicates construct validation is the fact that there is currently no consensus on how high correlations should be to determine adequate validity (Pols, Peeters, Kemper, & Grobbee, 1998).

Responsiveness is the ability of an instrument to detect change over time in the construct being measured as a result of some intervention (Terwee et al., 2010). Responsiveness can be thought of as an investigation into the validity of a ‘change score’ (Mokkink et al., 2010). This is a crucial concept in that a tool must be sensitive to change if it is to assess the physical activity of individuals over time. In a similar manner to construct validity, responsiveness looks at how well change scores of the measurement tool compare to the change scores of other instruments that measure closely related constructs.
In addition to the primary methods suggested above, there are several alternative ways that could assist a researcher in making a case for the validity of an instrument. A ‘known groups analysis’ can be performed which compares the outcomes of an instrument for a group that should have higher scores versus a group that should have lower scores based on a predetermined understanding of the relationship between PA and that group (Nunnally, 1978; Washburn, 2000). In the validation of a PAQ this could be a comparison between an intervention group that is participating in a walking regime and a sedentary control group. The hypothesis would be that scores in the intervention group would be higher than those in the control group. If the hypothesis was supported the instrument could be considered to be tapping the construct of interest.

Evidence for Current PAQ’s

Current literature suggests that there is no shortage of instruments available to assess physical activity in the older adult population. However, a major issue with the measurement of physical activity in older adults is the use of physical activity questionnaires that were intended for and validated in younger samples. For this reason, the next section will focus on physical activity questionnaires designed specifically for use in older adults.

A recent review outlining measurement properties of self-administered PAQ’s for the elderly found eighteen articles encompassing 13 PAQ’s that have been evaluated in samples of older adults (Forsen et al., 2010). The authors concluded that the methods used to examine the validity of these instruments were poor. For example, when assessing reliability many studies used very small samples and had an inadequate time
interval between test and retest of the instrument. Despite several studies showing an association between the tested PAQ and health/functioning variables, the knowledge about reliability and construct validity of self-administered PAQ’s is scarce and that more high-quality validation studies are needed. This is mirrored by very similar findings for construct validity and reliability for physical activity questionnaires in the regular adult population (Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012).

Despite the large variety of questionnaires that have been designed and used for older adults, there are two that stand out as the predominant instruments that have been used and validated. These are the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire (Stewart et al., 2001) and the Physical Activity Survey for the Elderly (PASE) (Washburn, Smith, Jette, & Janney, 1993).

The CHAMPS physical activity questionnaire is a comprehensive 41-item questionnaire capturing physical activity from a range of activities over the past 4 weeks. It was designed for use in intervention studies. Concerns exist over the length of time it takes to complete the entire CHAMPS with 15-30 mins test administration time commonly bring reported (Forsen et al., 2010). The main paper which reported the validity and reliability of the CHAMPS displayed modest correlations for their various construct validity measures and small to moderate effect sizes (0.38-0.64) for its sensitivity to detect change (Stewart et al., 2001). In this study, they failed to measure test-retest reliability of the CHAMPS. More importantly, they didn’t assess construct validity using activity monitors or DLW and thus relied on relationships with health measures, an approach that has suggested to be suboptimal (Masse & de Niet, 2012; Bowles, 2012). More recently, the CHAMPS has been validated against both activity
monitors (Pruitt et al., 2008; Cyarto, Marshall, Dickinson, & Brown, 2006; Giles & Marshall, 2009; Harada, Chiu, King, & Stewart, 2001) and DLW (Colbert et al., 2011). These studies found large variation in the correlations between CHAMPS and activity monitors with the majority falling between 0.2-0.4. Colbert found significant but low correlation between CHAMPS and DLW (0.28) (Colbert et al., 2011). The most recent study involving the CHAMPS investigated how the questionnaire interacted with a myriad of different intensity spectrums for accelerometry with correlations still ranging from 0.27-0.37 (Hekler et al., 2012). When considered together, the evidence for the validity of the CHAMPS questionnaire is less than ideal (Terwee et al., 2010).

The PASE was designed to assess physical activity over the past week. It has been criticized for having an outcome that is difficult to interpret in the context of the broader physical activity literature (Forsen et al., 2010). Although the PASE has been investigated in a range of validity studies since its creation in the 1990’s, the most recent evidence for it has been poor. Colbert and colleagues found no significant correlation between PASE score and DLW (Colbert et al., 2011). Most of the supporting literature for the PASE came from early studies that investigated its relationship with health/functional outcomes (Washburn, McAuley, Katula, Mihalko, & Boileau, 1999).

Rationale and Development of the MAT-PA

Despite the variety of self-report PA questionnaires that have previously been used to assess PA in older adults, the inconsistent and relatively poor validity and reliability findings discussed above necessitates further research in this area. Several researchers have suggested that sufficient questionnaires are already available and that
the focus of research in this area should be on refining and correctly validating already available tools and not the creation of new tools (Forsen et al., 2010; Masse & de Niet, 2012). This notion has some merit, with many questionnaires sharing strikingly similar qualities. However, capturing light intensity activity and assessing the relative intensity of specific tasks has been a major issue for currently available tools (Masse & de Niet, 2012). If new tools are to be created they should place focus on identifying ways to better capture physical activity. With the development and proliferation of technology, there may be potential to develop novel ways of assessing physical activity, both enhancing the accuracy and potentially the ease of administration.

Wake Forest University has developed a tool that aims to better address the contextual information required to assess physical activity in the older adult population. Additionally, the concern regarding the time burden of questionnaires such as the CHAMPS suggests that any newly developed tool should have brevity in mind. The range of tasks completed by older adults are likely not as extensive as those seen in the traditional adult population and thus, focus must be placed predominantly on commonly performed activities. The MAT-PA (Mobility Assessment Tool – Physical Activity) is an instrument that incorporates computer animation, shown to be effective in mobility assessment in older adults (Marsh, Ip, Barnard, Wong, & Rejeski, 2011). This thesis will focus on the walking components of the MAT-PA, with future research intending to assess the MAT-PA total physical activity score. As walking is the primary modality of physical activity in older adults, the ability to capture and assess this walking domain is of utmost importance (Kruger et al., 2008).
Essential in the development or selection of a questionnaire are its qualitative attributes. Concern exists that many studies on the development and validity of PAQ’s fail to describe these key criteria that address much of the face and content validity components of the instrument (Forsen et al., 2010; Terwee et al., 2010; Jorstad-Stein et al., 2005). Before the quantitative attributes of the MAT-PA are explored, we will clearly evaluate the qualitative attributes of the MAT-PA, based on the ‘Checklist for the appraisal of qualitative attributes of physical activity (PA) questionnaires’ (Terwee et al., 2010). This checklist includes clearly identifying the construct, setting, recall period, purpose, target population, justification, format, interpretability and ease of use.

1. Construct: The construct(s) that a questionnaire is intended to measure needs to be clearly defined from the outset. In doing so it allows the determination of the appropriateness of tools to assess the construct validity. The MAT-PA was designed with the purpose of assessing walking activity, energy expenditure and sedentary behaviors.

2. Setting: Setting refers to when the activity occurs, meaning was it in leisure time, transport or occupational. This is less important for a questionnaire designed for older adults as occupational physical activity and transport physical activity are less likely to contribute to overall physical activity performed. For the MAT-PA the setting is any physical activity performed.

3. Recall period: Developers of the IPAQ, a PAQ for the regular adult population, identified that participants sometimes had problems with interpretation of a ‘usual week’, and therefore concluded that a past week version was better (Craig et al., 2003). In contrast, in advanced age, long term memory may be better preserved than recent
recollectation of activity patterns so it could be suggested that a ‘usual week’ timeframe may be beneficial (Shephard, 2003). The MAT-PA is designed to assess physical activity for a typical week in the past month.

4. Purpose: To assist in developing a validation process for a questionnaire, the purpose of the instrument must be clearly explained. The MAT-PA aims to be discriminatory, meaning it could classify people into groups and assess patterns. It also aims to perform evaluation, which is the ability to monitor PA patterns over time, or to assess the effect of physical activity interventions. Validity of this evaluation component has seldom been explored in the older adult population where assessment of the responsiveness of the questionnaire would need to take place.

