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3-year changes in physical activity and physical performance decline over 9 years of follow-up in older adults: The InCHIANTI study

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Abstract

OBJECTIVES—To examine the associations of cumulative physical activity (PA) and its changes over 3-year with changes over 9 years of follow-up in physical performance in older adults.

DESIGN—Longitudinal.

SETTING—Community-based.

PARTICIPANTS—Men and women, aged 65 years and older, from the InCHIANTI study (N=782).

MEASUREMENTS—Physical performance was assessed at baseline and at 3-, 6- and 9-year follow-up with the Short Physical Performance Battery (SPPB). PA was assessed through an interviewer-administered questionnaire at baseline and at 3-year follow-up. Analyses were adjusted for education, body mass index, smoking, alcohol intake, coronary heart disease, stroke, peripheral arterial disease, cancer, lung disease, lower extremity osteoarthritis, depression, and Mini-mental state examination.

RESULTS—Over 3-year of follow-up, the prevalence of participants inactive, minimally active and active was 27.8%, 52.2% and 20.0%, respectively. The prevalence of participants who decreased, no change or increased PA over 3-year of follow-up was 37.2%, 50.1% and 12.7%, respectively. Compared with participants who spent most of the time inactive and after adjustment for potential covariates (–2.60 score, 95%CI: –2.92, –2.27), being mostly active (–1.08 score, 95%CI: –1.43, –0.73) and even minimally active (–1.33 score, 95%CI: –1.53, –1.12) over 3 years of follow-up was associated with lower declines in the SPPB score. When analyzing changes,

increasing PA (−0.57 score, 95%CI: −1.01, −0.12) was associated with lower declines in the SPPB score over 9 years as compared with those who decreased PA (−2.16 score, 95%CI: −2.42, −1.89).

CONCLUSION—Maintaining or increasing PA levels may attenuate age-associated physical performance decline.

Keywords

physical activity; aging; physical performance

INTRODUCTION

Physical performance declines with increasing age and is one of the most important predictors of future adverse health consequences such as disability, institutionalization, hospitalization, and home health care assistance.^{1–3} Considering the magnitude and speed of population aging⁴, preventing physical performance decline is a major health priority in both developed and developing countries. Management and control of physical performance decline in older adults through non-pharmacological strategies may be cost-effective for reducing future health care costs.⁴

Physical activity (PA) is considered a ‘polypill’ with potential capacity to attenuate the major hallmarks of aging, including physical performance decline.^{5,6} However, evidence from clinical trials are commonly developed in older populations with chronic conditions (e.g. frail or disabled), performed in ideal conditions, and with short-term interventions.^{5–10} Longitudinal studies on aging provide valuable information in more realistic conditions that might be effective at the population level.¹¹

To date, some longitudinal studies found that PA was inversely associated with physical performance decline in older adults, but most have typically examined the relationship of PA at baseline or a single point in time with subsequent changes in physical performance.^{12–14} Assessment of the relevant exposure variables at two or more time points in a prospective design provides the advantage of examining how maintaining or changing PA levels might predict the subsequent changes in physical performance, which provides more robust evidence on causal roles. Although it is common that people decrease their PA as they age¹⁵, potential improvements or even maintenance of a physically active lifestyle as long as possible might be key for preventing physical performance decline. Hence, we examined the associations of cumulative PA and its changes over 3-year with changes over 9 years of follow-up in physical performance in older adults from the InCHIANTI study.

METHODS

Study design and participants

The study participants comprised men and women, aged 65 years and older, who participated in the Invecchiare in Chianti, “Aging in Chianti” (InCHIANTI) study.¹⁶ The InCHIANTI study is an epidemiological, population-based longitudinal study on aging carried out in two Tuscany towns located in the Chianti geographic area in Italy. The baseline data were collected between 1998 and 2000, and the 3-year follow-up took place

between 2001 and 2003, the 6-year follow-up between 2004 and 2006, and the 9-year follow-up between 2007 and 2008. The study population consisted of a random sample of 1,270 community-dwelling persons aged ≥ 65 years selected from the population registries of these two towns. A total of 1,155 older adults agreed to participate in the study (participation rate= 90.1%). Further details on study design and protocols of the InCHIANTI study have been described elsewhere.¹⁶

Participants received an extensive description of the study and participated after providing written informed consent. The study protocol was approved by the Italian National Institute of Research and Care on Aging Ethical Committee.

