

Physical Activity and Risk of Coronary Heart Disease and Stroke in Older Adults

The Cardiovascular Health Study

Luisa Soares-Miranda, PhD; David S. Siscovick, MD, MPH; Bruce M. Psaty, MD, PhD;
W. T. Longstreth Jr, MD, MPH; Dariush Mozaffarian, MD, DrPH

Background—Although guidelines suggest that older adults engage in regular physical activity (PA) to reduce cardiovascular disease (CVD), surprisingly few studies have evaluated this relationship, especially in those >75 years. In addition, with advancing age the ability to perform some types of PA might decrease, making light-moderate exercise such as walking especially important to meet recommendations.

Methods and Results—Prospective cohort analysis among 4207 US men and women of a mean age of 73 years (standard deviation=6) who were free of CVD at baseline in the Cardiovascular Health Study were followed from 1989 to 1999. PA was assessed and cumulatively updated over time to minimize misclassification and assess the long-term effects of habitual activity. Walking (pace, blocks, combined walking score) was updated annually from baseline through 1999. Leisure-time activity and exercise intensity were updated at baseline, 1992, and 1996. Incident CVD (fatal or nonfatal myocardial infarction, coronary death, or stroke) was adjudicated using medical records. During 41 995 person-years of follow-up, 1182 CVD events occurred. After multivariable adjustment, greater PA was inversely associated with coronary heart disease, stroke (especially ischemic stroke), and total CVD, even in those ≥75 years. Walking pace, distance, and overall walking score, leisure-time activity, and exercise intensity were each associated with lower risk. For example, in comparison with a walking pace <2 mph, those that habitually walked at a pace >3 mph had a lower risk of coronary heart disease (0.50; confidence interval, 0.38–0.67), stroke (0.47; confidence interval, 0.33–0.66), and CVD (0.50; confidence interval, 0.40–0.62).

Conclusions—These data provide empirical evidence supporting PA recommendations, in particular, walking, to reduce the incidence of CVD among older adults.

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Key Words: aged ■ cardiovascular diseases ■ exercise ■ prevention & control

In the United States, >1 in every 3 adults (≈83.6 million) have ≥1 type of cardiovascular disease (CVD); of these, 42.2 million are >60 years of age.¹ Several studies have observed inverse associations between regular physical activity (PA) and CVD,^{2–4} and a 2008 systematic review by the US Physical Activity Guidelines Advisory Committee concluded that active individuals have lower rates of CVD than their sedentary counterparts.⁵ Yet, although CVD is especially common later in life, this report suggests that relatively little is known about the association between PA and CVD in older adults. The great majority of previous studies were conducted in middle-aged participants, typically averaging 45 to 60 years of age.⁵ Only a few studies comprised individuals with median or mean ages exceeding 65 years,^{5–10} and few data were available for individuals aged ≥75 years.⁵

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The influence of different types of PA on CVD later in life may also be relevant. With advancing age, the ability to perform more intense PA might decrease in many older adults, making light to moderate exercise such as walking of greater importance as a means to meet recommendations. An inverse association between moderate PA such as walking and the incidence of coronary heart disease (CHD) and stroke in older adults would be important to identify, especially among those age ≥75 years, because walking is the most common type of PA later in life.

Given the relative paucity of data on PA and the risk of CVD in older adults, especially those at higher ages (≥75 years), we investigated how habitual PA related to incident

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From Research Centre in Physical Activity, Health, and Leisure, Faculty of Sport, University of Porto, Portugal (L.S.-M.); Department of Epidemiology, University of Washington, Seattle (D.S.S., B.M.P., W.T.L.); Department of Medicine, Cardiovascular Health Research Unit, University of Washington, Seattle (D.S.S., B.M.P.); New York Academy of Medicine, New York (D.S.S.); Group Health Research Institute, Group Health Cooperative, Seattle, WA (B.M.P.); Department of Neurology, University of Washington, Seattle (W.T.L.); and Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA (D.M.).