5. Target population: A tool that is used outside of the intended application is likely being incorrectly implemented. The MAT-PA as mentioned previously is focused on the older adult population, although it could also have utility in the regular adult population. This notion would need additional validity evidence.

6. Rationale for instrument: One of the largest problems in physical activity research is the amount of existing questionnaires used hampers the ability to make judgment or interpret results correctly (Terwee et al., 2010). In addition, many questionnaires have been adjusted and reformatted, further adding to this dilemma. There should be a clear explanation of why a new questionnaire is better than previously available questionnaires. For the MAT-PA we believe that the distinguishing elements that improve it from previous PAQs are: a novel method to apply intensity to walking activity; short time period for completion; focus on the primary activities performed by
older adults; and a free text field to include non-walking activity which contributes significantly to reducing participant burden since many older adults participate in a very limited number of activities.

7. Format: The numbers of questions, the number and type of response categories and the scoring algorithm needs to be clearly described. This component is difficult to answer for the MAT-PA due to its computer based nature. Further refinement of the MAT-PA may be required, dependent on validity findings.

8. Interpretability: Many physical activity questionnaires (such as the PASE) have their own ranking and scoring system as the means for quantifying their results (Washburn et al., 1993). The use of commonly used and understood endpoints is an important element to consider to aid with the interpretation and comparisons of study results. This means that when referring to physical activity energy expenditure, focus should be on having the output in terms of kcals. In addition, when talking about minutes spent, whether it be walking or at moderate/vigorous levels, the output should be only minutes and not some category based derivative.

9. Ease of use: As this is the first study looking at the MAT-PA, we are unable to make judgment on the ease of use for the instrument.
PURPOSE OF THE STUDY

The purpose of this investigation was to assess the reliability, construct validity and responsiveness of the MAT-PA self-report physical activity questionnaire for walking in older adults. We did this by first assessing the 14 day test-retest reliability of the MAT-PA. We then determined if the self-reported, animation assisted method of estimating walking speed is a valid measure when compared to objective measurement of walking speed using a GAITRite instrumented carpet. We also examined the correlations between the MAT-PA and a modified version of the CHAMPS physical activity questionnaire, and assessed if the self-report assessments are comparable to physical activity determined via accelerometry. Lastly, we investigated if the MAT-PA is sensitive to change in walking physical activity, by examining 6 month follow up data in the CLIP-II trial.

Hypotheses

We hypothesize that:

1. There will be a significant relationship between MAT-PA walking outcomes tested 14 days apart.
2. MAT-PA derived self-reported walking speeds will have a significant relationship with objectively measured walking speed.
3. The MAT-PA walking outcomes will be significantly related to accelerometry and the mCHAMPS.
4. Individuals with higher function in the 400m walk will have greater levels of MAT-PA walking physical activity than those with lower function.
5. The CLIP-II aerobic training group will have significantly greater change in MAT-PA walking after 6 months than controls.
METHODS

Participants

Older adults were recruited via targeted mail outs to the greater Winston-Salem community to Co-operative Lifestyle Intervention Program – II (CLIP-II), a randomized controlled trial investigating the effects of exercise and weight loss on mobility. Respondents who passed a telephone screening were invited to attend an initial screening visit (SV1) at the Sticht Center on Aging at Wake Forest School of Medicine where blood work and physical function measures were collected. Participants who remained eligible were invited to attend a second visit (SV2) at the Reynolda Campus of Wake Forest University.

All participants met the following inclusion criteria: aged between 60-79 years old; community dwelling men and women from the county of interest that did not plan to move for the 18 month duration of the CLIP-II study; willing to provide consent and participate in all aspects of the trial; sedentary (self-reported less than 60 mins of moderate intensity structured PA per week); BMI between 28 and 42 kg/m²; documented evidence of a myocardial infarction (MI), percutaneous coronary intervention (PCI), chronic stable angina, cardiovascular surgery or an adult treatment panel II (ATP II) diagnosis of metabolic syndrome; mobility disability defined as self-reported difficulty with walking ¼ mile, climbing stairs, lifting and carrying groceries, or performing other household chores such as cleaning and yard work. Participants were excluded from the trial if they met any of the following criteria: Severe Symptomatic Heart Disease, MI or cardiovascular procedure within the last 3 months; resting blood pressure greater than 160/100mmHg; blood glucose greater than 140mg/dL, diagnosis of type 1 diabetes, or
diagnosis of type 2 diabetes and on insulin therapy; severe systemic disease, cancer, hearing, or sight impairments; psychiatric illness; alcohol intake greater than 14 alcoholic drinks per week; unable to walk unassisted; unable to speak or read English; working more than 21 hours per week, or judged to be unsuitable for the trial for any reason by the clinic staff. Full lists of inclusion and exclusion criteria are in Appendix 1. All inclusion and exclusion criteria were designed for the overall CLIP-II study to enhance safety, effectiveness, retention, and compliance.

Measures

Participants completed three assessment sessions for this study. At the first session (SV1), the MAT-PA and a modified CHAMPS physical activity questionnaire were administered. Demographic characteristics were collected and the 400m walk completed at this visit. At the second session (SV2), 7-14 days after the completion of SV1, the MAT-PA was administered again, gait analysis was performed, and an accelerometer was provided to the participant with detailed instructions on proper placement and wear-time. The participant was instructed to wear the accelerometer for the next 7 days from the time they woke up through to the time they went to bed each night, excluding any time spent where the accelerometer would be exposed to water (i.e. showering, swimming). At the 6 month follow-up visits (F06), participants completed the MAT-PA, the modified CHAMPS physical activity questionnaire, gait analysis and an accelerometer was again provided and worn for 7 days.
MAT-PA

The MAT-PA is a computer based self-report physical activity questionnaire developed for use in older adults. It uses animated video clips of walking, similar to the MAT-sf, a validated tool that assesses physical function in older adults (Rejeski, Ip, Marsh, & Barnard, 2010; Marsh et al., 2011; Rejeski et al., 2013). The MAT-PA assesses walking activity and also any sports, fitness or recreational activities performed on a regular basis. Participants are instructed to recall their physical activity during a typical week in the past month. For the purpose of this study, the questionnaire was administered in a supervised setting with the computer operated by assessment staff.

Following an initial page with instructions for the test (as shown in the appendix), participants go through a process of self-selecting their usual walking pace (the pace that they typically walk if there is no rush to get somewhere) via use of video animation (Figure 1). An animated clip is played of a figure completing a 4m walking track at a speed of 2.237mph (1.00m/s). Participants are instructed to select whether the walking speed shown represents their usual walking pace, or whether they believe their usual walking pace is faster, or slower. The participant can adjust the video clip by using the ‘Slower’ and ‘Faster’ buttons. Choosing ‘Slower’ or ‘Faster’ triggers a subsequent video at a new speed and adjustments are allowed until the participant believes the pace shown in the video represents their usual walking pace. They then select the ‘This Video Represents My Usual Walking Pace’ button. Walking animations were developed to encompass the range of speeds that older adults may potentially walk. Exact speeds were then calculated from the five animations. Walking speed options are; 0.716 mph (0.32
m/s), 1.521 mph (0.68 m/s), 2.237 mph (1.00 m/s) which was the first clip presented to participants, 2.684 mph (1.20 m/s), 3.355 mph (1.50 m/s).

Figure 1: Screenshot of MAT-PA walking speed animation

After the participant selected their usual walking speed, they were asked the number of days (0-7) during the past week in which they walked more than 10 mins at that pace, along with the time walked on those days (Figure 2). Although not utilized by participants in this study, the option for distance is also provided as an alternative method to report walking quantity information when preferred. This was added to the questionnaire for an international study where the MAT-PA was utilized in cultures where time is not a priority and information, such as distance between two points, is preferred. The chosen usual pace walking speed can be viewed at this response screen as a reminder to the participant if required. The process of selecting walking speed, frequency, and duration as described above is repeated for the participants fast walking pace. The fast walking pace is described to be a pace that would cause the participant to
work up a sweat, get the heart beating faster, or cause more rapid breathing. The animations of walking that are shown to the participant, including the initially presented clip, are the same for the fast pace item as those used for usual walking pace.

