Age-Specific Risk Factors for Incident Disability in Activities of Daily Living among Middle-Aged and Elderly Community-Dwelling Japanese Women during an 8-9 Year Follow-up: The Hizen-Oshima Study

Takuhiro Okabe, MA[1,2], Yasuyo Abe, MD, PhD[1], Yoshihito Tomita, MA[1,2], Satoshi Mizukami, PhD[1,2], Mitsuo Kanagae, PhD[1,2], Kazuhiko Arima, MD, PhD[1], Takayuki Nishimura, PhD[1], Ritsu Tsujimoto, MD[3], Natsumi Tanaka, MD[3], Hisashi Goto, MD, PhD[4], Itsuko Horiguchi, DDS, PhD[5], and Kiyoshi Aoyagi, MD, PhD[1]

Geriatrics & Gerontology International・in press

[1]Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Nagasaki, Japan

[2]Department of Rehabilitation, Nishi-Isahaya Hospital, Isahaya, Nagasaki, Japan

[3]Department of Orthopedic Surgery, Nagasaki University Graduate School

of Biomedical Sciences, Nagasaki, Japan
[4]Goto Health Care Office, Goto, Nagasaki, Japan
[5]Center for Public Relations Strategy, Nagasaki University, Nagasaki, Nagasaki, Japan

Correspondence to:

Yasuyo Abe, MD, PhD
Department of Public Health, Nagasaki University Graduate School of Biomedical Sciences, 1-12-4 Sakamoto, Nagasaki, Japan
Tel: +81 95 8197067, Fax: +81 95 8197069,
E-mail: yasuyo-a@nagasaki-u.ac.jp

Short running title: Age-Specific Risk Factors of Disability

ABSTRACT

Aim: The purposes of the present study were to investigate risk factors for incident disability in activities of daily living (ADL) among middle-aged and older women, and to determine whether there are differences in risk factors according to age groups.

Methods: The participants were 264 Japanese women aged 40 and older. A self-administered questionnaire was used to survey participants about difficulty in performing selected basic and instrumental ADLs at baseline and at follow-up. ADL disability was defined as difficulty performing 3 or more ADLs. Information on knee joint or back pain and comorbidities (heart disease, lung disease, stroke, or diabetes mellitus) was obtained using a self-administered questionnaire at baseline. Physical performance measurements (grip strength, chair stand time, rapid walking speed, and functional reach) were also conducted at baseline.

Results: Prevalence of incident ADL disability was 44 (27.5%) in women aged 40-64 years and 57 (54.8%) in women aged 65 years and older ($P<0.001$). Multiple logistic regression analysis revealed that decreased grip strength and having pain were significantly associated with a higher risk for incident ADL disability among women aged 40-64 years. For women aged 65 years and older, decreased rapid walking speed, having a comorbidity, and having pain were associated with incident ADL disability.

Conclusions: This study revealed that a different set of risk factors was associated with incident ADL disability among women aged 40-64 years and women aged 65 years and older. Age-specific screening and intervention strategies are necessary for effective prevention of incident ADL disability.

Key words: activities of daily living, knee pain, back pain, comorbidity, physical functioning

Introduction

The incidence of disability in activities of daily living (ADL) increases with age [1-3]. The number of elderly people is increasing worldwide [4]. In Japan, 26.0% of the population was older than 65 years in 2014, and 36.1% of the population will be older than 65 years by 2040 [5]. Approximately 26% of the Japanese population aged 60 years and older reported disability in ADL in 2014 [6]. Among women, ADL disability can especially be a critical issue since women are expected to spend a larger proportion of life in poor health than men[7].

Furthermore, the prevalence of ADL disability was shown to increase with advancing age (60-64 years, 12.8%; 65-74 years, 17.7%; 75 years and older, 44.6%) [6]. The ability to perform ADLs without assistance largely determines whether an individual can live independently [8]. ADL disability results in greater use of medical care, more institutionalization, and poorer physical and mental health [2]. Maintaining and restoring independence in ADL is important for optimal quality of life [9]. ADL disability in elderly adults is thus an important and growing public health concern.