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Correspondence to Luisa Soares-Miranda, PhD, Research Centre in Physical Activity, Health and Leisure, Faculty of Sport, University of Porto, Rua Dr. Plácido Costa, 91 4200.450 Porto Portugal. E-mail soaresmiranda@fade.up.pt

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CVD, including CHD and stroke, in the Cardiovascular Health Study (CHS), an established prospective cohort of older US adults with repeated measures of different types of PA and careful assessment of incident CVD.

Methods

Population

The design and recruitment of the CHS have been described.^{11,12} In brief, 5201 ambulatory, noninstitutionalized men and women ≥ 65 years of age were randomly selected and enrolled from Medicare eligibility lists in 4 US communities in 1989 to 1990, and an additional 687 black participants similarly, in 1992. The institutional review committee at each center approved the study, and all participants provided informed consent. Between 1989 to 1990 and 1998 to 1999 participants were followed by annual study visits. Standardized evaluations included physical examination, diagnostic testing, laboratory evaluation, and questionnaires on health status, medical history, and cardiovascular risk factors.^{11–13} From a total of 5888 participants, we excluded 1366 participants with prevalent CVD at baseline and 315 participants with missing information on PA at baseline. In total, 4207 participants were included in this analysis.

Assessment of PA

PA was assessed at multiple serial visits (Figure I in the online-only Data Supplement). Usual leisure-time activity was assessed by using a modified, validated Minnesota Leisure-Time Activities questionnaire,^{14,15} which correlates with objective and subjective PA and physical fitness measures ($r=0.23$ – 0.75)¹⁶ and has also been associated with risk of multiple disease outcomes in this cohort.^{17–21} The questionnaire evaluated the frequency and duration of 15 different activities during the previous 2 weeks, including gardening, mowing, raking, swimming, hiking, aerobics, tennis, jogging, racquetball, walking, golfing, bicycling, dancing, calisthenics, and exercise cycling.¹⁹ Each activity was defined as having an intensity value in metabolic equivalent task units,¹⁵ and participant responses regarding types, frequency, and duration of each activity were used to calculate weekly energy expenditure (kcal/week) from leisure-time activity. Usual exercise intensity was also separately assessed: based on the highest-intensity leisure-time activity reported over the previous 2 weeks, participants were categorized as having engaged in high-, moderate-, or low-intensity activity or none, where high-intensity activity was estimated to require >6 metabolic equivalent task units.¹⁹ Usual walking habits, including average walking pace (gait speed) and distance walked, were assessed annually at each follow-up visit. We evaluated these metrics in prespecified categories, including: usual pace walked (<2 , 2 – 3 , and >3 mph), blocks walked (quintiles), exercise intensity (none, low, moderate, and high), and leisure-time activity (quintiles). A previously defined walking score was also evaluated based on the combination of walking pace and walking distance.²¹

Ascertainment of Cardiovascular Events

Participants were observed during annual examinations and interim 6-month telephone contacts through 1999 and 6-month telephone contacts thereafter.²² Medical records, information from interviews, physician questionnaires, death certificates, medical examiner forms, Health Care Financing Administration hospitalizations, and available computed tomographic or MRI scans were reviewed by centralized cardiac and stroke adjudication committees to classify events.^{22,23} Myocardial infarction was diagnosed using an algorithm including cardiac symptoms as chest pain, abnormal cardiac enzyme concentrations, and serial ECG changes. Fatal CHD included deaths not meeting criteria for myocardial infarction if occurring within 72 hours of chest pain or with previous history of ischemic heart disease. CHD includes fatal and nonfatal myocardial infarction and CHD death. Strokes were classified as ischemic if there was evidence of focal brain deficit without evidence of primary hemorrhage; hemorrhagic

if there was bloody spinal fluid on lumbar puncture or evidence of blood in the subarachnoid space, ventricles, or parenchyma on brain imaging or at surgery or autopsy that did not appear consistent with hemorrhage into an infarction; or unknown type if information was insufficient for classification.²⁴ For this analysis, the primary outcome was incident CVD, defined as combined incident stroke, fatal and nonfatal myocardial infarction and coronary heart disease death.

