Original Article

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Cardiovascular disease and diabetes are not barriers to walking among the very elderly: findings from a national Australian survey

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Background: Walking has numerous health benefits and is an accessible option for most elderly people. This study explored the effects of age and sex on walking in community-dwelling respondents aged 75 years and older and the influence of chronic disease on this association.

Methods: Cross-sectional data on 349 men and 499 women from the Australian 2011–2012 National Nutrition and Physical Activity Survey were used. Data were weighted to enable generalization of the findings to the Australian population aged 75 years and older. Outcome measures were self-reported participation in walking and duration of walking. Chronic diseases considered were ischemic heart disease, angina, heart failure, cerebrovascular disease, and diabetes.

Results: No difference in walking participation was seen between men and women, but among those who walked, men walked for longer than women. Those aged 85 years and older were less likely to walk than those aged 75–79 years, but age was not associated with walking duration among older adults. Cardiovascular disease and/or diabetes had no effect on walking participation or duration.

Conclusion: There is a cohort of active older Australian men and women who continue to walk well into very old age, irrespective of cardiovascular disease and/or diabetes.

Keywords: Aged, Australia, Health surveys, Public health, Walking

Walking in older age, independent of other physical activity, is associated with multiple health benefits including the maintenance of mobility[1], independent living[2], protection against arthritis[3], better health-related quality of life[4], and improved sleep quality[5]. In addition, while few preventive measures have been identified to reduce the risk of dementia, a recent meta-analysis of prospective studies[6] concluded that increased physical activity among older adults, including walking, was associated with a reduced risk of Alzheimer's disease. Walking offers a means to increase physical activity among the most sedentary of adults[7], and low intensity exercise (eg, walking at a slower pace than brisk walking) also confers a health benefit[8].

Few studies have investigated walking in older people, and there are mixed results from those that have. Among studies of adults aged 65 years and older, differences between men and women and walking outcomes have been observed in both Australian[9,10] and US[11,12] research. A Norwegian study that compared differences across age groups reported that 65–69 years olds accumulated more than double the number of daily steps than 80–85 year olds, but differences between men and women were not apparent when similar age groups were compared[13]. A systematic review of total physical activity, including walking, among older adults aged 50 years and older[14] reported substantial sex differences in the types of physical activity performed: women walked more than men, but men were about 10% more physically active than women of a similar age. In a New Zealand study involving adults aged 80–90 years old[15] no differences were reported in walking frequency (number of times walked in the previous week) among non-Māori men and women, but differences in walking duration were observed in this population. Thus, although results are varied and limited data exist for the very old, age and sex may influence walking among older adults.

In studies of physical activity preferences, most older adults reported that walking was their preferred form of exercise[16–18]. Data from the 2011 to 2013 Australian Health Survey indicated that physical activity declined with age, particularly between the ages of 65 and 74 years, and more so for women than men, in those aged 75 years and older[19]. However, data comparing differences in walking, separate from other forms of physical activity, were not reported. In addition, no further age or sex distinctions were made for adults aged 75 years and older, despite the prevalence of considerable socio-demographic, health, and functional status diversity in this older age group[20].

Hence, the purpose of this study was to explore whether age and sex was associated with participation in and duration of walking, independent of other forms of physical activity, among men and women aged 75 years and older. We also aimed to assess whether cardiovascular disease and/or diabetes influenced

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participation in or duration of walking because of the high prevalence of these chronic diseases in this older age group[21].

Methods

Design

Data from the 2011 to 2012 National Nutrition and Physical Activity Survey (NNPAS) were used. The NNPAS was a component of the Australian Health Survey undertaken by the Australian Bureau of Statistics in 2011–2013. Detailed demographic, health risk factor, and nutrition and physical activity data were collected, as well as self-reported information about selected chronic diseases from 1 adult (aged 18 y or older) in a participating household. Data were obtained by face-to-face interviews conducted in private dwellings using trained personnel. The sample was drawn from predetermined geographic locations to ensure sufficient numbers of participants representative of the Australian population from each state, territory, capital city, and other broad geographic regions. For further details about the design and methods used in the Australian Health Survey 2011–2013, including the NNPAS see Australian Bureau of Statistics[22].