Figure 2: Screenshot of MAT-PA walking volume items

After completing the walking related section, participants were asked to identify any sports, fitness, or recreational activities other than walking that they do on a regular basis. This response page allows free text field data entry and includes the task description, duration and frequency (Figure 3). Participants are encouraged to enter all of the activities in which they participate. Physical activity performed in this section is then matched to the compendium of physical activities to identify the caloric expenditure of these activities when MAT-PA responses are scored (Ainsworth et al., 2011).
In the final component of the MAT-PA, participants were asked about their time spent sitting and napping (appendix). Sitting information was collected with the question, “On average, how many hours did you spend sitting each day?” Hours per day of sitting were partitioned into categories of morning, afternoon and evening to allow a better framework for the recall of information. This prompted participants to narrow their focus on typical daily patterns (i.e. breakfast, transport, TV watching), to try to obtain a more representative assessment of sitting behavior. Possible responses were provided in whole hours. Time spent napping was collected via the question, “On average, how many minutes did you spend napping each day?” These responses are also partitioned into morning, afternoon and evening with responses provided in whole minutes. Screenshots from the entire MAT-PA questionnaire software is in Appendix 2.

Outcomes that are assessed from the questionnaire consist of kcals/week of energy expenditure, speed walked at usual and fast walking pace, frequency and duration per week of walking at usual and fast pace, active and resting kcals/week, time spent sitting and napping and kcals/week of activities in light physical activity and moderate
physical activity. As the purpose of this present thesis was focused on the reliability and validity of the MAT-PA walking components, only the outcomes of walking minutes per week, walking speed, and a metric combining the walking speed, duration and frequency were processed from our data set. Future analyses will assess the utility of the other activity and sedentary behavior MAT-PA components.

Modified CHAMPS questionnaire (mCHAMPS)

At SV1, a modified CHAMPS (mCHAMPS) physical activity questionnaire was administered on a computer with the assistance of assessment staff. The mCHAMPS is a 6 item questionnaire designed to focus on the most common types of physical activity performed by older adults such as walking, common aerobic activities, gardening, dancing and strength training (Figure 4). In contrast, the full version of the CHAMPS Activities Questionnaire for Older Adults also includes non-physical activity questions, e.g., did you use a computer, and did you attend church or take part in church activities (Stewart et al., 2001). The administration of the full CHAMPS questionnaire can be time consuming, in part, due to the non-physical activity related items. To our knowledge, no published literature has investigated the validity of the mCHAMPS, however, all items are culled from the CHAMPS questionnaire, which is valid and has been used in studies of older adults where physical activity is an important outcome (Cyarto et al., 2006; Giles & Marshall, 2009; Hekler et al., 2012; Resnicow et al., 2003; Stewart et al., 2001).

The mCHAMPS were then processed to provide the number of minutes per week that participants engaged in these physical activities. Several scores can be derived from the mCHAMPS, however, with the focus of the present study on walking activity, we used the score obtained from items 1-5, which were related to the aerobic physical
activity that participants engage in. This score, in minutes per week, will be referred to as the mCHAMPS5.

Figure 4 – Modified CHAMPS questionnaire (mCHAMPS)

<table>
<thead>
<tr>
<th>Pre-Interview instructions for the participant:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am now going to ask you about various physical activities that you may have done in the past four weeks; for those activities that you have done, I will also ask you how many times you have done the activity and how many minutes each session typically lasts. There are no &quot;right&quot; or &quot;wrong&quot; responses, so please answer each question as honestly and accurately as you can.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In a typical or normal week during the past 4 weeks, did you . . .</th>
<th>Yes / No</th>
<th>Number of Days Each Week</th>
<th>Total Minutes per Day</th>
<th>Total Minutes per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do heavy gardening? (Such as spading, raking)</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jog or run?</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk fast or briskly for exercise outside or on a treadmill?</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do other aerobic activities such as cycling or step machines?</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do aerobic dancing of any type?</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do strength training?</td>
<td>-select-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Combined Weekly Total Minutes for 1-5</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Combined Weekly Total Minutes for 6 Only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Combined Weekly Total Minutes for 1-6</strong></td>
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Accelerometry

We used the Kenz Lifecorder EX accelerometer, a small hip mounted uniaxial device that stores “accelerations” for 4 second epochs. Previous investigations have found that the Lifecorder accelerometer is valid and reliable in a research setting (Abel et al., 2008; Ayabe, Ishii, Takayama, Aoki, & Tanaka, 2010). This device was given to the participant at the completion of their SV2 and F06 testing sessions. The participant was directed to wear the device during all waking hours for the following 7 days and to return it using a stamped addressed envelope provided by the assessment staff. Along with verbal instructions, a handout describing directions for accelerometer use and a logbook for recording dates and times the device was worn were also provided (Appendix 3). This logbook was used to verify that the correct wear period was captured from the accelerometer during processing. Prior to the device being provided to the participant, it was programmed with the participant’s age, height, and body mass.

Although there are currently no well-established criteria for the collection of accelerometry in older adults, a minimum of 5 days with at least 10 hours per day of wear time was considered appropriate for the measurement of habitual physical activity. This aligns with methods employed for the data collection, cleaning and reduction of accelerometry in previous research (Troiano et al., 2008; Matthews et al., 2002; Hart, Swartz, Cashin, & Strath, 2011). On return, accelerometer data were uploaded into the Kenz Physical Activity Analysis Software (PAAS) Lifestyle Coach V1.21 where the wear time period was selected. Data were assessed on the above criteria, and eligible accelerometry files exported to a Microsoft Excel Spreadsheet. If sufficient accelerometry data was unavailable (due to either equipment malfunction, or inadequate
wear time), the participant was given another accelerometer and asked to wear it for another 7 days. If we were unable to obtain sufficient accelerometry data on 2 separate occurrences, the individual was excluded from analyses involving accelerometry. After the data were exported to Microsoft Excel, days that were considered inadequate were removed and eligible days processed to provide the duration spent in Activity Intensity Zones 4-9, interpreted as the minutes of moderate and vigorous intensity activity (MVPA). Eligible days were then averaged to create the summary data used in analysis.

Walking speed

Walking speed was measured using spatiotemporal gait data collected using a GAITRite instrumented mat (CIR Systems Inc). The GAITRite walkway has an active sensing area of 192 inches x 24 inches, comprising 18,432 sensors on a 48 x 384 grid. The GAITRite system has good to excellent reliability in a range of cohorts and demonstrates good agreement with spatiotemporal parameters collected using 3-D motion analysis systems (Webster, Wittwer, & Feller, 2005; van Uden & Besser, 2004; Menz, Latt, Tiedemann, Mun San, & Lord, 2004).

During data collection, the participant started walking 4 m prior to the instrumented carpet allowing them to reach a constant walking speed by the time that foot strikes were measured. A diagram of the testing environment can be seen in Figure 5. Data were collected on four consecutive trials at a usual walking pace and four consecutive trials at a fast walking pace with participants having the option to rest in between trials if required. Usual pace was described to the participant as “the pace that
you typically walk if you were in no rush to get somewhere, for example walking to the mailbox or through a shopping mall”. Recall that this is the same description provided in the MAT-PA. The fast walking pace was described as “the pace that you typically walk if you were trying to attain a sweat or get your heart beating faster, something that would more likely be associated with walking for exercise”. Again, this replicated the description for fast walking speed in the MAT-PA. After the speed was described, the assessment staff instructed the participant to walk as naturally as possible down the middle of the carpet area at the usual or fast pace. Before each trial, the following script was read to the participant; “This is your ‘X’ trial at usual/fast walking pace, begin”. The assessment staff paid particular attention to the gait of the participants to identify if there was unnatural movement, for example, targeting the footfall to the beginning or end of the carpeted area. If this occurred, the trial was repeated. GAITRite Plus v4.7 (CIR systems Inc.) was used for the collection of footfall data and was done so in ‘real time’. Each trial is given an identifying ‘memo’ and at the completion of the final trial, walks were grouped as either ‘usual walking pace’ or ‘fast walking pace’ to provide the average walking speed for the four trials.
Figure 5 – GAITRite testing environment

The 400 m walk test was used as a health or function outcome to assist with the assessment of validity for the MAT-PA. It has been regularly used to test function in the older adult literature and has been shown to be an important prognostic indicator for total mortality, cardiovascular disease and mobility disability (Newman et al., 2006). It has been shown to have excellent reliability and validity (Rolland et al., 2004). Participants were asked to walk 400 m (10 laps of a 20 m course) as quickly as possible and the time for completion was recorded. Standard encouragement was given throughout the test.
CLIP-II Intervention

Participants that were recruited into the CLIP-II study were randomized into one of three groups: a Weight Loss only group (WL); Aerobic Training plus Weight Loss group (AT+WL); and a Resistance Training plus Weight Loss group (RT+WL). Full descriptions of CLIP-II study interventions have been published (Marsh et al., 2013). The walking prescription for the AT+WL group was individualized by YMCA staff. Beginning with a stimulus that was tolerable for the individual, progression of walking was shaped towards achieving 45mins/session at an intensity of 12-14 on the Borg Rating of Perceived Exertion Scale (RPE) for 4 days per week. The WL control group for CLIP-II were directed to begin no new physical activity regime for the entirety of the study.