Covariates

Information on a wide range of covariates was obtained during study visits, including demographics, education, income, detailed smoking habits, alcohol use, usual dietary habits, body mass index, blood pressure, lipid profile, C-reactive protein, medication use, health status, and daily living activities and instrumental scores.¹¹

Statistical Analyses

Cox proportional hazards models were used to estimate risk during the follow-up period. Follow-up was calculated from enrollment until the first event, death, or loss to follow-up, whichever happened first; we censored all follow-up at 10 years given the absence of further serial updated information on PA.¹² Less than 1% of person-time

Table 1. Baseline Characteristics of 4207 Older US Adults in the Cardiovascular Health Study With Longitudinal Assessment of Physical Activity From 1989 to 1999 and Without Cardiovascular Disease at Baseline

Characteristic	
Age, y (SD)	72.5 (5.5)
Sex, % male	39.0
Race, % white	78.3
Education	
<High school, %	28.0
High school, %	28.0
>High school, %	44.0
Annual income \geq \$25 000, %	39.9
Smoking habits	
Former smoker, %	39.9
Current smoker, %	12.3
Body mass index, kg/m ² (SD)	26.7 (4.6)
Health status	
Good/very good/excellent, %	83
Fair/poor, %	17
Physical activity*	
Walking pace, mph	
<2, %	26.6
2–3, %	42.8
≥ 3 , %	30.6
Walking blocks, blocks/wk (SD)	42 (55)
Leisure-time activity, kcal/wk (SD)	1258 (1640)
Exercise intensity	
None, %	7.2
Low, %	47.2
Moderate, %	34.2
High, %	11.4

SD indicates standard deviation.

*See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined.

Table 2. Incidence of CHD, Stroke, and CVD According to Different Types of Physical Activity Among 4207 older US Adults*

	Hazard Ratios (95% Confidence Intervals)					
	Total CHD	P Value	Total Stroke	P Value	Total CVD	P Value
No. of incidences/total	762/4207		563/4207		1182/4207	
Walking pace, mph						
<2	Reference		Reference		Reference	
2–3	0.66 (0.56–0.78)	<0.001	0.70 (0.58–0.85)	<0.001	0.67 (0.59–0.76)	<0.001
>3	0.50 (0.38–0.67)	<0.001	0.47 (0.33–0.66)	<0.001	0.50 (0.40–0.62)	<0.001
P trend	<0.001		<0.001		<0.001	
Walking distance, blocks/wk						
0–5	Reference		Reference		Reference	
6–12	0.82 (0.65–1.03)	0.095	0.59 (0.46–0.77)	<0.001	0.70 (0.58–0.83)	<0.001
13–25	0.80 (0.64–1.01)	0.062	0.54 (0.41–0.69)	<0.001	0.67 (0.56–0.80)	<0.001
26–48	0.60 (0.47–0.78)	<0.001	0.51 (0.38–0.67)	<0.001	0.56 (0.46–0.68)	<0.001
≥49	0.64 (0.50–0.83)	0.001	0.46 (0.35–0.62)	<0.001	0.53 (0.44–0.65)	<0.001
P trend	<0.001		<0.001		<0.001	
Walking score†						
I	Reference		Reference		Reference	
II	0.89 (0.72–1.10)	0.279	0.58 (0.46–0.73)	<0.001	0.73 (0.62–0.87)	<0.001
III	0.64 (0.51–0.81)	<0.001	0.46 (0.36–0.59)	<0.001	0.54 (0.45–0.65)	<0.001
IV	0.56 (0.43–0.73)	<0.001	0.40 (0.30–0.54)	<0.001	0.46 (0.37–0.57)	<0.001
P trend	<0.001		<0.001		<0.001	
Leisure-time activity, kcal/wk†						
I	Reference		Reference		Reference	
II	0.62 (0.49–0.78)	<0.001	0.81 (0.63–1.04)	0.093	0.71 (0.59–0.85)	<0.001
III	0.65 (0.52–0.82)	<0.001	0.62 (0.47–0.81)	<0.001	0.64 (0.53–0.77)	<0.001
IV	0.69 (0.54–0.86)	0.001	0.71 (0.55–0.93)	0.012	0.71 (0.58–0.85)	<0.001
V	0.57 (0.45–0.73)	<0.001	0.56 (0.42–0.75)	<0.001	0.59 (0.48–0.72)	<0.001
P trend	0.001		0.001		<0.001	
Exercise intensity†						
None	Reference		Reference		Reference	
Low	0.56 (0.43–0.72)	<0.001	0.71 (0.51–0.97)	0.030	0.64 (0.52–0.80)	<0.001
Moderate	0.53 (0.41–0.69)	<0.001	0.59 (0.42–0.82)	0.002	0.57 (0.46–0.72)	<0.001
High	0.47 (0.32–0.69)	<0.001	0.42 (0.26–0.69)	0.001	0.47 (0.34–0.64)	<0.001
P trend	0.001		<0.001		<0.001	