Participants

This study included 349 men and 499 women aged 75 years and older who completed the NNPAS. No exclusions were imposed. Participant characteristics included: age, sex, geographic region, marital status, country of birth, education level, Socio-Economic Indexes for Areas, self-assessed health status, cardiovascular disease and/or diabetes (where cardiovascular disease included ischemic heart disease, angina, heart failure, and cerebrovascular disease), body mass index (BMI), smoking status, and other physical activity (which included participation in either moderate or vigorous physical activity, apart from walking, for ≥10 minutes per week). With the exception of BMI, which was derived from objectively measured height and weight, all data were self-reported. Age and sex were the correlates of interest and the remaining variables were treated as control variables.

Outcome of interest

Data were collected on how much time participants spent "walking for exercise", that is, the total time in the previous week spent "walking for fitness, recreation or sport," and "walking for transport," that is, the total time in the previous week spent "walking for at least 10 minutes to get to or from places." Responses to these questions were not directly available in the NNPAS data set but were calculated from self-reported physical activity data. Hence, total time walked in the previous week (minute) was derived from total time spent doing physical activity (which included time spent walking for exercise and transport, but excluded time spent doing vigorous gardening or household chores), minus the time spent doing moderate or vigorous physical activity in the previous week. The outcome variable of interest, total time walked, was then subdivided into 2 variables: (1) participation in walking (yes/no, where "yes" was ≥10 min/wk), and (2) duration of walking (min/wk among those who walked).

Data analysis

The Pearson χ^2 analyses were used to examine differences between the characteristics of men and women and between age groups, and to examine differences in walking patterns between men and women by age. Multivariate binary logistic regression was used to analyze walking participation and multivariate negative binomial regression was used to analyze walking duration. Multivariate Poisson regression was initially considered to analyze count data for walking duration, but as these data were highly dispersed (men: mean = 253 min/wk, SD = 319; women: mean = 159 min/wk, SD = 178), multivariate negative binomial regression was preferred. Walking duration was positively skewed (with a substantial proportion of zeros representing persons who did not walk at all); hence percentiles were reported rather than means.

Seasonally adjusted weighted data were used in the analysis enabling the findings to be generalized to the Australian population aged 75 years and older. Weights were included as part of the release of the data set by the Australian Bureau of Statistics. All analyses were performed using Stata software, version 13.1.

Approach to missing data

Missing walking data for 0.1% of men (n = 2) and 0.8% of women (n = 3) were excluded from the analysis. Less than 2% of data were missing for the control variables "education" (n = 17) and "other physical activity" (n = 5), hence their effect on the analysis was deemed minimal. However, 21% of male participants (n = 77) and 24% of females (n = 124) had missing BMI data. This was considered an important control variable in both walking participation and duration, and our findings would have been biased if participants lacking these data were excluded.

Therefore, we investigated whether multiple imputation of the missing data was appropriate; in particular whether BMI was "missing at random,"[23] by running a Heckman selection model using BMI as the dependent variable. The selection model had 2 components: (1) variables contributing to the missingness of BMI (where BMI was coded as a binary variable), and (2) variables predicting BMI (where BMI for nonmissing cases were treated as a continuous variable and missing data were coded as 0). On the basis of univariate analysis, age and marital status were significantly correlated with missingness of BMI ($r = -0.10$ and $r = -0.12$, respectively, $P < 0.01$) although only marital status was correlated with missingness ($r = -0.12$, $P < 0.01$) after applying the Bonferroni adjustment of significance levels.

The Heckman selection model was run sequentially using different combinations of variables for each of the 2 model components. This process was informed by, but not constrained to, the univariate association between independent variables and BMI missingness. A statistically significant model was identified ($\chi^2 = 85.67$, $P < 0.01$), where age and marital status predicted the missingness of BMI, and age, sex, cardiovascular disease and/or diabetes, and walking predicted BMI. Thus, it was concluded that multiple imputation of BMI was appropriate because it could be derived from observed data.

To impute missing BMI data, the Stata command "mi impute chained (logit)" and age and marital status were used as the predictor variables. Cardiovascular disease and/or diabetes was originally included in the imputation, but after exclusion made negligible difference to the results. A variable representing the ratio of energy intake to basal metabolic rate for each observation was also considered, but the proportion of missing data for this variable was substantial (> 20%); hence, it was excluded. The number of imputations was set at 25 because ~22% of BMI data for men and women combined were missing.

