Archives of Gerontology and Geriatrics 60 (2015) 45–51

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Longitudinal association between habitual walking and fall occurrences among community-dwelling older adults: Analyzing the different risks of falling

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ARTICLE INFO

Article history:
Received 25 January 2014
Received in revised form 8 October 2014
Accepted 9 October 2014
Available online 22 October 2014

Keywords:
Falling
Elderly
Walking
Risk

ABSTRACT

The purpose of this longitudinal study was to examine the association between habitual walking and multiple or injurious falls (falls) among community-dwelling older adults, by considering the relative risk of falling. A cohort of Japanese community-dwelling older adults ($n = 535$) aged 60–91 years (73.1 ± 6.6 year, 157 men and 378 women) who underwent community-based health check-ups from 2008 to 2012 were followed until 2013. Incidence rate of falls between walkers and non-walkers was compared separately by the number of risk factors (Groups R0, R1, R2, R3 and R4+). The Cox proportional hazard model was used to assess the association between habitual walking and falls separately by lower- ($R < 2$) and higher- ($R \geq 2$) risk groups. In Groups R0 and R1, the incidence of falls was lower in walkers than non-walkers; however, in Groups R2, R3, and R4+, the incidence of falls was higher in walkers. The Cox proportional hazard model showed that habitual walking was not significantly associated with falls (hazard ratio (HR): 0.88, 95% confidence interval (CI): 0.48–1.62) among the lower risk group but that it was significantly associated with increased falls (HR: 1.89, 95% CI: 1.04–3.43) among the higher risk group. The significant interaction between habitual walking and higher risk of falling was found ($P < 0.05$). When individuals have two or more risk factors for falling, caution is needed when recommending walking because walking can actually increase their risk of experiencing multiple or injurious falls.

1. Introduction

Approximately 30% of community-dwelling elderly individuals experience falls each year (Tinetti, Speechley, & Ginter, 1988). In Japan, falls and consequent fractures are the fifth most common cause of functional dependence (Japanese Ministry of Health, Labour and Welfare, 2007). In the rapidly aging Japanese society, approximately one in four people are now 65 years of age or older (Japanese Ministry of Health, Labour and Welfare, 2013). The number of falls and their seriousness are expected to dramatically increase as the number of older adults increases worldwide (World Health Organization, 2008). The increasing age of the worldwide population has led to a corresponding need for fall prevention programs and solution-oriented approaches. Several attempts to develop national and community-wide approaches have recently been reported (Campbell & Robertson, 2010; McClure et al., 2005; Tinetti et al., 2008). Appropriate fall prevention programs that can benefit the greater community are urgently needed.

Recommended walking regimens have the potential to serve as effective community-wide fall prevention programs because such regimens can be implemented regardless of the time, location, previous sports experience of the participants, or the presence of instructors. Furthermore, walking is the most prevalent type of exercise (Japanese Ministry of Education, Culture, Sports Science and Technology, 2013; Morris & Hardman, 1997). However, the effects of walking as a part of fall prevention programs remain unclear (Gregg, Pereira, & Caspersen, 2000). A meta-analysis of randomized controlled trials (RCTs) reported that the inclusion of a

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http://dx.doi.org/10.1016/j.archger.2014.10.008
0167-4943/

walking program significantly increased the pooled fall rate by 32% (Sherrington et al., 2008). One study that reported an increase in the rate of falls with a walking-related intervention suggested that increased exposure to environmental hazards was likely to be the cause of the increased fall incidence (Vetter, Lewis, & Ford, 1992). Our previous cross-sectional study showed that among higher-risk, community-dwelling, older adults, habitual walking was significantly correlated with a greater number of falls (Okubo et al., 2011). In contrast, among lower-risk participants, habitual walking was significantly correlated with a history of fewer falls (Okubo et al., 2011). Although the above study suggested both the possible fall prevention effects of habitual walking among the lower-risk older population and the need for caution among higher-risk individuals, the cause–effect relationship between walking and falls requires re-examination in a longitudinal study.

Therefore, the purpose of this study was to examine the longitudinal association between habitual walking and falls among community-dwelling older adults, by considering the relative risk of falling.

