Association of gait speed with mortality among the Japanese elderly in the New Integrated Suburban Seniority Investigation Project: a prospective cohort study

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Abstract

Background: gait speed is associated with mortality among the elderly, but evidence for this in Japan is lacking. We investigated the impact of gait speed on mortality among younger-elderly people and determined whether daily walking modifies that association.
Subjects: data were obtained from 2,105 community-dwelling individuals (990 men, 1,025 women) approaching age 65 who were free of heart disease, cerebrovascular disease and cancer, and who were enrolled in the New Integrated Suburban Seniority Investigation Project between 1996 and 2003.
Methods: Cox proportional hazard regression was applied to estimate hazard ratios (HRs) of all-cause mortality and 95% confidence intervals (CIs) according to gait speed and daily walking. We adjusted for potential confounders, including survey year, marital status, work status, education, smoking and drinking status, body mass index and medical history.
Results: during the total 21,192 person-year follow-up to age 75, 188 participants (140 men, 48 women) died. Slow gait speed was significantly associated with increased all-cause mortality among men after full adjustment (HR, 1.72; 95% CI, 1.08–2.63). This association disappeared when men with slow gait speed walked ≥1 h/day (HR, 0.98; 95% CI, 0.34–2.25) compared with subjects with normal or fast gait speed walking >1 h/day. Slow gait speed yielded a threefold greater risk of mortality when women walked ≥1 h/day (HR, 3.04; 95% CI, 1.34–6.49), compared with the normal- or fast-gait group.
Conclusion: slow gait speed is associated with an increased risk of all-cause mortality among younger-elderly people. Daily walking was found to modify this association among men.

Keywords: *gait speed, mortality, daily walking, early old age, older people*

Introduction

Maintaining high physical performance is recognised as an essential component of successful ageing [1]. Physical performance is usually assessed by means of single or composite measures, which include gait speed, repeated chair stands, balance tests and hand-grip strength [2–5]. The association between gait speed and adverse health-related outcomes has attracted wide interest because slow gait speed may reflect functional capacity and subclinical health impairment in the elderly [6]. Previous studies have investigated the association between gait speed and all-cause mortality among

older people, including the well-functioning elderly in Western countries toward recognising the risk of early mortality [2, 7–10]. However, to our knowledge, no such study has been conducted among the younger elderly in Japan.

Over recent decades, greater priority has been placed on preventing or postponing disability and reducing early mortality in ageing populations, and many related modifiable behavioural factors have been reported [11, 12]. Given that daily walking, a popular moderate-intensity physical activity helps to promote or maintain physical function [13] and even decreases mortality [14], the purpose of this report was to investigate the impact of gait speed on mortality among younger-elderly Japanese and to determine whether daily walking modifies that association.

Method

Study population

The present study was based on data from the New Integrated Suburban Seniority Investigation Project (NISSIN Project)—an ongoing age-specific prospective cohort study. The rationale and design of this project have been described in detail elsewhere [15]. (Refer to Supplementary data are available in *Age and Ageing* online for background information on the NISSIN Project.) From 1996 to 2005, 3,073 people approaching age 65 years were enrolled in the study. We excluded data from the following subjects: 617 subjects enrolled after 2003, since 10-year follow-up was not complete; 437 subjects who reported a history of heart disease, cerebrovascular disease or cancer, since such diseases may impact gait speed and it is difficult to regard these participants as well-functioning younger elderly [2] and four subjects for whom data on gait speed was missing. Thus, data on 2,015 participants (990 men, 1,025 women) were used in the final analyses.

Baseline assessment

Baseline data were obtained through self-administered questionnaires and objective measurements during an initial comprehensive health check-up. Gait speed was assessed with the question 'How fast have you walked over the past year?' Responses were categorised into three groups—slow, normal and fast. Daily walking was determined using the question 'How many hours a day do you walk?' Response options were <30 min/day, 30 min to 1 h/day, 1–2 h/day and ≥2 h/day. Time spent walking included both walking as exercise and time spent working or doing household, social or other activities. (Refer to Supplementary data are available in *Age and Ageing* online for other baseline variables.)

Follow-up

Data relating to date of death and relocation out of the city were obtained from the basic resident register. All participants were followed until death, relocation or the last day of the year or when they reached the age of 75 years—whichever came first.

Statistical analysis

Cox proportional hazard regression was applied to estimate the hazard ratios (HRs) for all-cause mortality and 95% confidence intervals (CIs). In multivariate analyses, potential confounders included survey year, marital status, working status, education, smoking and drinking status, body mass index and medical history. Analyses were repeated with regard to stratified daily walking (<1 h/day and ≥1 h/day) and in the restricted sample. The restricted sample (1,706 participants) included participants with high functional capacity (Tokyo Metropolitan Institute of Gerontology Index of Competence scores >10) or who did not die or were not otherwise censored within the first 3 years.