Independent regression models were run for each outcome: walking participation and walking duration. For each of these, a fully adjusted model (Model 1) and a parsimonious model (Model 2) were developed. Model 1 included the correlates of interest (age and sex) and all control variables. Model 2 comprised age and sex and those control variables found to be statistically different between men and women and between age groups in the univariate analysis. The effect of chronic disease (cardiovascular disease and/or diabetes) on walking participation and duration among men and women combined was also analyzed.

Results

Study participants

Significantly more women than men were included in our study, and men and women's characteristics differed on the basis of marital status, education, cardiovascular disease, and/or diabetes and BMI (**Table 1**). Men aged 75 years and older were significantly more likely to be married, have postschool qualifications, cardiovascular disease and/or diabetes, and a higher BMI than women of the same age. Age differences occurred by geographic region, marital status, education, health status, and BMI. On the basis of univariate analysis, walking participation did not differ between men or women, or between age groups.

Walking patterns

The proportion of older men and women who did not walk at all did not change significantly with age (**Table 2**). Of those who did some walking, most men and women across all age groups participated in walking only (ie, they did not report participation in other physical activity) and about 25% of men and 20% of women fulfilled the recommended duration of 150 minutes of weekly physical activity from walking alone.

Sex differences in walking participation and duration

Walking participation did not differ between men or women in either model 1 or 2 (**Table 3**). By contrast, sex differences in walking duration were consistent and strong in both models, with men walking for longer than women.

Effect of age on walking participation and duration

Participation in walking declined with age in men and women combined, and was significantly different among men and women aged 85 years and older compared with those aged 75–79 years (**Table 4**). However, walking duration was not significantly different between men and women aged 75–79 years and those aged 80 years and older, despite most elderly men and women walking for longer (median of 150 min/wk) than younger age groups (median of 120 min/wk).

Effect of chronic disease on walking participation and duration

The presence of chronic disease (cardiovascular disease and/or diabetes) had no effect on walking participation or duration among men and women combined (**Table 5**).

Discussion

Our findings indicate that age is associated with walking participation (older age groups were less likely to walk) and sex with walking duration (men walked for longer than women). However, our negative results are equally important. After adjusting for potential confounding variables, we found no statistically significant difference in walking participation between men and women, or between those who did some walking (58% of men and 50% of women). Increasing age had no appreciable effect on walking duration.

The unexpected lack of an age effect on walking duration may be because the NNPAS excluded persons living in institutional care; hence, study participants may have been in better health and with better functional mobility than the general community-dwelling population of Australians aged 75 years and older. Nevertheless, the finding suggests that although walking participation declined with age, among those who did walk, a substantial proportion of older men and women continued to walk well into their old age and many of these walked for the recommended 150 minutes or more per week. As the data were cross-sectional we could not determine whether the same individuals continued to walk as they aged, or whether some individuals who walked in their 70s stopped as they got older, while at the same time others only started walking in their 80s when they had previously not walked. A prospective study of walking patterns in this age group is needed to answer these questions.

There are few studies of this age group with which we can compare our findings, and no studies that enable comparisons of different ages between older adults aged 75 years and older. The differences we observed in walking duration between men and women were similar to those seen in the New Zealand study[15], which found that non-Māori men aged 80–90 years walked for a longer duration than non-Māori women in this age group. However, this study did not report walking participation. We observed no difference in walking participation between men and women, but findings of studies involving younger age groups and walking participation have been mixed. In a US study[12], older men aged 60 years and older (the majority of which were over 70 y) were more likely to be regular walkers (defined as walking 6 miles/wk) than women. However, in an Australian study of culturally diverse adults aged 60 years and older[10], no significant difference was found in walking participation for exercise between men and women. By contrast, when our data were adjusted for country of birth in our fully adjusted model, no significant difference in walking participation between men and women was observed. Thus, differences between our results and the findings from the few available studies could be explained by the inclusion of younger older adults (60 y and above of age compared with 75 y and above in our study) and a focus on a specific population of interest rather than a representative sample of older adults. All studies, including ours, relied on self-reported walking; hence, this factor was unlikely to contribute to differences between findings.