Statistical Analysis

We used IBM SPSS Statistics, Version 21 for all statistical analyses. Tests for normality were performed to determine whether data transformations were appropriate and if nonparametric analyses would be required. Test-Retest reliability was examined by performing Spearman’s rank correlation coefficients on MAT-PA walking activity collected at SV1 and 10-14 days later at SV2. Construct validity for the MAT-PA self-reported walking speeds were determined by Spearman’s correlations examining MAT-PA usual and fast walking speeds and the average walking speeds from the respective GAITRite walking speed trials. MAT-PA assessed at baseline (SV2) was used for walking speed validity analyses to maximize our sample size.
Validity of the MAT-PA walking physical activity measure was determined by performing Spearman’s correlations examining the association between MAT-PA walking, accelerometry derived MVPA and mCHAMPS5 minutes of physical activity. For the walking physical activity analysis, we used MAT-PA follow-up scores since the distribution was ‘more normal’ at this point in time. To assess how the MAT-PA was related to physical function, the time to complete the 400m walk was partitioned into quartiles and MAT-PA walking activity at baseline was used to determine differences between those with high versus low function. Difference scores between baseline (SV2) and 6 month MAT-PA walking and accelerometry derived MVPA were computed, and Spearman’s correlation was performed between change values.

General linear models were completed on the MAT-PA scores using the 6 month data as the outcome, randomization assignment to either the control or walking group as a fixed treatment effect, and the baseline values for each score as a covariate. It must be noted that participants that were randomized to the resistance training group were excluded from this analysis to allow a direct contrast between the walking and control group.
RESULTS

Demographics

A total of 185 older adults participated in this study at the time of the baseline testing and 6-month follow-up data were available on 114 of these participants at the time the analyses for the thesis were conducted. A large proportion of our sample was female (72.4%) and white (64.9%). Descriptive statistics for relevant demographic, biometric, and functional variables can be found in Table 1.

Descriptive Data for Baseline MAT-PA Scales and Measures Used in Validation

Of the 185 participants tested at baseline, 169 had valid Accelerometry data (91%). There were 182 that had interpretable MAT-PA data from SV2 testing, which is considered the baseline measurement time-point for this variable. One hundred ten participants successfully completed the MAT-PA at SV1, and we were able to conduct reliability analyses using SV1 and SV2 data on 109 of these subjects. Of the 114 participants who completed 6 month testing, there were 109 that successfully completed the MAT-PA and 98 that had valid Accelerometry data.

Descriptive data for baseline and follow-up MAT-PA outcome variables are provided in Table 2. It is important to note that this Table includes data for both minutes of activity as well as a metric for distance walked. The reason for this approach is that the distance metric enabled us to create a score that incorporated the speed at which participants
walked during their usual and fast pace, i.e., a person with a faster walking pace would walk further in a given amount of time. Therefore, the use of distance as a metric for the outcome takes advantage of the different speeds of movement within both the usual and fast paced conditions—an innovation made possible by the inclusion of video of different walking speeds into the MAT-PA. Also, the distance measure is used in subsequent analyses related to reliability, validity, and sensitivity to change.

Using the MAT-PA baseline visit, participants reported performing 95.9 min of walking per week, predominantly conducted at their usual walking pace (67.0 min) as opposed to their fast pace (28.9 min). At the 6 month follow-up, the total walking time assessed via the MAT-PA increased to 195.2 min per week with a higher proportion of the walking being conducted at a participant’s fast pace as compared to baseline. As we will demonstrate in a later section of the results on validation of the MAT-PA, this increase was largely due to changes in the walking group and not the control.

The Accelerometry data for MVPA are provided in Table 3. We directed our attention to minutes of moderate activity each week since this is the focus of the CLIP-II intervention. These data highlight the sedentary nature of the study cohort, and also suggest that our screening methods that were designed to identify sedentary older adults were effective. At the time of baseline testing, participants in CLIP-II were involved in only 51.8 minutes per week of moderate physical activity, i.e., less than an hour out of an estimated ~100 hrs/week of awake time.

Finally, Table 3 provides data on usual and fast-paced walking speed assessed using the GAITRite mat, 400-m walk time, and minutes of moderate physical activity reported
via the CHAMPS5. These measures are used to examine the validity of the MAT-PA. It is interesting to note that the minutes per week reported via the CHAMPS5 at baseline was very close to what was reported for fast pace walking using the MAT-PA (31.3 vs. 28.9 min/wk).

Reliability of the MAT-PA

To assess the reliability of the MAT-PA, we examined the relationship between the MAT-PA administered at baseline during SV1 and again at SV2. There was an average separation of 18 days between these visits. Using the Spearman correlation as a conservative estimate of the stability for the MAT-PA distance scales, we found correlations of .59 for the fast-pace walking distance, .59 for the usual-pace walking distance, and .63 for the composite index that includes both the usual and fast pace data. It is important to note that the size of these correlations are compromised by the sedentary nature of the study population and the fact that we used Spearman rank order correlation coefficients.

Evidence for Validity

We used a number of approaches to establish the validity of the MAT-PA. First, we demonstrate that the speeds selected in the MAT-PA video clips for the usual and fast paced walking speeds were comparable to the speeds measured during the usual and fast walk trials using the GAITRite assessment system. These data are shown in Figure 6 for usual walking pace and Figure 7 for fast walking pace. Note that in both figures, there
were trends for linear increases between speeds selected in the MAT-PA measure and the objectively measured gait speed. Despite the trend of increases in measured walking speed corresponding with perceptions of increased speed, this relationship was not evident for the 1.0 and 1.2m/s categories in usual walking pace where the mean scores were both 1.16m/s. For usual walking there was a tendency for those that self-selected a slow speed (0.3, 0.7, 1.0m/s) to have a faster measured walking speed than reported, while those that self-selected a relatively faster speed (1.2, 1.5m/s) tended to have a slower measured walking speed than reported. For the fast pace walking, all self-selected speed categories displayed higher measured walking speeds than what the animation displayed. Using a Spearman correlation coefficient, we found that the speeds selected for the MAT-PA were related to speed data collected using the GAITRite system for both the usual ($r_s = .33, p<0.001$) and fast walking speeds ($r_s = .41, p<0.001$).

Second, evidence for convergent and construct validity was established by correlating the distance variable for the MAT-PA with the CHAMPS5 score and Accelerometry minutes of moderate activity, respectfully. In these analyses, we used data from the 6-month visit because there was greater heterogeneity in the data at this point in time, since the sample comprised subjects in the control group and the walking group. The skewed distribution of MAT-PA outcomes at baseline are seen in Appendix 4. Using Spearman correlation, the MAT-PA was found to have a substantial relationship with both the CHAMPS5 score ($r_s = .54, p<0.001$) and minutes of moderate physical activity assessed by Accelerometry ($r_s = .60, p<0.001$). We also computed difference scores for both the MAT-PA total score and the Accelerometry minutes of moderate activity by subtracting baseline from 6-month values. We correlated these two change scores and found that
there was a significant relationship between change in these two measures ($r_s = .43$, $p<0001$).

As a final step in construct validity, we partitioned the 400-m walk time at baseline in quartiles and examined the relationship of these scores to the total walking distance from the MAT-PA for each quartile. The mean (SE) MAT-PA scores for fast walking distance each week by quartile moving from the most highly functioning to low functional group were as follows: 53.7 (7.2), 54.7 (5.8), 38.7 (6.6), 37.2 (6.9). The linear contrast was statistically significant, $F(3,178) = 3.2$, $p = .026$, although this effect was influenced primarily by differences between the top two and bottom two quartiles.