Physical performance

Physical performance was assessed at baseline and at 3-, 6- and 9-year follow-up with the Short Physical Performance Battery (SPPB).¹⁻³ This battery includes 3 tests of physical function: balance, gait speed and chair stands. For the standing balance test, participants were asked to stand in 3 progressively more challenge positions (feet in side-by-side, semi-tandem and full tandem positions) for 10 seconds each. Gait speed was defined as the better performance of 2 walks at usual pace over a 4-m course. The chair stands test required participants to rise 5 times from a chair with arms across their chest for five repetitions as quickly as possible. Each of the three tests were scored 0 to 4 according to standardized criteria, with a score of 0 indicating the inability to complete the test and 4 the highest level of physical performance in such test. Scores from the three tests (hereafter called sub-scores) were summed into a composite score ranging 0 to 12, with higher scores reflecting better physical function. The SPPB has shown excellent reliability and predictive validity for mortality, disability, and nursing home admission in older adults.^{1-4,17}

Physical activity

PA was assessed through an interviewer-administered questionnaire at baseline and at 3-year follow-up. Participants were asked to indicate their average level of PA during the past year with a 6-point scale.^{12,18} The response categories were (i) hardly any PA, (ii) mostly sitting or some walking, (iii) light PA performed 2–4 hours per week not accompanied by sweating, (iv) moderate PA performed 1 to 2 hours per week accompanied by sweating or light PA not accompanied by sweating for more than 4 hours per week, (v) moderate PA performed 3 or more hours per week accompanied by sweating, and (vi) physical exercise performed regularly including maximal strength and endurance several times per week. The most predominant activities to achieve high levels of PA were soccer, hunting, swimming, cycling, and participation in senior fitness training programs.

To evaluate maintained levels of PA over time, a cumulative score was computed as the average of PA at baseline and at 3-year follow-up.^{12,19} Participants who scored ≤ 3 in the cumulative score were classified as ‘mostly inactive’, whereas those who scored ≥ 3 to ≤ 4 (e.g. active older adults but not enough to meet PA guidelines) or ≥ 4 (e.g. active older adults who meet PA guidelines) were classified as ‘mostly minimally active’ and ‘mostly active’, respectively.²⁰⁻²² To evaluate the effect of increasing or decreasing PA over 3 years, we calculated changes in PA as the measure at 3-year follow-up minus the measure at baseline.

A score of 0 indicates no change in PA, and positive and negative scores indicate increases and decreases in PA, respectively.

Covariates

Covariates were derived from baseline data. Education was recorded in years. Body mass index was calculated as measured weight in kilograms divided by measured height in meters squared (kg/m^2). Smoking status was categorized into never, former, and current smokers. Alcohol intake (g) was estimated by the European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire and participants were classified as <30 g and ≥ 30 g per day.²³

Diseases were determined by a trained geriatrician according to standardized and well-known pre-established criteria as well as algorithms combining information from self-reported physician diagnoses, medical records, current pharmacological treatment, clinical examinations, and blood tests. The following diseases were included: coronary heart disease, stroke, peripheral arterial disease, lung disease (i.e. bronchitis and asthma), diabetes, lower extremity osteoarthritis, and cancer. Depressive symptoms were assessed by the Center for Epidemiologic Studies Depression Scale was, and a score ≥ 16 indicated an individual at risk for clinical depression.^{24,25} The Mini-mental state examination (0–30 score) was used to assess global cognitive function.^{26,27}

Statistical analysis

From the total sample aged 65 years and older included in the InCHIANTI study, 996 participants had baseline PA and SPPB measurements. Before the 3-year follow-up 91 participants had died and among those alive, 123 did not have information on PA at 3-year follow-up or at least one follow-up SPPB measure. Hence, the final analytic sample included 782 participants (347 men).

Baseline descriptive data for the final sample are shown as means (SD) for continuous variables and frequencies (%) for categorical variables. Descriptive data on PA at baseline and at 3 years of follow-up, and SPPB scores and sub-scores at baseline and over 9 years of follow-up are also presented with the same summary statistics. We also compared participants who were excluded due to missing data to those who were included in the final sample.