The lack of an effect of chronic disease (cardiovascular disease and/or diabetes) on walking participation was not unexpected. The relatively high prevalence of these diseases in this age group, coupled with the possibility that being diagnosed with cardiovascular disease or diabetes might increase a person's likelihood to start or continue to walk, may both contribute to this finding. Two recent studies also investigated the effect of chronic disease

Table 1

Characteristics of study participants.

	Sex			Age			
	% Men (n = 349)	% Women (n = 499)	Men vs. Women	% 75–79 (n = 385)	% 80–84 (n = 275)	% 85 + (n = 188)	All Age Groups Compared
Socio-economic status							
Sex							
Men	44.5	—	*	45.3	45.0	42.1	NS
Women	—	55.5	—	54.7	55.0	57.9	—
Age (y)							
75–79	49.7	48.1	NS	—	—	—	—
80–84	29.5	29.0	—	—	—	—	—
85 +	20.8	23.0	—	—	—	—	—
Geographic region							
Major city	68.7	70.2	NS	68.8	64.1	78.5	*
Other†	31.3	29.8	—	31.2	35.9	21.5	—
Marital status							
Married (including de facto)	74.1	39.8	*	59.8	55.2	44.4	*
Not married	25.9	60.2	—	40.3	44.8	55.6	—
Country of birth							
Australia	69.3	73.5	NS	71.0	75.2	68.3	NS
Other	30.7	26.5	—	29.1	24.8	31.7	—
Education							
School only	46.7	75.4	*	42.6	27.9	30.9	*
Postschool qualification	50.6	23.8	—	55.3	70.8	68.1	—
Missing	2.8	0.7	—	2.1	1.3	1.0	—
Socio-Economic Indexes for Areas (SEIFA)[24]							
1–2nd quintile (lowest)	42.1	45.3	NS	43.3	49.9	37.2	NS
3–5th quintile (highest)	57.9	54.7	—	56.7	50.1	62.9	—
Health status							
Self-assessed health status							
Excellent/very good/good	65.5	63.1	NS	65.4	69.0	54.9	*
Fair/poor	34.5	36.9	—	34.6	31.0	45.1	—
CVD and/or diabetes‡							
No CVD or diabetes	52.8	69.4	*	62.4	62.3	60.8	NS
CVD or diabetes	41.5	27.5	—	32.4	32.9	37.5	—
CVD and diabetes	5.8	3.2	—	5.2	4.8	1.7	—
Risk factors							
BMI							
< 25	20.2	27.8	*	21.8	24.3	30.4	*
≥ 25	59.0	48.6	—	59.4	53.3	39.6	—
Missing	20.8	23.5	—	18.8	22.4	30.0	—
Smoking							
Never/ex	95.4	96.4	NS	94.6	96.6	98.2	NS
Current	4.6	3.6	—	5.5	3.4	1.8	—
Physical activity							
Other exercise§							
None	82.4	84.0	NS	80.6	84.0	88.2	NS
Some (≥ 10 min in previous week)	17.5	15.3	—	18.7	15.8	11.6	—
Missing	0.1	0.8	—	0.7	0.2	0.2	—
Walking¶							
None	41.6	49.7	NS	41.8	46.0	55.6	NS
Some (≥ 10 min in previous week)	58.4	49.5	—	57.4	53.7	44.3	—
Missing	0.1	0.8	—	0.7	0.2	0.2	—

All data were based on self-reported information, except BMI, which was derived from measured height and weight. Proportions were based on weighted data.

†"Other" geographic regions included inner regional, outer regional, remote Australia, and very remote Australia.

‡"Cardiovascular disease and/or diabetes" included any ischemic heart disease, angina, heart failure, cerebrovascular disease, or diabetes.

§"Other exercise" included participation in either moderate or vigorous physical activity, apart from walking.

¶Walking (min) = total physical activity (min) − (moderate physical activity (min) + vigorous physical activity (min)). Note that total physical activity excluded vigorous gardening and household chores but included walking for transport.

BMI indicates body mass index; CVD, cardiovascular disease; NS, not significant.

*Significant difference at ($P < 0.05$) level.

Table 2

Walking patterns.