2. Methods

2.1. Participants

The study participants included community-dwelling older adults who participated in health checkups. These checkups were organized by their municipalities as part of a nursing care prevention program in Ibaraki, Chiba, and Fukushima from 2008 to 2012. Follow-up checkups continued until 2013. Almost all of the participants were recruited through local advertisements and flyers. The eligibility criteria were as follows: (1) community dwellers aged 60 years or older and (2) individuals who were able to understand the instructions on the performance tests and the questionnaires. In total, 1474 individuals (448 men and 1026 women) aged 60–91 participated in the health checkups. We excluded 773 individuals (247 men and 526 women) from the analysis due to incomplete follow-up from 2009 to 2013. We also excluded 49 individuals (12 men and 37 women) who were under the age of 60 and 117 individuals (32 men and 85 women) from whom we collected incomplete data. Thus, a total of 535 individuals (157 men and 378 women) were enrolled in the present study. All participants provided their written informed consent for participation. We conducted this study in accordance with the guidelines proposed in the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the University of Tsukuba, Japan.

2.2. Baseline measurements

At baseline, the participants completed self-reported health status questionnaires that included items related to age, gender, frequency of outings, fear of falling (yes/no), self-rated health (good/bad), medical history during the previous year (e.g., history of stroke, hypertension, diabetes, heart disease, osteoporosis, glaucoma/cataracts), and functional status using the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) (Koyano, Shibata, Nakazato, Haga, & Suyama, 1991). Height (cm) and weight (kg) were measured using a stadiometer and a calibrated scale, respectively. The presence of scoliosis (yes/no) was determined when measuring height. Body mass index (kg/m^2) was calculated by dividing the weight by the height. Trained researchers measured the participants' one-leg balance with open eyes, tandem balance and functional reach, five repetitions of sitting-to-standing, alternate step ability, timed up and go, 5-m habitual walk, and 3-m tandem walk. All of the performance tests used in this study have been described in detail elsewhere (Kim et al., 2010).

2.2.1. Habitual walking

The duration (min), frequency (times/week), and number of years that each participant engaged in habitual walking were ascertained in an interview. The participants were classified as walkers if, for more than 1 year, they reported walking for at least 30 min a day two times a week (Japanese Ministry of Health, Labour and Welfare, 2012) or if their total walking amounted to more than 60 min a week. Those who walked for shorter periods of time were classified as non-walkers.

2.2.2. Risk of falling

Of the measurements collected during the health checkups, seven risk factors for falling had been previously identified (American Geriatrics Society et al., 2001). All risk factors can be easily assessed in a community or home setting (Okubo et al., 2011). The fall risk factors were as follows:

2.2.2.1. Poor balance. To measure balance, participants were asked to stand on their preferred leg in a standard position for a maximum of 60 s with their eyes open. A one-leg standing time of less than 10 s was considered as indicative of poor balance (Okubo et al., 2011; Vellas et al., 1997).

2.2.2.2. Mobility limitation. The participants who reported difficulty in climbing 10 steps or walking 400 m without resting were defined as having a mobility limitation (Guralnik et al., 1993; Seino et al., 2010).

2.2.2.3. Knee pain. The participants who experienced knee pain or underwent treatment for knee osteoarthritis were defined as having knee pain.

2.2.2.4. Depressive symptoms. The participants who reported "I felt everything I did was an effort" or "I could not get going" during the past week were defined as having depressive symptoms (Fried et al., 2001; Radloff, 1977).

2.2.2.5. Assistive device. The participants who regularly used a walking cane, walker, or wheelchair were defined as requiring an assistive device.

2.2.2.6. Polypharmacy. Participants who were taking four or more medications were defined as requiring polypharmacy (Robbins et al., 1989).

2.2.2.7. Previous fall history. The participants who experienced an injurious fall or multiple falls within the year prior to entry in the study were defined as having a previous fall history (Delbaere et al., 2010; Okubo et al., 2011).

2.3. Follow-up surveillance and end point determination

For the purposes of this study, a fall was defined as "unintentionally coming to rest on the ground, floor, or other lower level due to reasons other than sudden-onset paralysis, epileptic seizures, or overwhelming external forces." The fall frequency for the past year and sustained injuries (e.g., contusions, incised wounds, abrasions, and fractures) were ascertained at the annual health checkup. When the participants reported falls, both the activities being performed when the falls occurred and the causes of the falls were recorded only for the most serious falls. The "fallers" in this study included both participants who suffered multiple falls within 1 year during the follow-up period and