We performed generalized estimation equations using an exchangeable correlation structure to control for the intra-individual correlation between repeated measurements^{28,29} when examining the association of 3-year cumulative PA (i.e. mostly inactive, mostly minimally active, active) with changes over 9 years of follow-up with the SPPB score and sub-scores, using a sex- and age- adjusted model that also included the specific outcome at baseline (model 1), and an additional multivariate model adjusted for variables in model 1 plus the aforementioned covariates (model 2). Generalized estimation equations were also used to examine the association of 3-year changes in PA (i.e. decreased PA, no change, increased PA) with changes over 9 years of follow-up in the SPPB score and sub-scores, using the same two adjusted models plus baseline PA in both. In addition, pairwise comparisons, using Bonferroni's adjustment, were performed to examine the difference in adjusted means of the

physical performance variables across the three categories of PA examined. The analyses were repeated using 3-year cumulative PA and changes in PA as continuous variables, which indicate changes over 9 years of follow-up per one-category increment in the 6-point PA scale.

We performed a final sensitivity analysis for comparative purposes that reexamined the main associations in participants from the final sample alive and with information on SPPB data at 9 years of follow-up ($n=437$). All tests were 2-sided and statistical significance was set at $P<0.05$. Analyses were performed with STATA® 14 for Macintosh.

RESULTS

Baseline characteristics of the study population are shown in Table 1. Over 3-year of follow-up, most participants maintained a minimally active lifestyle (52.2%), with more individuals classified as mostly inactive than active (27.8 vs. 20.0%) (Table 2). Although there was a small decrease in PA during this period, a total of 99 participants (12.7%) increased their PA (Table 2). Participants had a marked physical performance decline over 9 years of follow-up with the loss of more than 2 points in the SPPB and decreases in the three sub-scores (Table 2). The study population was younger (73.6 vs 79.3 years), more educated (5.6 vs 4.7 years), and had a greater proportion of alcohol consuming ≥ 30 g/day (15.2 vs 9.4%) than participants who were excluded. In addition, the study population also had higher physical performance scores (10.2 vs 7.9 scores in the SPPB) than excluded participants.

Baseline characteristics of the study population according to 3 years of follow-up PA groups are shown in Supplementary Table S1. The association of 3-year cumulative PA with changes over 9 years of follow-up in the SPPB score and sub-scores are shown in Table 3. Compared with participants who spent most of the time inactive (-2.60 score, 95%CI: $-2.92, -2.27$) and after adjustment for potential covariates, being active (-1.08 score, 95%CI: $-1.43, -0.73$) and even minimally active (-1.33 score, 95%CI: $-1.53, -1.12$) during this period was associated with a lower decline in the SPPB score and sub-scores. In contrast, the greater declines in all physical performance variables were observed in the persistently inactive individuals.

When analyzing changes during 3 years of follow-up, maintaining or increasing PA was associated with lower declines in the SPPB and sub-scores over 9 years (Table 4). Specifically, increasing PA largely attenuated gait speed decline (-0.03 score, 94%CI $-0.18; 0.13$). Compared with participants maintaining their PA levels, those who increased their PA added more than 1 point in the SPPB (1.20 score, 95%CI: 0.56; 1.84), as well as significant increases in the three sub-scores, after adjustment for covariates, including PA at baseline. Also, compared with participants who had not changed their levels of PA, those who decreased PA had a significant decline in physical performance in the SPPB (-0.65 score, 95%CI: $-1.01; -0.30$), and balance (-0.22 score, 95%: $-0.37; -0.07$), gait speed (-0.34 score, 95%: $-0.47; -0.22$) and chair stand (-0.24 score, 95%CI: $-0.39; -0.08$) sub-scores.

When the analyses were performed with 3-year PA data as a continuous variable, for example, per one-category increments in cumulative PA and changes in PA were associated

with improvements of 0.94 (95%CI: 0.68; 1.20) and 0.76 (95%CI: 0.53; 1.00) in scores in the SPPB over 9-years of follow-up, respectively (Supplementary Table S2). We performed sensitivity analyses limited to participants alive at 9 years of follow-up with information on SPPB data ($n=437$), and despite the loss of statistical power, the results showed similar effects of cumulative, maintaining or increasing PA on physical performance (Supplementary Tables S3 and S4).

DISCUSSION

The aim of study was to examine the role of 3-year cumulative PA as well as changes in PA during this period on physical performance decline in older adults. Using data from the InCHIANTI study with 9 years of follow-up, we found that maintaining a minimal level of PA or increasing PA attenuated physical performance decline among older adults; whereas decreasing PA or maintaining a persistent physically inactive lifestyle were associated with greater decline in physical performance.