P values were two-tailed, and $P < 0.05$ was taken to be statistically significant. All statistical analysis was conducted by means of JMP Pro 10.0.0 for Microsoft Windows (SAS Institute Inc., Cary, NC, USA).

Results

During the total 21,192 person-year follow-up, 188 participants (140 men, 48 women) died. Participants with slow gait speed had lower functional capacity than those with normal gait speed. Men with slow gait speed were more likely to smoke, have a greater body mass index, have a higher prevalence of diabetes mellitus and spend less time walking. In comparison, women with slow gait speed were more likely to have a lower education, and less likely to consume alcohol than those with normal gait speed (Table 1).

As shown in Table 2, slow gait speed was significantly associated with increased all-cause mortality among men after full adjustment (HR, 1.72; 95% CI, 1.08–2.63). This association disappeared when men with slow gait speed walked more than 1 h/day (HR, 0.98; 95% CI, 0.34–2.25). It became greater when men walking <1 h/day were compared with those with normal or fast gait speed and walking more than 1 h/day (HR, 2.41; 95% CI, 1.40–4.01). Among women, slow gait speed tended to be associated with increased mortality risk (HR, 2.01; 95% CI, 0.98–3.86), while fast gait decreased the risk of death (HR, 0.19; 95% CI, 0.01–0.88). Slow gait speed among women yielded no risk and a threefold greater risk of mortality when they walked <1 h/day (HR, 1.02; 95% CI, 0.16–3.57) and more than 1 h/day (HR, 3.04; 95% CI, 1.34–6.49), respectively, compared with women with a normal or fast gait. The above findings were essentially similar to the restricted sample. (Refer to Supplementary data are available in *Age and Ageing* online.)

Discussion

In this study, we found that slow gait speed at baseline increased the risk of all-cause mortality among younger-elderly participants. This association disappeared when men with slow gait speed walked more than 1 h/day.

This is the first age-specific cohort study in Japan to elucidate the impact of gait speed on all-cause mortality among

Table 1. Gender-specific characteristics of the participants at baseline by gait speed ($n = 2,015$)

	Men ($n = 990$)			Women ($n = 1,025$)		
	Slow	Normal	Fast	Slow	Normal	Fast
Marital status						
Married	105 (92.9)*	703 (94.9)	127 (93.4)	110 (75.9)	627 (83.0)	101 (80.8)
Other	7 (6.2)	38 (5.1)	9 (6.6)	35 (24.1)	126 (16.7)	23 (18.4)
Working status						
Not working	54 (47.8)	293 (39.5)	57 (41.9)	102 (70.3)	556 (73.6)	91 (72.8)
Working	59 (52.2)	442 (59.6)	77 (56.6)	43 (29.7)	195 (25.8)	34 (27.2)
Education						
Junior high school or less	38 (33.6)	244 (32.9)	26 (19.1)	67 (46.2)	297 (39.3)	30 (24.0)
High school	36 (31.9)	279 (37.7)	55 (40.4)	63 (43.4)	357 (47.3)	72 (57.6)
College or more	39 (34.5)	217 (29.3)	55 (40.4)	15 (10.3)	101 (13.4)	23 (18.4)
Smoking						
Never	22 (19.5)	142 (19.2)	29 (21.3)	134 (92.4)	687 (91.0)	113 (90.4)
Past	44 (38.9)	331 (44.7)	72 (52.9)	5 (3.4)	35 (4.6)	9 (7.2)
Current	46 (40.7)	268 (36.2)	35 (25.7)	6 (4.1)	33 (4.4)	3 (2.4)
Drinking						
Never	35 (31.0)	237 (32.0)	31 (22.8)	133 (91.7)	608 (80.5)	86 (68.8)
Current	78 (69.0)	504 (68.0)	105 (77.2)	12 (8.3)	147 (19.5)	39 (31.2)
BMI (kg/m²)						
<18.5	5 (4.4)	35 (4.7)	5 (3.7)	6 (4.1)	29 (3.8)	7 (5.6)
18.5–25	72 (63.7)	544 (73.4)	109 (80.1)	104 (71.7)	573 (75.9)	105 (84.0)
≥25	36 (31.9)	162 (21.9)	22 (16.2)	35 (24.1)	153 (20.3)	13 (10.4)
Medical history						
Hypertension	59 (52.2)	393 (53.0)	65 (47.8)	61 (42.1)	312 (41.3)	53 (42.4)
Hyperlipidaemia	29 (25.7)	259 (35.0)	54 (39.7)	83 (57.2)	461 (61.1)	81 (64.8)
Diabetes mellitus	26 (23.2)	100 (13.5)	25 (18.4)	17 (11.7)	53 (7.0)	9 (7.2)
TMIG scores						
≤10	29 (25.7)	95 (12.8)	14 (10.3)	22 (15.2)	63 (8.3)	8 (6.4)
>10	84 (74.3)	645 (87.2)	122 (89.7)	123 (84.8)	692 (91.7)	117 (93.6)
Time spent walking						
<1 h/day	77 (68.1)	375 (50.6)	67 (49.3)	52 (35.9)	259 (34.3)	35 (28.0)
≥1 h/day	36 (31.9)	361 (48.7)	69 (50.7)	92 (63.4)	491 (65.0)	89 (71.2)

The proportions of variables do not equal 100% because of missing data. Values are shown as numbers (%).
BMI, body mass index; TMIG, Tokyo Metropolitan Institute of Gerontology Index of Competence.

