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Full Length Article

# Duration of moderate to vigorous daily activity is negatively associated with slow walking speed independently from step counts in elderly women aged 75 years or over: A cross-sectional study

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ABSTRACT

*Objectives:* This study aimed 1) to examine whether objectively measured duration of moderate to vigorous physical activity (MVPA) was associated with slow walking speed, independent from step counts, in elderly women aged 75 or over (old-old) and 2) to determine a possible cut-off value for duration of MVPA related to slow walking speed.

*Methods:* Participants were 350 community-dwelling old-old women. Slow walking speed was defined as usual walking speed < 1.0 m/s. Duration of MVPA (activity at an intensity > 3 metabolic equivalents) and number of step counts were measured using a uniaxial accelerometer over 1 wk. Body mass index, grip strength, back and leg pain, cognitive function, executive function, and presence of depression were also assessed. Participants with missing data were excluded from the main analysis.

*Results:* The mean age of the participants was 79.9 ± 3.6 y. The prevalence of slow walking speed was 14.9%. Multiple logistic regression analysis showed that the duration of MVPA was significantly and inversely associated with slow walking speed, independent from step counts and other confounding factors (adjusted odds ratio = 0.94 per 1 min/d increment, 95% confidence interval = 0.73–0.99; $p$ = 0.031). This relationship was also observed in sensitivity analysis that included all participants. A MVPA cut-off value of 8.7 min/d was determined using the receiver operating characteristic analysis.

*Conclusion:* The findings from the present study suggest that promoting MVPA may be helpful to prevent slow walking speed. The validity of MVPA for predicting slow walking speed needs to be confirmed in future prospective studies.

## 1. Introduction

Walking speed declines with aging (Auyeung, Lee, Leung, Kwok, & Woo, 2014) and slow walking speed predicts adverse health outcomes such as falls (Montero-Odasso et al., 2005), disability (Shinkai et al., 2000), and mortality (Studenski et al., 2011). In addition, walking speed is a reliable (Peters, Fritz, & Krotish, 2013) and easily evaluated parameter in the clinical setting. Consequently, walking speed has been recommended as a useful clinical indicator, and is sometimes considered a vital sign for the care of elderly people (Cummings, Studenski, & Ferrucci, 2014). The prevalence of physical frailty in community-dwelling elderly people is high especially in elderly women aged 75 years or over (hereafter referred to as "old-old") (Collard, Boter, Schoevers, & Oude Voshaar, 2012). Therefore, early detection of slow walking speed in this population may provide key information for health promotion.

In addition to aging, walking speed is associated with sensorimotor function (Tiedemann, Sherrington, & Lord, 2005), psychological functions (Tiedemann et al., 2005), as well as habitual physical activity (PA) (Aoyagi, Park, Watanabe, Park, & Shephard, 2009). PA has been reported as a predictor of disability in activities of daily living (Tak, Kuiper, Chorus, & Hopman-Rock, 2013). Additionally, a randomized controlled trial by Pahor et al. recently reported that a structured moderate-intensity PA program, compared with a health education program, reduced major mobility disability. Mobility disability was defined as the inability to complete a 400-m walk test within 15 min

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without sitting and without the help of another person or walker (Pahor et al., 2014). Thus, promotion of PA can also be effective in maintaining or improving walking speed and potentially over all long-term health.

Although the relationship of PA to walking speed has been well documented (Brach et al., 2003; Busch T. de et al., 2015; De Pew, Karpman, Novotny, & Benzo, 2013; Haight, van der Laan, Manini, & Tager, 2013; Kwan et al., 2014), there is a lack of evidence in old-old women, who have a higher risk of frailty compared to men or younger individuals (Collard et al., 2012). Additionally, these previous studies did not consider confounding factors of PA and walking speed such as muscle strength or presence of depression. Furthermore, it remains unknown whether moderate to vigorous PA (MVPA) is beneficial for promoting health in old-old women. Duration of habitual MVPA (i.e., brisk walking, stepping up stairs, and aerobics) is a representative measure of PA intensity and is generally defined as activity at an intensity > 3 metabolic equivalents (METs) (Ainsworth et al., 2011; Aoyagi & Shephard, 2010). MVPA has beneficial effects for reducing risks of cardiovascular disease and all-cause mortality (Bucksch, 2005; Tanasescu et al., 2002). In elderly people aged 65 years or over, MVPA has been reported to have a stronger negative correlation with loss of lean body mass than step counts (Shephard, Park, Park, & Aoyagi, 2013). This evidence suggests that promoting MVPA is likely to have more benefits than merely increasing steps counts for health promotion in elderly people. However, there has been little research on the relationship between duration of habitual MVPA and slow walking speed in old-old women.