Multiple risk factors appear to be responsible for ADL disability [10]. Identifying contributors to ADL disability is important in establishing prevention strategies. Previous cross-sectional studies have demonstrated associations of physical function [11], pain [12], and comorbid disorders [13] with ADL disability. Longitudinal studies have also reported that similar risk factors (physical function [2, 3, 14-16], pain [17, 18], and comorbidities [1, 2]) may predict future incidence of ADL disability.

Most previous studies have assessed the factors associated with incident ADL disability only in elderly people aged 65 years and older. To the best of our knowledge, no studies have investigated ADL disability and its risk factors considering possible differences between middle-aged and elderly people. It is important to identify risk factors for the incidence of ADL disability considering possible differences between middle-aged and elderly people to prevent ADL disability at an earlier age.

The objective of the present study was to investigate risk factors for incident ADL disability during 8-9 years of follow-up among women aged 40 years and older, and determine whether there are differences in risk factors between women younger than 65 years and women aged 65 and older.

Methods

Study participants

The Hizen-Oshima Study is a prospective, population-based cohort study of osteoporosis and osteoarthritis. Details of the Hizen-Oshima study have been previously published [19]. Briefly, all women aged 40 years and older in Oshima, a town in Nagasaki Prefecture in Japan, were invited to participate. The town of Oshima has a population of approximately 5800 (2850 men, 2950 women), including approximately 2000 women aged 40 or older. Despite having a shipyard in the town, Oshima is mainly a rural area. The baseline examination of each participant was performed at the Oshima Health Center between 1998 and 1999. A total of 586 women (approximately 30% of eligible women) participated in the study. All participants were noninstitutionalized, living independently at baseline, and were able to ambulate independently (with or without a cane). All participants provided written informed consent before participation. In 2008, a follow-up mail survey on ADL was conducted. Of the 586 participants in the baseline survey, 495 were alive, 46 were dead, and 45 had moved to a different municipality. The questionnaire was mailed to the women who were known to be alive, and 394 women responded (Figure 1). This study was approved by the local and institutional ethics committees.

Main outcome measurement

Our primary outcome was incident of difficulty in performing selected basic and instrumental ADL at 8-9 years follow-up, measured by a self-administered questionnaire. The ADL questionnaire survey was conducted at baseline (in 1998-1999) and at follow-up (in 2008). Participants were asked if they had any difficulty performing the following 6 ADLs that included 14 activities (yes/no): (1) bending-related activities (getting in or out of a car, bending over or picking up a lightweight object, putting on socks or stockings, lifting a 5-kg object from the floor), (2) spine-extension activity (reaching an object above your head), (3) walking-related activities (walking 100m on a level surface, climbing 10 steps without stopping, walking down 10 steps, shopping for groceries or clothes), (4) standing endurance (standing on your feet for 2 hours), (5) heavy activities (heavy housework or yard work, lifting a heavy suitcase of about 15 kg or a 3- to 4-year-old child by yourself), and (6) basic activities (feeding or dressing yourself, preparing your own meals). ADL disability was defined as difficulty performing 3 or more ADLs; this definition was validated previously [20].

Measurements at baseline

All participants were asked if they had knee joint and back pain on most days during the previous month, and if they had comorbidities (heart disease, lung disease, stroke, or diabetes mellitus). Height and weight were measured with the participants in light clothing and without shoes. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$. Measures of physical performance included grip strength, chair stand time, rapid walking speed, and functional reach. Grip strength of the dominant hand was measured using a hydraulic dynamometer (Jamar Hydraulic Hand Dynamometer Model J00105, Lafayette Instrument Company, Inc., Lafayette, IN, USA). Grip strength was calculated as the average of 2 trials. Chair stand time was measured as the time to stand up from a standard chair 5 times; the participants were asked, if possible, to not use their arms for assistance [21]. Results were calculated as the average of 2 trials. Rapid walking speed was calculated from the time required for participants to walk a 6-meter course at a rapid but safe pace (rapid walking speed). Rapid walking speed was recorded as a single trial. To determine functional reach, the subject first stood comfortably upright, facing forward, hand in a fist, with the arm extended next to a yardstick mounted on a wall. The participants then reached forward as far as possible without stepping or losing balance, and the difference between the 2 points on the yardstick was taken as functional reach, calculated as the average of 3 trials.