Table 2. Association of gait speed and mortality according to gender and daily walking

	Total			Daily walking <1 h/day		Daily walking ≥1 h/day	
	Slow	Normal	Fast	Slow	Normal/Fast	Slow	Normal/Fast
Men							
Person-years	1,109	7,710	1,412	738	4,605	371	4,468
Death cases	28	94	18	23	60	5	51
Multi-adjusted HR (95% CI)	1.72 (1.08–2.63)*	1.00	1.19 (0.69–1.95)	2.41 (1.40–4.01)*	1.24 (0.85–1.82)	0.98 (0.34–2.25)	1.00
Women							
Person-years	1,537	8,082	1,341	548	3,164	978	6,190
Death cases	12	35	1	2	14	10	22
Multi-adjusted HR (95% CI)	2.01 (0.98–3.86)	1.00	0.19 (0.01–0.88)*	1.02 (0.16–3.57)	1.07 (0.52–2.12)	3.04 (1.34–6.49)*	1.00

*$P < 0.05$; the potential confounders included survey year, marital status, working status, education, smoking and drinking status, body mass index and medical history.

the younger elderly. Our findings are consistent with previous studies, which have demonstrated an association between slow gait speed and mortality among elderly subjects living in communities aged ≥65 [3, 8, 10, 16], ≥75 [2] and even ≥ 85 years [9]. Although there is, as yet, no agreement regarding whether gait speed among the well-functioning population is associated with mortality [2, 4, 10], our well-functioning subgroup with slow gait speed was indeed at increased risk of death. With advancing age, gait speed decreases by 12.4% per decade among women and by 16.1% for men [17]. Diminished gait speed has been found to be a marker of vulnerability or frailty in the elderly and an integrated indicator of dysfunction of the brain, heart, lungs, as well as the circulatory, nervous and musculoskeletal systems [6, 16, 18]. From a biological perspective, inflammatory response is correlated with age-related decline in physical performance [19,

20] and increasing mortality in the elderly [21]. Furthermore, age-related white matter [22] and grey matter volume in the brain [23] and cognitive functions [24, 25] have all been demonstrated as being associated with slow gait speed.

Our stratified analyses highlight the value of intervention strategies based on daily walking. The simultaneous condition of walking <1 h/day and slow gait speed resulted in an over twofold increase in mortality risk for younger-elderly men. However, the risk of slow gait speed on mortality almost disappeared when men walked over 1 h/day. Although in the present study it is difficult to explain the causal pathway between slow gait speed and less walking time owing to both variables being measured simultaneously at baseline, we observed that longer walking time could modify the association between slow gait speed and mortality among men.

Women, however, displayed a different pattern from men. Slower women who walked more than 1 h/day had a threefold higher risk of death than those with normal or fast gait speed. This finding adds support to other studies, whereby elderly women once disabled are less likely to recover from disability or frailty than men [26]. It is also necessary to consider the definition of daily walking used in the present study. Walking included both walking as exercise and during household activities, which are also likely to involve a considerable amount of daily time, especially for women [27]. One survey on household-related time in Japan found that women spent almost 4 h/day on housework [28]. Being forced to walk for long periods, especially during household activities, may be too vigorous, and represent a risk among women with slow gait speed.

The main strength of this age-specific cohort study was that it completely eliminated age-derived bias [15] because the age of the participants was reported to be a significant determinant of gait speed changed among the elderly aged 63 or above [17]. Furthermore, the restricted sample with higher functional capacity and without life-threatening illnesses allowed us to avoid a reverse causal relationship between gait speed and mortality.

One important limitation has to be considered: the use of self-reported gait speed. However, self-reported gait speed was related to objective measurement of gait speed (942 subjects). (Refer to Supplementary data are available in *Age and Ageing* online on study validity.) Thus, the self-reported gait speed used in this study would appear to be reliable.

To conclude, slow gait speed was associated with increased mortality among younger-elderly Japanese.

Key points

- Gait speed reflects the functional capacity necessary for independent living in a community, and slow gait speed indicates the frailty or vulnerability among the elderly.
- Slow gait speed was associated with all-cause mortality.
- Daily walking can modify the association between gait speed and mortality.

Supplementary data

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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Conflicts of interest

None declared.

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