**Sensitivity to Change**

To assess whether the MAT-PA was sensitive to change after a 6 month walking intervention, we performed general linear models on the MAT-PA scores using the 6 month data as the outcome, randomization assignment to either the control or walking group as a fixed treatment effect, and the baseline values for each score as a covariate. Results of these analyses produced significant treatment effects for total walking distance ($F(1,68)= 31.253$, $p<0.0001$, $\text{Eta}^2=0.32$), usual walking distance ($F(1,67)= 30.954$, $p<0.0001$, $\text{Eta}^2=0.32$), and fast walking distance ($F(1,68)= 27.298$, $p<0.0001$, $\text{Eta}^2=0.29$). It is important to point out that all 3 effects were substantial in magnitude accounting for close to 1/3 of the variance in the 6-month scores. Table 4 provides the least squared means ($\pm \text{SE}$) for each variable by group assignment. Clearly the MAT-PA effectively
distinguished the change in walking behavior between the control and walking group at
the 6-month follow-up.
Table 1: Demographics for Baseline and 6-months (Values are mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>6-month</th>
</tr>
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<tbody>
<tr>
<td>n</td>
<td>185</td>
<td>114</td>
</tr>
<tr>
<td>Age (y)</td>
<td>67.0 ± 4.8</td>
<td>66.9 ± 4.7</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>34.0 ± 3.6</td>
<td>33.7 ± 3.7</td>
</tr>
<tr>
<td>Female sex (n, %)</td>
<td>134 (72.4%)</td>
<td>87 (76.3%)</td>
</tr>
<tr>
<td>400m walk time (sec)</td>
<td>340.2 ± 60.1</td>
<td>NA¹</td>
</tr>
<tr>
<td>CHAMPS5 (min/wk)</td>
<td>31.3 ± 99.8</td>
<td>123.4 ± 148.7</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>64.9%</td>
<td>61.4%</td>
</tr>
<tr>
<td>AA</td>
<td>32.4%</td>
<td>36.8%</td>
</tr>
<tr>
<td>Other</td>
<td>2.7%</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

BMI-Body Mass Index; CHAMPS5-Community Healthy Activities Model Program for Seniors modified questionnaire; AA-African American; NA = not available

¹ 400m walk time was unavailable as it is a primary outcome of the CLIP-II study.
Table 2: Descriptive data for MAT-PA outcomes on volume of walking activity at usual or fast pace, and total of usual and fast walking volume per week (Values are mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>SV1 $^1$</th>
<th>SV2 (Baseline)</th>
<th>6-month (Follow up)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 110</td>
<td>n = 182</td>
<td>n = 109 $^3$</td>
</tr>
<tr>
<td>Usual pace walking (min/wk)</td>
<td>36.9 ± 70.1</td>
<td>67.0 ± 124.4</td>
<td>118.2 ± 148.1</td>
</tr>
<tr>
<td>Fast pace walking (min/wk)</td>
<td>26.0 ± 86.7</td>
<td>28.9 ± 40.9</td>
<td>77.1 ± 88.7</td>
</tr>
<tr>
<td><strong>Total walking (min/wk)</strong></td>
<td>62.9 ± 133.0</td>
<td>95.9 ± 150.3</td>
<td>195.2 ± 214.0</td>
</tr>
<tr>
<td>Usual Pace Distance (meters/wk)</td>
<td>952.7 ± 1098.5</td>
<td>2141.0 ± 1914.9</td>
<td>5054.8 ± 1885.9</td>
</tr>
<tr>
<td>Fast Pace Distance (meters/wk)</td>
<td>521.6 ± 1463.9</td>
<td>1078.3 ± 1088.2</td>
<td>6457.1 ± 2289.3</td>
</tr>
<tr>
<td><strong>Total Distance (meters/wk)</strong></td>
<td>1712.1 ± 2250.1</td>
<td>3548.3 ± 2789.2</td>
<td>11541.5 ± 4145.2</td>
</tr>
</tbody>
</table>

$^1$ In the analyses conducted on these variables, we computed a square root transformation of the data to normalize the distributions for use in linear models. The values in these tables were converted back to raw units for interpretation by squaring all values.

$^2$ The MAT-PA was administered at SV1 and SV2 in order to evaluate the reliability of the MAT-PA. We used the MAT-PA assessed at SV2 as the baseline value for use in validation and sensitivity to change analyses.

$^3$ Although the participant numbers for SV1 and F06 are similar, these data are not representing the same individuals and were a subset of the overall 185 participants.
Table 3: Descriptive data for other measures used in validity assessment (Values are mean ± SD)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Baseline</th>
<th>6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual walking speed (m/s)$^1$</td>
<td>1.15 ± 0.17</td>
<td>1.19 ± 0.17</td>
</tr>
<tr>
<td>Fast walking speed (m/s)$^1$</td>
<td>1.54 ± 0.20</td>
<td>1.58 ± 0.22</td>
</tr>
<tr>
<td>Accelerometry MVPA (min/wk)</td>
<td>51.8 ± 58.8</td>
<td>91.7 ± 88.9</td>
</tr>
<tr>
<td>400m walk time (sec)</td>
<td>340.2 ± 60.1</td>
<td>NA$^2$</td>
</tr>
<tr>
<td>CHAMPS5 (min/wk)</td>
<td>31.3 ± 99.8</td>
<td>123.4 ± 148.7</td>
</tr>
</tbody>
</table>

CHAMPS5 - Community Healthy Activities Model Program for Seniors modified questionnaire

MVPA – Moderate and Vigorous Intensity Physical Activity

$^1$ Walking speed was assessed using the GAITRite instrumented carpet as described in the methods

$^2$ 400m walk time was unavailable as it is a primary outcome of the CLIP-II study.
Figure 6: Objective versus MAT-PA Usual Gait Speed

Figure 7: Objective versus MAT-PA Fast Gait Speed

1 0.3 m/s category is empty as no participant selected it for their fast pace walking
Table 4: Least Squared Means (SE) for MAT-PA Scores for the Control and Walking Group at 6-months

<table>
<thead>
<tr>
<th></th>
<th>Total Distance (meters/week)</th>
<th>Usual Pace Distance (meters/week)</th>
<th>Fast Pace Distance (meters/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>80.598 ± 9.107</td>
<td>51.879 ± 6.332</td>
<td>62.452 ± 6.607</td>
</tr>
<tr>
<td>Walking group</td>
<td>152.252 ± 8.979</td>
<td>101.705 ± 6.332</td>
<td>111.379 ± 6.513</td>
</tr>
</tbody>
</table>
DISCUSSION

Summary of Introduction

The number of older adults in the US is increasing dramatically (United States Census Bureau, 2011). With this increase comes a rise in those suffering from chronic disease (World Health Organization, 2011). Physical activity has been suggested as a key behavior in stemming the development and progression of chronic disease (Chodzko-Zajko et al., 2009). However, physical activity is also important in helping older adults to maintain their independence and fulfill their daily living needs for as long as possible. The assessment of physical activity is important to: understand the relationship between physical activity and disease states; monitor physical activity behaviors in the wider population; understand dose-response dynamics of exercise; and assess the success of interventions targeting physical activity. In addition, it could also be used by primary care providers in guiding health behaviors for those commonly under their care.

Various barriers to the accurate and feasible use of objective physical activity measurement tools necessitates the need for subjective self-report methods for the assessment of older adult PA. Self-report instruments that were not designed or validated for use in older adults, such as the International Physical Activity Questionnaire (IPAQ) have been commonly employed (Grimm, Swartz, Hart, Miller, & Strath, 2012; Tomioka, Iwamoto, Saeki, & Okamoto, 2011). Several instruments exist that were specifically designed to capture PA in older adults such as the CHAMPS (Stewart et al., 2001) or the PASE (Washburn et al., 1993). However, these have displayed inconsistent reliability and
validity when assessing older adults (Forsen et al., 2010). In addition, questionnaires can be time consuming to administer; the CHAMPS typically takes over 20 mins to complete. Evaluations of these instruments have suggested that they may do a poor job of capturing all the walking activity performed. With walking being the primary modality of physical activity performed by older adults, it is of utmost importance that questionnaires are optimized to capture this domain of physical activity.