Statistical analysis

Women who had any missing variables (n=21) or with ADL disability at baseline (n=109) were excluded from the analysis, leaving 264 women for the final analysis (Figure). The follow-up rate was 45.1% (264/586). Student's *t*-test was used for continuous variables, and the chi-square test was used for categorical variables to determine significant differences between women with and without incident ADL disability at follow-up. Multiple logistic regression analysis was used to evaluate the simultaneous effects of variables on incident ADL disability. Odds ratios and 95% confidence intervals were calculated. Starting with a model including all variables with P values <0.20 in the univariate analysis, the most appropriate model was selected based on Akaike's information criteria. P values <0.05 were considered significant. Statistical analysis was performed using SPSS software version 20 for Windows (SPSS Inc., Chicago, IL, USA).

Results

Table 1 summarizes some of the baseline characteristics of participants according to age groups. Mean follow-up time was 9.1 ± 0.4 years (range, 8.3 - 9.7 years), and mean age at baseline was 61.1±8.4 years. Women aged 65 years and older had significantly poorer physical functioning (grip strength, chair stand time, rapid walking speed, and functional reach test) than women aged 40-64 years. Prevalence of comorbidity was 20 (12.5%) in women of aged 40-64 years and 28 (26.9%) in women aged 65 years and older (P=0.005). Prevalence of pain was 65 (40.6%) in women aged 40-64 years and 38 (36.5%) in women aged 65 years and older (P=0.52). Prevalence of incident ADL disability was 44 (27.5%) in women aged 40-64 years and 57 (54.8%) in women aged 65 years and older ($P<0.001$).

Table 2 shows comparisons of baseline variables between women with and without incident ADL disability at follow-up. In women aged 40-64 years, women with incident ADL disability had lower grip strength ($P=0.01$), poorer functional reach test ($P=0.03$), and greater frequency of pain ($P<0.001$) compared with women without incident ADL disability. For women aged 65 years and older, women with incident ADL disability had significantly older age ($P=0.005$), slower rapid walking speed ($P=0.002$), greater prevalence of comorbidity ($P=0.004$), and greater prevalence of pain ($P=0.004$) compared with women without incident ADL disability.

Multiple logistic regression analysis was used to evaluate the simultaneous effects of baseline variables on incident ADL disability (Table 3). In women aged 40-64 years, decreased grip strength and having pain were significantly associated with higher risk of incident ADL disability. For women aged 65 and older, decreased rapid walking speed, comorbidity, and having pain were significantly associated with a higher risk of incident ADL disability.

Discussion

This study assessed risk factors for incident ADL disability among women aged 40-64 years and 65 years and older. To the best of our knowledge, this is the first study that reported risk factors of ADL disability considering differences between women younger than 65 years and those aged 65 years and older.

Aging causes gradual changes in the organism, which leads to poor physical conditions such as decline in physical function[22-24] and increased comorbidity[25]. In our population, as expected, all examined physical performance measures showed significant negative correlation with age (data not shown), and the number of comorbidity significantly increased with age (data not shown). On the other hand, level of age related changes may vary according to factors. For example, decline in grip strength is reported to start as early as ages 40 years[23], whereas rapid walking speed decreases at a much later life[22]. Thus, predictive factors of incident ADL disability might differ according to different age categories.