Several mechanisms could explain the beneficial association between PA and physical performance among older adults. PA has been related to lower cardiovascular, muscle, cognitive, frailty risk, as well as other major hallmarks of aging, which are, in turn, associated with physical performance decline.^{5,6}

A previous work from the InCHIANTI study found that greater PA at baseline is associated with lower decline in physical performance over 9 years of follow-up.¹² However, the present study extends these observations to demonstrate in a clearer manner the potential key role of PA on physical performance in the elderly by examining PA at two time points in a prospective way. For example, our analyses on the cumulative effect of PA in this life period indicate that it is essential to be as physically active as possible. Although public health recommendations on PA suggest specific doses and intensities to provide health in the population aged 65 years and older (i.e. 150 minutes of moderate-intensity, or 75 minutes of vigorous-intensity, or an equivalent combination of both per week)²⁰, the real picture of older adults' PA levels suggest that only a small proportion meets these recommendations.^{30,31}

In the InCHIANTI study only 5% of older adults meet public health recommendations for PA. However, our results support maintaining a minimally active lifestyle (i.e. doing light PA 2–4 hours per week not accompanied by sweating, or moderate PA performed 1 to 2 hours per week accompanied by sweating or light PA not accompanied by sweating for more than 4 hours per week) that is protective against physical performance decline, as compared with older adults being persistently inactive. Importantly, our results with PA as a continuous variable not only support the idea of being as active as possible, but also the paradigm of 'every minute of PA really does count'.³²

Regarding the effect of increasing or decreasing PA on physical performance, we found that increasing PA in the elderly is associated with a clinically meaningful attenuation (i.e. 1 point or less in the SPPB score) of physical performance changes over 9 years, specially in gait speed capacity, whereas those participants who decreased PA had a sharp and

accelerated decline in physical performance. Changes in PA were based on at least one-category increment in PA, hence, to become as physically active as suggested in public health recommendations would be not necessary to achieve some improvements in physical performance. Also, since changes in PA were adjusted for baseline PA, this is an important finding reflecting that never is it too late to increase PA levels, with consequent gains in health among older adults.²⁰

As in previous studies^{33,34}, the present study fails to find clear correlates of change in PA levels in older adults and, it limits the ability to identify target individuals likely to increase their PA levels. However, older adults who are physically inactive were more clearly identified (e.g. women, the oldest people, and those with lower education, multimorbidity, and depression). On the other hand, the proportion of older adults who increased their PA was smaller than compared with those who decreased PA. Taken together, the development of public health strategies focused on both maintaining PA levels in older people who are active or minimally active and increasing PA in those who are mainly inactive are likely to achieve a greater impact at population level.

All analyses in our study were examined by sub-scores in the SPPB. The SPPB includes three components of physical performance: balance, gait speed and capacity of chair stand. The effect of accumulating or increasing PA was higher in the gait speed component than in other two components. The information on PA included in this study comes from asking participants to indicate their levels of aerobic activity. Hence, it seems that aerobic PA has a key role to prevent physical performance decline throughout walking function, but some benefits on the other components must be also acknowledged.^{6,35,36} These findings provide encouragement to do aerobic PA but the combination of other types of physical activities would likely have greater benefits to attenuate physical performance decline.³⁵⁻³⁷ In addition to aerobic physical activities and being as physically active as their abilities and conditions allow, public health recommendations also suggest persons perform (i) physical activities to enhance balance on 3 or more days per week and (ii) muscle-strengthening activities on 2 or more days a week.²⁰

Some strengths of this study included its large longitudinal design over 9 years of follow-up, the inclusion of the main exposure variable at 2 time points, statistical adjustment for many confounders, and the use of a standardized battery of physical performance tests with a well-known predictive ability of adverse health outcomes in older adults. In addition, the SPPB is probably less biased than self-report measures. However, information on PA in this study was self-reported and our findings must be interpreted with caution.³³⁸ Further longitudinal studies including objective measures of PA (e.g. accelerometers) should be developed to confirm or refute our findings. Another limitation of this study is the loss of participants to follow-up.³⁹ Participants who were lost to follow-up were significantly older, less educated, and with a lower proportion of alcohol drinkers compared to those who participated in the final sample; this could limit the generalization of the findings. However, participants who were lost also had significantly lower physical performance. Therefore, censoring of these participants might be underestimating the strength of the associations herein found between PA and physical performance decline.³⁹ On the other hand, although the InCHIANTI study has a longitudinal design, reverse causality on the direction of the association between PA

and physical performance, mainly among older adults, should not be totally discarded. Finally, other potential covariates and effect modifiers were not included (e.g. marital status, energy intake, severity of disease) and it must take into account when interpreting these findings.