The MAT-PA is a new tool that was designed to assess the walking physical activity performed by older adults using interactive software that incorporates computer animations of walking behavior. The primary purpose of this thesis was to investigate the reliability and validity of this novel self-report method to assess walking physical activity levels in older adults. We hypothesized that (1) There would be a significant relationship between MAT-PA walking outcomes tested 14 days apart; (2) MAT-PA derived self-reported walking speeds will have a significant relationship with objectively measured walking speed; (3) The MAT-PA walking outcomes will be significantly related to accelerometry and the mCHAMPS; (4) Individuals with higher function in the 400m walk will have greater levels of MAT-PA walking physical activity than those with lower function; (5) The CLIP-II aerobic training group will have significantly greater change in MAT-PA walking after 6 months than controls.

Participants

An important consideration for investigations into the reliability and validity of a self-report instrument is the study sample. The psychometric properties of an instrument can depend on the study sample. We achieved our goal of testing an older adult
population, however comparisons with the broader US older adult population indicate that our sample was relatively young (age range of 60-79). Therefore, we cannot say how those of advanced age (75+) would interact with the MAT-PA software. Our sample size of 185 exceeds much of the previous literature investigating measurement properties of older adult physical activity assessment (Forsen et al., 2010; Helmerhorst et al., 2012). In general, the older adult population is characterized by large variability in levels of both physical and cognitive functioning. The inclusion/exclusion criteria of the CLIP-II study focused on those with established cardiovascular disease or metabolic syndrome and created a relatively homogeneous sample, where older adults that were of good health or very low function were excluded from the study (Marsh et al., 2013). Although our sample had proportionally more females, the inclusion of 51 males was likely enough to ensure our findings could be externally valid to both men and women. CLIP-II inclusion criteria meant our sample was sedentary at baseline, however it must be noted that only 37.1% of older adults in the US currently engage in regular physical activity and therefore our sample reflects the activity level of a large majority of the older adult population (Schoenborn CA, 2013).

Reliability of the MAT-PA

In order to assess whether the MAT-PA is a valid tool for the assessment of walking activity in older adults, we first needed to assess the reliability. We did this by assessing the test-retest reliability of two separate MAT-PA questionnaire administrations. A Spearman’s correlation of .63 for combined usual and fast pace walking suggests that
the MAT-PA has acceptable reliability, although more research is warranted on this issue. These values are below the desired levels for Intraclass Correlations (> 0.70) or Spearman’s correlation coefficients (> 0.80), for older adult physical activity instruments (Terwee et al., 2010). However, these values are promising for the MAT-PA when compared with previously reported reliability of currently available self-report questionnaires (Forsen et al., 2010). Several studies that had similar or higher reliability findings exhibited significant methodological flaws, such as small sample sizes (Cyarto et al., 2006), inappropriate test-retest windows (Stewart et al., 2001) and missing data (Giles & Marshall, 2009).

Although ICC’s are often employed for reliability analysis, it was determined that this was not an appropriate method due to the skewness of our data. The sedentary nature of our sample at baseline caused the MAT-PA data to exhibit a floor effect, that is, a large number of participants reported no physical activity at all. This could mean that we have conservative estimates of the reliability of the MAT-PA. To ensure that this assumption is correct and that reliability would be improved with a more normal distributions, the test-retest reliability of the MAT-PA should be assessed with a wider cohort of the US older adult population or alternatively at a follow up time-point of the current CLIP-II study. It is also important to emphasize the low levels of physical activity in the CLIP-II participants at baseline created a very restricted range of score, a feature that is known to compromise the size of correlations.

The focus on only the walking component of the MAT-PA and subsequent exclusion of other moderate intensity activities, such as resistance training or sporting pursuits, may have reduced reliability when compared to research of existing
questionnaires. When contrasted to walking activity, older adults may find it easier to consistently recall these other forms of moderate intensity activity as it would usually represent something that is more planned or structured. Interestingly, preliminary analysis of total physical activity performed, incorporating all physical activity, improved reliability of the MAT-PA instrument. One issue that complicates the comparison of our reliability findings to existing questionnaires, is that no previous study that had acceptable methodology in older adults has partitioned out types of physical activity in their analyses.

Validity of the self-reported measure of walking speed

The MAT-PA uses a novel approach to determine walking speed and thus, walking intensity. If a participant cannot correctly identify their speed from the animation, it would have an impact on our estimates of walking volume. First, it was important to establish that individuals were correctly assessing their fast speed to be faster than, or at least the same as their usual walking speed. This showed that on the surface there was an ability to distinguish between the concepts of usual and fast walking speed.

The stepwise progression that was shown in Figure 6 for usual paced walking and Figure 7 for fast paced walking illustrates that individuals were able to do a reasonably good job at identifying the speed that they actually walk at both usual and fast pace. The categorical nature of the MAT-PA walking animations provides challenges in the analysis of the data. For example, when looking at the people that selected the 1.0 m/s
speed selection, anyone that had objectively measured speeds ranging from 0.85-1.1m/s would be correctly identifying their walking speed category. Despite these challenges, the observation of this progression when compared to objectively measured gait speed suggests that individuals do have the ability to discriminate between the walking speed animations. A more consistent trend for the ability to discriminate between self-reported speeds was observed for fast paced walking. Interestingly, for usual walking pace, those with slower gait speeds tended to report that they walked slower than they actually did, while those with faster gait speeds tended to over report their usual walking pace. For the fast walking pace, everyone in our sample actually walked faster than they perceived themselves to do based on the animation speeds. Individuals may have walked faster in the GAITRite walking test than they normally would when engaging in fast pace walking because of the controlled, intermittent, and short nature of the GAITRite walking test. In addition to those parameters, the fact that it is a test, and people want to do well on a test may have interacted with this relationship. Therefore, the true difference between perceived and free living fast paced walking may not be of the magnitude that we observed.

Validity of MAT-PA walking physical activity

Several steps were taken to investigate the construct validity of MAT-PA walking physical activity outcomes. The challenges that existed in determining whether the MAT-PA correctly assesses ones walking speed necessitated analysis of MAT-PA total walking physical activity based on two separate metrics. The first method excluded the MAT-PA walking speed component and assessed walking physical activity solely in terms of the duration per week. The second, identified as walking distance, incorporated the outcome
of walking speed into its results by combining the meters per second walked with the duration of that activity. Both of these outputs are easily created from the MAT-PA responses. Although the items pertaining to the walking duration and frequency are assessed in a similar format in existing questionnaires, the act of viewing a walking speed animation and the separation of usual and fast walking pace components could help contextualize and assist with the recall of walking behavior, thus enhancing the ability to identify walking durations. This notion suggests that even if the walking speed component may not accurately identify exact walking speed (something that is difficult to test), that there may still be an independent benefit from displaying the walking speed animations. This ability to contextualize and discriminate may therefore be enough to support the use of the MAT-PA. Our findings suggest that when comparing MAT-PA outcomes with accelerometry, there was not an increased strength in correlations by using the distance metric. Still there may be benefit from using walking distance when assessing the MAT-PA’s relationship with health outcomes, disease states, or prognosis for downstream disability.

The construct validity of the MAT-PA was very good when compared to the literature investigating other self-report physical activity questionnaires in older adults. As previously identified, no existing literature has separately analyzed the validity for walking physical activity like the present thesis. This is interesting, as the most common method of investigating validity of physical activity questionnaires is via comparison with activity monitors, such as accelerometry, which are notoriously poor at measuring non-ambulatory physical activity. Considering walking is the primary mode of physical activity in older adults, this gap in knowledge could be considered a limitation of the
previous research investigating the validity of existing questionnaires. The correlation of 0.60 between MAT-PA scores and accelerometry derived minutes of moderate and vigorous PA is stronger than typically reported on construct validity for existing questionnaires. As discussed in detail in the literature review, commonly reported correlations seen between self-reported physical activity from the CHAMPS and accelerometry are between 0.20 and 0.40 (Hekler et al., 2012) A correlation with the CHAMPS5 of 0.54 demonstrated that the MAT-PA was also significantly related with the CHAMPS, currently considered best practice for self-report in older adults. It must be noted that the CHAMPS5 addresses only the aerobic components of the CHAMPS and that the full questionnaire is typically used in the current literature. Despite this, we felt it was important to also provide a method of pen and paper comparison with the MAT-PA. Relationships between the mCHAMPS, accelerometry and MAT-PA will be further explored in future research assessing all the dimensions of the MAT-PA.