This study revealed that different sets of risk factors were associated with incident ADL disability among women aged 40-64 years and women aged 65 years and older. Previous studies have reported risk factors of incident ADL disability among people aged 65 and older, such as comorbidity, physical performance measurements, and pain [1, 2, 15, 17, 18]. However, few studies have reported risk factors for ADL disability among people younger than 65 years. Rantanen et al. reported that grip strength was associated with an elevated risk of incident ADL disability in men aged 45-68 years [16]. Ouden et al. reported that, among a group of participants including both middle-aged and elderly people, grip strength, leg strength, and level of physical activity were associated with a high risk of ADL disability [26]. However, no studies have assessed risk factors for incident ADL disability in elderly and middle-aged people separately. Our study demonstrated that risk factors for ADL disability might vary depending on age. There would be a need for age-specific screening and intervention strategies to prevent ADL disability.

Walking ability plays an important role in ADL independence of the elderly. Walking speed is a common physical performance measurement used in clinical practice and is a good predictor of ADL dependence [14].

Several studies reported that slower walking speed was significantly associated with the risk for incident ADL disability [2, 3, 15]. In our study, women aged 65 years and older with slower baseline rapid walking speed had a higher risk of incident ADL disability, which is in line with previous studies. Rapid walking speed decreases with advancing age, especially after 70 years [22]. Suzuki et al. confirmed that decreased rapid walking speed increases the risk for falls and therefore increases ADL disability either from fracture itself or post-fall syndrome in the community-dwelling elderly [3]. Thus an age-related decline in walking speed might lead to lower physical activity, a higher risk for falls, and ADL disability. In the elderly, walking ability should be targeted in interventions aimed at preventing ADL disability.

In our study, among women aged 65 years and older, having a comorbidity was significantly associated with a higher risk of incident ADL disability. Several studies reported that elderly people with a comorbidity have a higher risk of developing incident ADL disability [1, 2, 11, 13] and mortality [1]. Our study is consistent with these previous studies. Prevalence of comorbidity increases with age, and number of comorbidities is reported to increase with age [25], which might lead to ADL disability in older age. Proper screening and management of medical conditions is thus important.

Our study showed that having knee joint or back pain was significantly associated with a higher risk of incident ADL disability both among women aged 40-64 years and women aged 65 years and older. Several studies reported that elderly people with pain have a higher risk of developing incident ADL disability [17, 18]. Knee joint pain and back pain are major symptoms that occur in middle-aged and elderly people [27, 28], and these symptoms often become chronic. Covinsky et al. reported that people with pain also commonly have functional limitations and speculated that mutual feedback loops in which pain and functional limitations are mutually reinforcing, with pain exacerbating functional limitations and functional limitations exacerbating pain [24]. Having pain might cause functional limitations, which might lead to difficulties in various ADLs.

We showed that poorer grip strength was significantly associated with incident ADL disability only in middle-aged women. Two studies have shown significant associations between weaker grip strength and higher risk of incident ADL disability among populations that include middle-aged people [16, 26]. Grip strength decreases with advancing age [29].

In a study of Japanese women, grip strength was reported to be at the highest among women in their early 40s and then decrease with age [23]. Strength training should be started at an earlier age, before a decline in muscular strength becomes evident.

As for elderly women, previous studies reported that grip strength was not significantly associated with the incidence of ADL disability [3, 14, 30]. Our study showed no association between grip strength and risk for incident ADL disability, which is consistent with previous studies. On the other hand, several studies conducted in elderly populations, including both genders, reported significant associations between weaker grip strength and a higher risk of incident ADL disability [2, 31]. Further studies are needed to determine the effect of grip strength on incident ADL disability.

This study has several limitations. First, physical performance measurements and information on comorbidity and pain were not available at follow-up. Therefore, changes in these parameters over time could not be considered. Second, non-responders were older than responders. Some women may have not responded because they were functionally limited by their age-related medical conditions, which might weaken the association of incident ADL disability with baseline variables. Third, we did not assess severity of pain; thus the influence of pain severity on incident ADL disability could not be assessed. Fourth, because the present study included only women, these results cannot be generalized to men.

In conclusion, this study revealed that a different set of risk factors were associated with incident ADL disability among women aged 40-64 years and women aged 65 years and older. Age-specific screening and intervention strategies may be necessary for effective prevention of incident ADL disability among elderly women.