In conclusion, in this longitudinal study in Italian community-dwelling older adults over 9 years of follow-up, maintaining or increasing physical activity levels may attenuate age-associated physical performance decline. Further longitudinal studies including objective measures of physical activity are necessary to confirm these results. Also, the effect of combining different types of physical activity (e.g. aerobic, resistance training and balance activities) on physical performance decline warrants further study and consideration.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Conflict of interest: The InCHIANTI study baseline (1998–2000) was supported as a “targeted project” (ICS110.1/RF97.71) by the Italian Ministry of Health and in part by the U.S. National Institute on Aging (contracts: 263 MD 9164 and 263 MD 821336); the InCHIANTI Follow-up 1 (2001–2003) was funded by the U.S. National Institute on Aging (contracts: N.1-AG-1-1 and N.1-AG-1-2111); the InCHIANTI Follow-up 2 study (2004–2006) was financed by the U.S. National Institute on Aging (contract: N01-AG-5-0002); and the InCHIANTI Follow-up 3 study (2007–2008) was financed by the U.S. National Institute on Aging (contract: 1 Z01 AG001050-01). This work was also supported by grants from the Spanish Ministry of Economy and Competitiveness (DEP2013-47786-R) and the Spanish Ministry of Education, Culture and Sport (CAS15/00080).

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Table 1

Baseline characteristics of the study population

n, %	782 (100)
Women, %	435 (55.6)
Age, years	73.6 (6.5)
Education, years	5.6 (3.3)
Height, cm	158.8 (9.1)
Weight, kg	69.3 (11.9)
Body mass index, kg/m ²	27.1 (5.2)
Smoking, %	
Never	455 (58.2)
Former	214 (27.3)
Current	113 (14.5)
Alcohol intake ≥ 30 g/day, %	119 (15.2)
Coronary heart disease, %	83 (10.6)
Stroke, %	54 (6.9)
Peripheral arterial disease, %	75 (10.0)
Diabetes, %	94 (12.0)
Cancer, %	47 (6.0)
Lung disease, %	74 (9.5)
Lower extremity osteoarthritis, %	85 (10.9)
Depression (CES-D ≥ 16), %	236 (30.2)
Mini-mental state examination, score	25.3 (3.8)

Values are mean (SD) or *n* (%). CES-D: Center for Epidemiological Studies-Depression.

Table 2

Descriptive information on physical activity and the Short Physical Performance Battery (SPPB) score and sub-scores

	Mean (SE) or <i>n</i> (%)
Physical activity at baseline (1–6 categories)	3.26 (0.03)
Physical activity at 3-year follow-up (1–6 categories)	2.96 (0.03)
Cumulative physical activity (1–6 categories)*	3.11 (0.03)
Cumulative physical activity groups	
Mostly inactive (<3 categories)	217 (28)
Mostly minimally active (3 to <4 categories)	408 (52)
Mostly active (≥4 categories)	157 (20)
3-year changes in physical activity (1–6 categories)	−0.30 (0.03)
3-year changes in physical activity groups	
Decreased (−1 category)	291 (37)
No change (unchanged category)	392 (50)
Increased (+1 category)	99 (13)
SPPB at baseline (0–12 score)	10.22 (0.10)
SPPB at 9 years (0–12 score)	8.83 (0.10)
Changes over 9 years in SPPB (0–12 score)	−1.39 (0.11)
Balance at baseline (0–4 score)	3.40 (0.04)
Balance at 9 years (0–4 score)	2.91 (0.06)
Changes over 9 years in balance (0–4 score)	−0.49 (0.06)
Gait speed at baseline (0–4 score)	3.69 (0.03)
Gait speed at 9 years (0–4 score)	3.21 (0.04)
Changes over 9 years in gait speed (0–4 score)	−0.48 (0.04)
Chair stand at baseline (0–4 score)	3.13 (0.04)
Chair stand at 9 years (0–4 score)	2.61 (0.05)
Changes over 9 years in chair stand (0–4 score)	−0.52 (0.05)

* Cumulative physical activity was calculated as the average of physical activity at baseline and 3-year follow-up.