An encouraging result of the present study was that the MAT-PA was able to capture change in physical activity levels. For intervention based studies, this should be considered one of the most important factors in deciding on which questionnaire to employ. Only one other study has investigated the responsiveness or sensitivity to change of currently available questionnaires. This was the original study by Stewart and colleagues on the CHAMPS and they identified only a small to moderate ability to detect change in physical activity (Stewart et al., 2001). We observed significant treatment effects in the walking group suggesting that the MAT-PA was effective at distinguishing the change seen in walking behavior. In addition to this analysis, the relationship between the change seen over time in accelerometry and MAT-PA was also observed. These
findings provide encouraging evidence for the efficacy of using the MAT-PA to assess physical activity in walking based interventions.

Limitations of our current study

The results of this study should be interpreted in the context of the study limitations. First, the validity and reliability of a tool is a dynamic concept. An instrument is not ‘valid’ or ‘reliable’, but can show good validity and reliability in specific contexts or settings. Therefore, interpretation of our results are only appropriate for the group that we tested. In other words, the validity of this instrument do not necessarily extend to the wider older adult population in the US, particularly for individuals that are above 79 years old, or those suffering from cognitive decline.

The MAT-PA has provided a unique way of assessing walking activity by using video animation, and separating usual and fast paced walking items. One potential limitation to this method is the occurrence of double reporting, the act of attributing the same physical activity to two separate questionnaire items, which artificially inflates the physical activity that is reported (Shephard, 2003; Bowles, 2012). Several studies have identified double-reporting to be a significant problem within the physical activity questionnaire literature, however this phenomenon is very difficult to evaluate. One idea for the MAT-PA would be to assess time spent in the slow and fast pace walking speeds against light and moderate classifications of activity using accelerometry. Some studies have reported the percentage of cases when item responses were identical (Hekler et al., 2012), however this fails to consider whether: 1) the participant actually did complete both activities for the same duration, or 2) whether there was partial overlap between the
responses to the two questionnaire items, which is more likely to be the case. The failure to evaluate double-reporting in the current study means that our dataset may have been prone to older adults referring to the same walking done for both their usual and fast paced responses. This could be particularly problematic for individuals whose slow and fast walking speeds are very close to one another. The fact that our results displayed very good correlation between MAT-PA and accelerometry suggests that even if we did have some double-reporting within our walking variables, this did not have a significant effect on the ranking of participants.

The process of creating video animations is complex. As it is important that the animations appear to be moving in a way that is representative of human gait, this process needs to be reverse engineered. Therefore, the clips are created, and the speeds calculated from that, counterintuitive to what would be ideal for our purpose. This requirement for smooth movement created a categorical scale for walking speed. At this stage, it cannot be determined if the number and speeds for the categories should be expanded. The clip representing 1.0 m/s is always presented first to participants, with adjustments being made from that point. A potentially more robust way to approach this would be to have variation in the first speed displayed, which could assist with the accuracy of walking speed self-report. Also, since the highest speed option was only 1.5m/s it created a ceiling effect for the fast walking pace data, meaning an additional speed above that of 1.5m/s may be beneficial.

The primary limitation in the discussion of construct validity of physical activity questionnaires is the comparison tools themselves. The lack of a gold-standard to measure free living physical activity or walking behavior, is an inherent limitation of this
form of research. We minimized this limitation by using accelerometry, the current best practice for assessment of physical activity in older adults. One issue that arises with using accelerometry is the concept of cut-points. Depending on the cut-point selection there could be an under or over-estimation of the physical activity that is ascribed to a dataset. For this study we used the cut point of intensity 4, which has been shown to roughly correspond with 4 METS. This is considered by the device manufacturers to be moderate intensity activity. Research suggests that moderate intensity activity may be performed at levels below this for older adults and that the physical activity performed through accelerometry has potentially under-predicted moderate intensity PA levels (Hall et al., 2013). More research is needed to provide insight into the correct accelerometer cut points to use in the older adult population.

CONCLUSION

With the number of older adults increasing, focus must be placed on identifying the best ways to measure physical activity, and in particular walking activity since it is the most common form of PA. There is a scarcity of research that has examined validity and reliability of current measurement tools in older adults and a lack of instruments focused on assessing walking activity. Findings from this study suggest that the MAT-PA displays excellent validity when measured on a single occasion and that it is sensitive to change caused by the adoption of a physical activity intervention. This provides the potential for the quick and easily administered measurement of physical activity in both research and clinical settings. Further research on the MAT-PA should focus on fine tuning the self-reported walking speed component, assessing its validity and reliability in
a range of cohorts, and investigating whether the full questionnaire is valid in assessing overall physical activity.
REFERENCES


APPENDIX

Appendix 1 – Inclusion/Exclusion Criteria

CLIP II- Inclusion Criteria (must meet ALL of the following)

- **Residence**: community dwelling men and women from the counties of interest
- **Age**: between 60-79 years
- **Activity Status**: sedentary (less than 60 minutes of moderate intensity structured physical activity each week and occurs in no less than 10 minute blocks)
- **Adiposity**: BMI >=28 to <=42
- **Medical Criteria**: documented evidence of an MI, PCTI, chronic stable angina, cardiovascular surgery (coronary artery or valvular heart disease) or an ATP II diagnosis of metabolic syndrome
- **Mobility Disability**: disability defined as self-reported difficulty with walking ¼ mile, climbing stairs, lifting and carrying groceries, or performing other household chores such as cleaning and yard work
- **Stability of Residence**: does not plan to move out of the county of residence for the duration of the study
- **Agreeableness**: willing and able to participate in all aspects of the trial
- **Consent**: willing to give consent and sign an informed consent/HIPAA authorization form

Exclusion Criteria (one or more of the following EXCLUDES participant from the study)

- **Severe Symptomatic Heart Disease**: evidence of unstable angina, symptomatic congestive heart failure, or exercise induced complex ventricular arrhythmias
- **MI or cardiovascular procedure within the last 3 months**
- **Blood pressure**: a resting blood pressure >160/100mmHg
- **Blood glucose**: a fasting blood glucose >140mg/dL, diagnosis of type 1 diabetes, or diagnosis of type 2 diabetes and on insulin therapy
- **Severe Systemic Disease**: diagnosis of Parkinson’s disease, chronic liver disease (cirrhosis, chronic hepatitis, etc), systemic rheumatic condition (rheumatoid arthritis, psoriatic arthritis, Reiter’s disease, systemic lupus erythematosus, etc), end stage renal disease or other systemic diseases or abnormal laboratory values which would preclude participants from safely participating in the protocol or impair their ability to complete the study
- **Cancer**: active treatment for cancer other than non-melanotic skin cancer
• **Hearing or Sight Impairments**: significant visual or hearing impairments that cannot be corrected and results in the inability to use the telephone or hear normal conversation
• **Psychiatric Illness**: bipolar depression or schizophrenia (defined as self-reported treatment for these conditions), currently receiving lithium or neuroleptics
• **Participation in Other Trials**: currently participating in or planning to participate in another medical intervention study
• **Alcohol Intake**: consuming more than 14 alcoholic drinks per week or alcoholism
• **Functional Limitations**: unable to walk unassisted
• **English Literacy**: unable to speak or read English
• **Working (employment)**: >=21 hours per week
• **Clinical Center Staff Evaluation**: judged to be unsuitable for the trial for any reason by the clinic staff. A participant can be excluded prior to randomization because of some unspecified health problem that has been identified that would put the patient at risk for adherence or retention. These cases are discussed with a recruitment team consisting of the person who has raised the concern, an MD, and the study PIs.
Appendix 2 – MAT-PA Screenshots

This interactive questionnaire is designed to assess your walking activity and also any sports, fitness, or recreational activities other than walking that you do on a regular basis. When answering the questions, please think about a typical week during the past month.

Please answer the questions below to the best of your ability. There are no right or wrong answers.

If you have questions or are confused, be sure to ask for help.

In this first step, you will be asked to watch a video clip of walking and determine if it describes your usual walking pace; that is, the pace you typically walk if there is no rush to get somewhere. Once you have finished reading these instructions and are ready to watch the video, simply click the PLAY button on the next screen.

If after watching the video, you feel that it is faster or slower than your usual pace, then speed it up or slow it down by clicking the SLOWER or FASTER button to select the pace that best represents your usual pace.