Therefore, the primary purpose of this study was to examine whether objectively measured duration of habitual MVPA was associated with slow walking speed, independent from confounding factors among old-old women. If so, we aimed to determine a possible cut-off value for duration of MVPA related to slow walking speed, which was defined as usual walking speed < 1.0 m/s.

## 2. Methods

### 2.1. Study design and participants

This cross-sectional study was a secondary investigation from a prospective cohort study conducted by our laboratory at the Graduate School of Medicine at Nagoya University in Japan. The inclusion criterion of the cohort study was community-dwelling old-old people. The study protocol was approved by the Ethics Committee of the School of Health Sciences at Nagoya University (approval number 2012-0131). The cohort study recruited community-dwelling volunteers via mail, and a total of 428 elderly people provided written informed consent to participate. For the present study, we enrolled 350 old-old women who could walk independently without any walking assistance. No participants had any severe cardiac, pulmonary, musculoskeletal, or neurological disorders.

### 2.2. Assessment of slow walking speed

A 14-m walkway was used to measure usual walking speed. Usual walking speed was calculated over a 10-m distance between the 2- and 12-m marks of the 14-m walkway (Liu-Ambrose, Pang, & Eng, 2007). The test was performed twice, and the faster result was used as the index of usual walking speed. Slow walking speed was defined as usual walking speed < 1.0 m/s according to an epidemiological study of Japanese community-dwelling elderly people (Shimada, Suzuki et al., 2013).

### 2.3. Assessment of PA

PA was measured in autumn (September to November) in order to avoid seasonal effects. MVPA and step counts were measured using a uniaxial accelerometer (Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Japan). The device records step counts and intensity of PA. The intensity of PA was categorized into 11 levels (0, 0.5, 1–9) based on the recorded acceleration pattern.

A previous study assessed the relationship between these accelerometer levels and METs determined using objectively measured oxygen consumption during walking on a treadmill in young men (Kumahara et al., 2004). The study revealed that an accelerometer level > 4 corresponded to > 3 METs. Since metabolism is lower in the elderly compared to young adults (Kwan, Woo, & Kwok, 2004), the oxygen consumption may also be lower in the elderly. Yet, even if an accelerometer level > 4 corresponded to < 3 METs in the elderly, the relative intensity of the activity > level 4 is actually higher in the elderly due to their lower fitness level. Therefore, the accelerometer level > 4 in the elderly is likely to be appropriate as an indicator of MVPA. To date, PA with an acceleration level > 4 from this device has been widely used to categorize MVPA in middle aged and elderly adults (Aoyagi et al., 2009; Hara et al., 2016; Nicklas et al., 2016).

All of the participants were instructed to wear the accelerometer at the waist all day with the exception of bathing and sleeping, for seven consecutive days to assess daily PA. We defined daily PA measured for seven days as habitual although there is not sufficient consensus about the definition of habitual PA. Moreover, participants were asked to continue their normal activities of daily living during the measurement period, and were blinded to their measured values. The mean duration of MVPA and the mean number of daily step counts were calculated.

### 2.4. Physical and psychological factor

As the physical factor, we assessed body mass index (BMI), grip strength, and presence of leg or back pain. BMI was calculated as weight divided by the square of height. Body weight was measured using a digital weight scale and height was measured using a stadiometer. Grip strength was measured with the Jamar dynamometer (Sammons Preston, Bolingbrook, IL, USA) set at the second handle position. The participants sat with the wrist in a neutral position and the elbow flexed at 90°. Grip strength was measured twice for each hand, and the highest value was used as the index of grip strength. Each participant self-reported presence of pain in the back or leg as “none,” “sometimes,” or “always.” Presence of pain for data analysis in this study was defined as the participant feeling pain “sometimes” or “always.”

As the psychological factor, we assessed cognitive state, executive function and depression using the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), Trail Making Test (TMT) (Reitan, 1958), and 5-item Geriatric Depression Scale (GDS-5) (Hoyl et al., 1999), respectively. MMSE is a standard test to assess global cognitive function that includes 11 questions with a maximum score of 30. TMT is a visual task in which participants are asked to draw a line from one point to the next as quickly as possible in order to connect circles in numerical order (part A) and in alternating order between numerical and Japanese characters (part B). The time to finish each part was recorded and the difference between part B and A (ΔTMT) was calculated (Hirota et al., 2010). GDS-5 is a questionnaire to assess depression symptoms using five items. A GDS-5 score ≥2 points was defined as depression (Hoyl et al., 1999).

### 2.5. Statistical analysis

Characteristics of the participants with and without missing data were compared using the Mann-Whitney *U* test or chi-square test. The Shapiro-Wilk test was used to analyze normality of distribution for usual walking speed.

In the present study, the participants with missing data were excluded from the main analysis. The Mann-Whitney *U* test or chi-square test was used to compare each variable between those with and without slow walking speed. Then, we performed logistic regression analysis

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