Acknowledgments

The authors thank all the healthcare staff and study participants for the contribution of their time, effort, and dedication. The study was supported in part by the

Japan Society for the Promotion of Science.

Disclosure statement

We declare that there is no financial support or relationship that may pose conflicts of interest.

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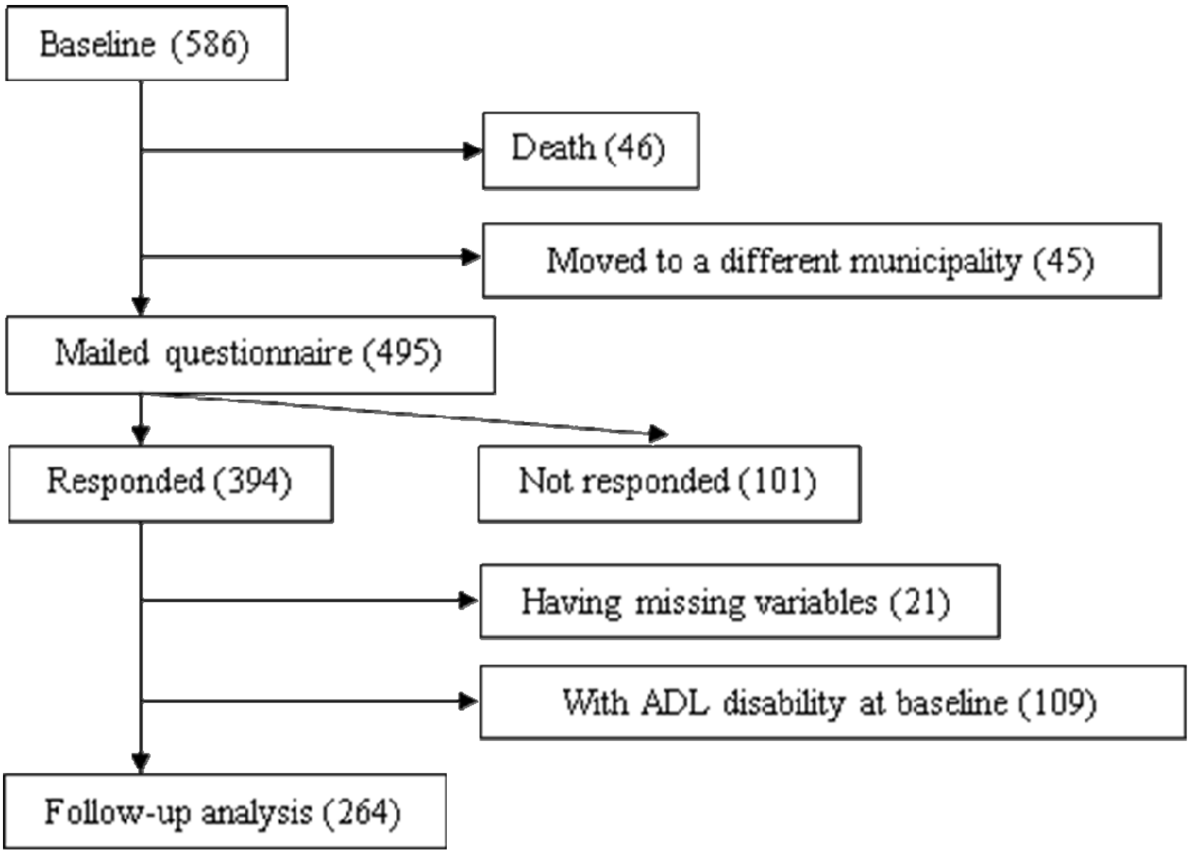

Figure 1

Participants from baseline to follow up. Of the 586 participants in the baseline survey, 495 were alive, 46 were dead, and 45 had moved to a different municipality at follow-up. The questionnaire was mailed to the women who were known to be alive, and 394 women responded. Women who had any missing variables (n=21) or with ADL disability at baseline (n=109) were excluded from the analysis, leaving 264 women for data analysis.