	Men (%)				Women (%)			
	Age (y)				Age (y)			
Walking Status	75–79	80–84	85 +	All Age Groups Compared	75–79	80–84	85 +	All Age Groups Compared
Participation								
No walking (< 10 min/wk)	39.1	40.8	48.6	—	44.7	50.5	60.8	—
Some walking†	60.9	59.2	51.4	NS	55.3	49.5	39.2	NS
Duration‡								
10– < 60 min/wk	15.1	12.8	10.3	—	11.8	14.3	11.8	—
60– < 150 min/wk	14.4	21.2	11.5	—	20.9	17.1	9.6	—
≥ 150 min/wk	31.4	25.2	29.5	NS	22.6	18.1	17.9	NS
Only walking§								
Participants	47.9 (78.7)	47.4 (80.1)	46.4 (90.3)	NS	43.6 (78.8)	38.8 (78.4)	30.9 (78.8)	NS

Proportions were based on weighted data. Missing walking data were included in the proportion who did no walking.
†"Some walking" included those study participants who did other physical activity in addition to walking in the previous week.
‡"Duration of walking" is the time walked among those who did some walking.
§"Only walking" is the proportion of study participants whose only reported physical activity in the previous week was walking and in brackets expressed as a proportion of those who walk.
NS indicates not significant.

on physical activity participation among older adults. In support of our findings, McKee et al[25] noted that only when long-term illness was severe enough to interfere with functional ability did it adversely influence adults' (aged 65 y and above) participation in physical activity. By contrast, Smith et al[26], in their sample of adults aged 60 years and over, found that diabetes in men and women, and heart disease in women, significantly decreased the likelihood of participating in physical activity, including walking for pleasure. This finding was unusual because participants were older adults who self-identified as not having an illness or health condition that would restrict their participation in physical activity. Thus, in Smith and colleague's study, although a statistical association was found between some chronic diseases and nonparticipation, the presence of these diseases was not the reason for nonparticipation. As such, results from their self-selected sample of "healthy" older adults concur with the lack of association between cardiovascular disease and/diabetes and walking in our study.

A strength of our study was the focus on adults aged 75 years and older; most studies in the current literature have involved older adults aged 60 years and older. Unless studies report their findings by age group as opposed to older adults as a whole, the inclusion of younger ages in studies on walking may mask differences between older adults and the very elderly. We also examined age and sex differences in walking duration based on those who walked, rather than including a comparison of all study participants; to our knowledge no other study has made this comparison in this age group. Weighting of the study sample further enabled generalization of the findings to the Australian population aged 75 years and older. The 2011–2012 NNPAS collected walking data, as well as data about other physical activity, which allowed adjustment of the models for participation in other physical activity. However, interestingly at this older age, participation in other physical activity was not a significant confounder and hence was not included in our parsimonious model.

The study also had several limitations. All data, except BMI, were based on self-reported information from study participants. In a review of the validity of self-reported physical activity among older adults, Heesch et al[27] noted that, in the Active Australia questionnaire (a modified version of which was used in the 2011–2012 NNPAS), the same activity could be reported multiple times. They also noted that walking was more likely to be included in answers to the question about moderate activity. Hence, our focus on walking as the outcome of interest may make it less vulnerable to over-reporting than if we had focused on all

Table 3

Sex differences in participation and duration of walking.

	Proportion of Walkers (%)		Men Compared With Women	
Participation	**Men**	**Women**	**Model 1* [β (95% CI)]**	**Model 2† [β (95% CI)]**
Walking status	58.4	49.5	– 0.38 (– 0.80, 0.03)	– 0.33 (– 0.73, 0.06)
Duration	**Minutes walked per week among walkers**		**Model 1* [β (95% CI)]**	**Model 2† [β (95% CI)]**
25th percentile	60	55	– 0.51 (– 0.80, – 0.22)	– 0.51 (– 0.80, – 0.23)
Median	140	120		
75th percentile	330	210		

Proportions and percentiles were based on weighted data. Missing walking data (0.1% of men and 0.8% of women) were excluded from the analysis.
*Model 1 included the correlate sex and was adjusted for age, geographic region, marital status, country of birth, education, Socio-Economic Indexes for Areas (SEIFA), health status, cardiovascular disease and/or diabetes, BMI, smoking status, and other physical activity.
†Model 2 included the correlate sex and was adjusted for age, marital status, education, cardiovascular disease and/or diabetes, and BMI.
β indicates regression coefficient; BMI, body mass index; CI confidence interval.