Table 3

Changes over 9 years of follow-up in the Short Physical Performance Battery (SPPB) score and sub-scores according to 3-year cumulative physical activity in older adults

	Mostly inactive (<i>n</i> =217)	Mostly minimally active (<i>n</i> =408)	Mostly active (<i>n</i> =157)
Changes over 9 years in SPPB (0–12 score)			
Model 1	−2.71 (−3.04; −2.39) *	−1.30 (−1.51; −1.10)	−0.98 (−1.33; −0.63)
Model 2	−2.60 (−2.92; −2.27) *	−1.33 (−1.53; −1.12)	−1.08 (−1.43; −0.73)
Changes over 9 years in balance (0–4 score)			
Model 1	−0.97 (−1.10; −0.84) *	−0.38 (−0.47; −0.30)	−0.25 (−0.40; −0.10)
Model 2	−0.91 (−1.05; −0.78) *	−0.40 (−0.49; −0.31)	−0.29 (−0.44; −0.14)
Changes over 9 years in gait speed (0–4 score)			
Model 1	−0.97 (−1.08; −0.85) *	−0.29 (−0.36; −0.21)	−0.19 (−0.32; −0.07)
Model 2	−0.92 (−1.03; −0.80) *	−0.30 (−0.37; −0.22)	−0.23 (−0.36; −0.11)
Changes over 9 years in chair stand (0–4 score)			
Model 1	−1.14 (−1.28; −1.00) *	−0.56 (−0.65; −0.46)	−0.42 (−0.58; −0.26)
Model 2	−1.07 (−1.21; −0.92) *	−0.57 (−0.66; −0.48)	−0.48 (−0.64; −0.33)

Values are adjusted means (95% confidence interval).

* Significantly different from the active categories with Bonferroni correction for multiple comparisons. Cumulative physical activity was calculated as the average of physical activity at baseline and 3-year follow-up. Model 1: adjusted for age, sex and balance/chair stand/gait speed/SPPB at baseline; Model 2: Model 1 + adjusted for education, body mass index, smoking, alcohol intake, coronary heart disease, stroke, peripheral arterial disease, cancer, lung disease, lower extremity osteoarthritis, depression and Mini-mental state examination.

Table 4

Changes over 9 years of follow-up in the Short Physical Performance Battery (SPPB) score and sub-scores according to 3-year changes in physical activity (PA) in older adults

	Decreased PA (n=291)	No change PA (n=392)	Increased PA (n=99)
Changes over 9 years in SPPB (0–12 score)			
Model 1	–2.24 (–2.51; –1.98) *	–1.46 (–1.66; –1.25) *	–0.53 (–0.99; –0.08) *
Model 2	–2.16 (–2.42; –1.89) *	–1.51 (–1.71; –1.30) *	–0.57 (–1.01; –0.12) *
Changes over 9 years in balance (0–4 score)			
Model 1	–0.73 (–0.85; –0.62) *	–0.46 (–0.55; –0.37) *	–0.14 (–0.33; 0.06) *
Model 2	–0.70 (–0.81; –0.59) *	–0.48 (–0.57; –0.39) *	–0.16 (–0.35; 0.03) *
Changes over 9 years in gait speed (0–4 score)			
Model 1	–0.75 (–0.84; –0.65) *	–0.36 (–0.43; –0.28) *	0.01 (–0.16; 0.16) *
Model 2	–0.72 (–0.81; –0.62) *	–0.37 (–0.45; –0.30) *	–0.03 (–0.18; 0.13) *
Changes over 9 years in chair stand (0–4 score)			
Model 1	–0.93 (–1.05; –0.81) *	–0.62 (–0.71; –0.52) *	–0.29 (–0.49; –0.08) *
Model 2	–0.88 (–1.00; –0.76) *	–0.65 (–0.73; –0.55) *	–0.31 (–0.51; –0.11) *

Values are adjusted means (95% confidence interval).

* Significantly different from the other two categories with Bonferroni correction for multiple comparisons. Model 1: adjusted for age, sex, balance/ chair stand/gait speed/SPPB at baseline and PA at baseline; Model 2: Model 1 + adjusted for education, body mass index, smoking, alcohol intake, coronary heart disease, stroke, peripheral arterial disease, cancer, lung disease, lower extremity osteoarthritis, depression, and Mini-mental state examination.