When you see your usual pace in the video, click the button that says: This video represents my usual pace. You will then be asked about how many days per week you walk at this pace and for how long or how far.

Proceed
How many days each week would you say that you walked at this pace for at least 10 minutes without stopping?

<table>
<thead>
<tr>
<th>0 Days</th>
<th>1 Day</th>
<th>2 Days</th>
<th>3 Days</th>
<th>4 Days</th>
<th>5 Days</th>
<th>6 Days</th>
<th>7 Days</th>
</tr>
</thead>
</table>

On average, what total time (min) or distance (meters) did you walk at this pace each day?

[ ] _Minutes_ [ ] _Meters_

Remember, when answering all questions please _think about a typical week during the past month_.

In the second step of this questionnaire, you will be asked to identify a video clip of walking that represents a _fast_ walking pace for you, _one that would cause you to work up a sweat, get your heart beating faster, and cause you to breathe more rapidly_. Once you have finished reading these instructions and are ready to watch the video, simply click the PLAY button on the next screen.

If after watching the video it is either faster or slower than _your fast pace_, then click on the SLOWER or FASTER button until you find the video that best captures _your fast pace_. When you have identified _your fast pace_, click the button that says _This video represents my fast pace_. You will then be asked about how many days per week you walk at that pace and for how long or how far.
Remember, when answering the questions please *think about a typical week during the past month.*

In this third step, you will be asked about how often and for how long you do any sports, fitness, or recreational activities other than walking on a regular basis. If you do not do these type of activities, leave this question blank and click the PROCEED button. If you do other sports, fitness, or recreational activities on a regular basis, then list these and the approximate time that you are active in each activity.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Average Time/Episode</th>
<th>Times/Week</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>0:minutes</td>
<td>0:times</td>
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</tbody>
</table>

In the final step, you will be asked about how much time you spend sitting and napping.

On average, how many hours did you spend sitting each day?

<table>
<thead>
<tr>
<th>Morning</th>
<th>Afternoon</th>
<th>Evening</th>
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<tbody>
<tr>
<td>0:Hours</td>
<td>0:Hours</td>
<td>0:Hours</td>
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</tbody>
</table>

On average, how many minutes did you spend napping each day?

<table>
<thead>
<tr>
<th>Morning</th>
<th>Afternoon</th>
<th>Evening</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:Minutes</td>
<td>0:Minutes</td>
<td>0:Minutes</td>
</tr>
</tbody>
</table>
Appendix 3 – Accelerometry Log

The CLIP-II Study

Motion Sensor Log

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>Finish Time</th>
<th>Time Off</th>
<th>Time On</th>
<th>Time Off</th>
<th>Time On</th>
<th>Time Off</th>
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Special Notes
(Please include date with any notes.)
Total_Mins_C_sv2 – the total duration of walking physical activity, combing both usual and fast pace. SV2 refers to our baseline assessment.
CURRICULUM VITAE

James A. Janssen

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Education

Graduate  
Wake Forest University, M.S. (Health and Exercise Science)  
2012-2014  
Winston-Salem, NC

(graduating May 19, 2014)

Thesis: Validity and Reliability of a Novel Computer-Animated Self Report Physical Activity Instrument for Older Adults

Undergraduate  
Deakin University, B.Ex.Sp.Sci (Double Major: Exercise Physiology, Sports Nutrition) with Distinction  
2006-2008  
Melbourne, Vic, Australia

Research

2012 to present  
Wake Forest University  
Department of Health and Exercise Science

Research Assistant  
Dr. Jack Rejeski and Dr. Anthony Marsh, Supervisors

CLIP-II Study  
Cooperative Lifestyle Intervention Program – II

The purpose of this study is to investigate the effects of weight loss and weight loss combined with different forms of physical activity on changes in physical functioning for older adults who are at risk for cardiovascular disease.
Responsibilities: Assessments (including but not limited to; DXA; isokinetic strength testing; physical function tests; gait analysis; questionnaire administration); management of accelerometry; development of testing protocols; front line data management; cleaning of gait/accelerometry data.

2011 to 2012  Deakin University  
School of Exercise and Nutrition Sciences  
Research Assistant  
Dr. Brad Aisbett and Dr. Sally Ferguson, Supervisors  

ASH project  The ‘Awake, Smoky and Hot’ project  
The purpose of this study was to investigate how multiple stressors (heat, sleep disruption and smoke) can have an impact on job based physical performance and physiology in bushfire firefighters.  

Responsibilities: Development of work based simulation of bushfire firefighting; development of researcher handbook including testing protocols; physiological and performance based data collection.

2010  Deakin University  
School of Exercise and Nutrition Sciences  
Research Assistant  
Dr. Brad Aisbett and Dr. Kevin Netto, Supervisors  

Body Armour  Kinematic and physiological comparison of body armour  
The purpose of this study was to evaluate the varying kinematic and physiological responses to the use of three body armour conditions in Australian armed forces.  

Responsibilities: Development of a military movement-based simulation for testing with trained military personnel.

2009 to 2010  Deakin University  
School of Exercise and Nutrition Sciences  
Research Assistant / Project Manager  
Dr. Brad Aisbett and Dr. Kevin Netto, Supervisors
Pack Hike EMG  Muscle activation during the pack hike

This study aimed to examine the muscle activation that occurs during the pack hike test; a field test that is commonly used to assess job readiness in physically demanding occupations and compare these with bushfire firefighting job related tasks.

Responsibilities: Development of testing protocol, field testing management; EMG data collection; data management and cleaning; recruitment of research assistants.

2008-2009  Deakin University
School of Exercise and Nutrition Sciences

Research Assistant
Dr. Brad Aisbett, Supervisors

CFA CVD Risk  Cardiovascular disease risk profiling in wildfire firefighters

The purpose of this study was to perform health appraisals on wildfire firefighters throughout the state of Victoria and develop an understanding of the CVD risk profiles of this cohort.

Responsibilities: Performance of 1000’s of health appraisals throughout rural Victoria including fingertip blood sampling, blood pressures and anthropometrics. Appraisals also included a brief healthy lifestyle consultation.

Teaching

2008 to 2012  Deakin University
School of Exercise and Nutrition Sciences

HSE301 – Principles of Exercise Testing and Prescription

HSE304 – Physiology of Sports Performance

HSE202 – Biomechanics

HSE302 – Exercise Programming

HSE312 – Exercise and Sports Science Practicum
Also taught into several other units on a guest lecture basis including Research and Advances in Sports Nutrition.

Awards/Other

Received commendation for teaching in all 8 semesters from Head of School – Teaching and Learning for exceptional student feedback results (achieving total scores of 4.5+/5 in SETU).

Selected as representative of the school to mentor casual instructors that were new to the Faculty of Health.

Served on action team to develop and integrate e-learning solutions within School of Exercise and Nutrition Sciences.

Assisted with a project that was focused on the structural alignment of exercise science curriculum and identifying key graduate competencies.

Publications


Professional

2012 – 2014 Wake Forest University Women’s Basketball

Graduate Consultant Coach
Responsibilities: statistical analysis; contributed to game planning and practice; advised on international recruiting landscape; in-game strategy; player development.

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2006 – 2012 **Blackburn Vikings Basketball Club**

President 2011-2012

Vice President 2009-2011

Board Member 2006-2009

Blackburn Vikings Basketball Club is an incorporated organization in South East Melbourne, Australia that consists of both junior basketball (u12-u18) as well as mens and womens teams competing in the second tier professional leagues.

Responsibilities (included but not limited to): basketball operations; financials; acting as club delegate to Basketball Victoria meetings; strategic direction; hiring of staff; sponsorship development; oversee club re-branding 2011.

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2006-2012 **Personal Training / Strength and Conditioning**

Elevate Personal Training

HealthByDesign

Equilibrium Health and Fitness

Responsibilities: Acted as strength and conditioning coach / consultant to a number of sporting organizations including basketball and Australian rules football teams; Personal training of a range of clientele; Led exercise group sessions for older adults called ‘active adults’ encompassing movement, balance and muscle strengthening based activities.

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**Certifications**

2014  ACSM Certified Clinical Exercise Specialist

2012  CPR and AED certified, American Heart Association
Memberships

2014-present  American College of Sports Medicine
2012-present  Southeast American College of Sports Medicine