Table 4

Age differences in participation and duration of walking.

		All Age Groups Compared	
Participation	**Men and Women Proportion of Walkers (%)**	**Model 1* [β (95% CI)]**	**Model 2† [β (95% CI)]**
75–79 y	57.9	Ref	Ref
80–84 y	53.9	− 0.10 (− 0.51, 0.31)	− 0.09 (− 0.51, 0.32)
85 + y	44.3	− 0.65 (− 1.13, − 0.17)	− 0.67 (− 1.14, − 0.19)
Duration	**Minutes walked per week among walkers (mean, median)**	**Model 1* [β (95% CI)]**	**Model 2† [β (95% CI)]**
75–79 y	217, 120	Ref	Ref
80–84 y	183, 115	− 0.19 (− 0.49, 0.10)	− 0.19 (− 0.50, 0.11)
85 + y	201, 150	− 0.13 (− 0.43, 0.18)	− 0.14 (− 0.45, 0.16)

Proportions and percentiles were based on weighted data. Missing walking data (0.1% of men and 0.8% of women) were excluded from the analysis.

*Model 1 included the correlate age and was adjusted for sex, geographic region, marital status, country of birth, education, Socio-Economic Indexes for Areas (SEIFA), health status, cardiovascular disease and/or diabetes, BMI, smoking status, and other physical activity.

†Model 2 included the correlate age and was adjusted for sex, geographic region, marital status, education, health status, and BMI.

β indicates regression coefficient; BMI, body mass index; CI confidence interval.

physical activity. Despite this, recall affected the validity of reported walking participation and duration, particularly incidental walking such as walking for transport, which was included in total walking estimates.

Data were based on a cross-sectional study design; hence, we only investigated the effects of age and sex on walking at a single point in time, rather than over time. In addition, as this study was based on secondary analysis of the 2011–2012 NNPAS, available data limited the control variables we could include. Social and environmental factors (in particular destinations) also influence walking participation among older adults[28–32] and contribute to differences between sexes[11,33]. In addition, participation in physical activity earlier in life, in particular competitive sports, has been associated with current physical activity in older men and women[34], but to our knowledge, no study has investigated lifelong participation in physical activity or walking and its effect on walking participation among adults aged 75 years and older. This study also did not distinguish between walking for exercise and walking for transport—both of which may vary between age and sex in older age[9].

Table 5

Effect of cardiovascular disease or diabetes on participation and duration of walking.

	Men and Women	
Participation	**Walking Status Proportion of Walkers (%)**	**Comparison of the Presence or Absence of Chronic Disease [β (95% CI)]***
No CVD or diabetes	54.5	Ref
CVD or diabetes	51.0	− 0.16 (− 0.56, 0.22)
CVD and diabetes	57.0	0.09 (− 0.80, 0.99)
Duration	**Minutes Walked per Week Among Walkers (mean, median)**	**Comparison of the Presence or Absence of Chronic Disease [β (95% CI)]†**
No CVD or diabetes	189, 120	Ref
CVD or diabetes	237, 140	0.09 (− 0.17, 0.36)
CVD and diabetes	172, 180	− 0.31 (− 0.83, 0.21)

Proportions, means and percentiles were based on weighted data. Missing walking data (0.1% of men and 0.8% of women) were excluded from the analysis.

*Model included the correlate cardiovascular disease and/or diabetes and was adjusted for age, sex, geographic region, marital status, education, and BMI.

†Model included the correlate cardiovascular disease and/or diabetes and was adjusted for age, sex, marital status, and education.

β indicates regression coefficient; BMI, body mass index; CI, confidence interval; CVD, cardiovascular disease.

Conclusions

By analyzing existing data representative of older adults in Australia aged 75 years and older, we have identified differences and similarities in walking participation and duration in this age group. The findings indicate that age but not sex, influences walking participation, and sex but not age, is associated with walking duration. This latter finding suggests the presence of a cohort of active older men and women who maintain their walking activity well into very old age. Although physical activity studies across all age groups have focused on barriers to participation, further investigation of this active group is warranted to understand predictors of ongoing walking participation and duration as older adults age, and to potentially increase walking participation among the nonwalking elderly. As our study found that the presence of chronic disease did not seem to be a barrier to walking in this age group, further study in this area is also warranted.

Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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