Table 1. Characteristics of participants (N=264)

	total n=264 Mean ± SD, n (%)	40-64 years n=160 Mean ± SD, n (%)	65 + years n=104 Mean ± SD, n (%)	p-value §
follow-up time (years)	9.1 ± 0.4	9.1 ± 0.4	9.2 ± 0.4	0.78
Age (years)	61.1 ± 8.4	55.8 ± 6.4	69.3 ± 3.0	<0.001
Body mass index (kg/m^2)	23.1 ± 3.0	23.3 ± 3.0	22.9 ± 3.1	0.35
Grip strength (kg)	25.8 ± 5.0	27.5 ± 4.8	23.2 ± 4.1	<0.001
Chair stand time (sec)	8.2 ± 1.8	7.6 ± 1.5	9.1 ± 1.9	<0.001
Rapid walking speed (m/s)	1.79 ± 0.24	1.87 ± 0.23	1.66 ± 0.21	<0.001
Functional reach test (cm)	27.0 ± 6.8	28.6 ± 6.6	24.5 ± 6.2	<0.001
Comorbidity †	48 (18.2)	20 (12.5)	28 (26.9)	0.005
Pain ‡	103 (39.0)	65 (40.6)	38 (36.5)	0.52
Incident ADL disability	101 (38.3)	44 (27.5)	57 (54.8)	<0.001

† Presence of heart disease, lung disease, stroke, or diabetes mellitus.

‡ Presence of knee or back pain.

§ Comparison of variables between women aged 40-64 years and aged 65 + years.

Table 2. Comparison of baseline variables between women with and without incident ADL disability at follow-up

Variables	40-64 years (n=160) incident ADL disability		p-value	65 + years (n=104) incident ADL disability		p-value
	with n=44	without n=116		with n=57	without n=47	
	Mean ± SD, n (%)			Mean ± SD, n (%)		
Age (years)	57.2 ± 5.1	55.3 ± 6.7	0.06	70.0 ± 3.2	68.4 ± 2.6	0.005
Body mass index (kg/m^2)	23.4 ± 3.1	23.2 ± 3.0	0.67	22.9 ± 3.0	22.9 ± 3.2	0.92
Grip strength (kg)	26.0 ± 3.8	28.0 ± 5.0	0.014	23.5 ± 4.2	22.9 ± 4.0	0.40
Chair stand time (sec)	7.9 ± 1.7	7.6 ± 1.5	0.21	9.3 ± 2.1	8.8 ± 1.7	0.17
Rapid walking speed (m/s)	1.86 ± 0.21	1.87 ± 0.23	0.69	1.61 ± 0.18	1.74 ± 0.22	0.002
Functional reach test (cm)	26.8 ± 6.7	29.3 ± 6.5	0.03	23.9 ± 6.5	25.1 ± 5.7	0.32
Comorbidity [†]	8 (18.2)	12 (10.3)	0.19	22 (38.6)	6 (12.8)	0.004
Pain [‡]	29 (65.9)	36 (31.0)	<0.001	28 (49.1)	10 (21.3)	0.004

[†] Presence of heart disease, lung disease, stroke, or diabetes mellitus.

[‡] Presence of knee or back pain.

Table 3. Multiple logistic regression models for incident ADL disability at follow-up

Age	Variables	Units	Odds ratios (95%CI)
40-64 years (n=160)	Grip strength (kg)	-5	1.82 (1.17 – 2.83)
	Pain ‡	Yes/No	4.87 (2.25 – 10.54)
65 + years (n=104)	Rapid walking speed (m/s)	- 1 SD §	2.19 (1.24 – 3.87)
	Comorbidity †	Yes/No	4.40 (1.47 – 13.16)
	Pain ‡	Yes/No	4.72 (1.77 – 12.60)

† Presence of heart disease, lung disease, stroke, or diabetes mellitus.

‡ Presence of knee or back pain.

§ Rapid walking speed : 1SD=0.24 m/s