CHD indicates coronary heart disease; and CVD, cardiovascular disease.

*For each analysis, participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), sex (male/female), race (white/nonwhite), education (<high school, high school, >high school), income (≤/ > \$25 000/y), clinical sites (4 categories), smoking (never, former, current), and body mass index (kg/m²). All physical activity variables were updated over time.

†See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined.

was missing because of loss to follow-up. PA was updated over time by means of cumulative averaging to minimize misclassification (measurement error) and to assess long-term effects of habitual activity. Walking (pace and blocks) was updated annually from baseline in 1989 to 1990 until 1998 to 1999. Leisure-time activity and exercise intensity were updated using data from baseline, 1992 to 1993, and 1996 to 1997. Multivariable models were adjusted for potential confounding factors including age, sex, race, education, income, enrollment site, smoking status, and body mass index. Time-varying covariates were updated at the same time periods as the PA measures. We separately evaluated factors that might be potential confounders or mediators of the effect of PA, such as body mass index, diabetes mellitus, hypertension, cholesterol levels, self-perceived health

status, depression, arthritis, cystatin-C, chronic obstructive pulmonary disease, forced expiratory volume, and forced vital capacity.

We also conducted several sensitivity analyses to minimize bias attributable to reverse causation because of undiagnosed CVD. First, we performed analyses with a 3-year lag between the PA measure and incident CVD events. Second, we restricted analyses to participants reporting only good, very good, or excellent overall health status. Potential effect modification was assessed by age, sex, and overall self-perceived health status in stratified analyses. Because PA is known to improve self-perceived health status, we recognized that the latter stratified analyses might represent overadjustment for a mediator of the causal effects.²⁵ Finally, we performed analyses with mutual adjustment for walking score, leisure-time activity, and

Table 3. Incidence of Cardiovascular Disease According to Different Types of Physical Activity Among Older US Adults, Stratified by Age and Sex*

	Hazard Ratios (95% Confidence Intervals) for Cardiovascular Disease							
	<75 y (69.4±2.6)	PValue	≥75 y (79.3±3.9)	PValue	Men	PValue	Women	PValue
No. of incidence/total	698/2926		484/1281		546/1633		636/2574	
Walking pace, mph								
<2	Reference		Reference		Reference		Reference	
2–3	0.67 (0.56–0.79)	<0.001	0.69 (0.57–0.83)	<0.001	0.64 (0.53–0.77)	<0.001	0.70 (0.59–0.84)	<0.001
>3	0.52 (0.40–0.67)	<0.001	0.39 (0.24–0.64)	<0.001	0.48 (0.35–0.66)	<0.001	0.52 (0.37–0.72)	<0.001
P trend	<0.001		<0.001		<0.001		<0.001	
Walking distance, blocks/wk								
0–5	Reference		Reference		Reference		Reference	
6–12	0.67 (0.51–0.88)	0.004	0.75 (0.58–0.96)	0.023	0.52 (0.38–0.71)	<0.001	0.80 (0.64–1.00)	0.052
13–25	0.67 (0.52–0.86)	0.002	0.69 (0.53–0.90)	0.006	0.55 (0.41–0.73)	<0.001	0.73 (0.57–0.92)	0.007
26–48	0.55 (0.42–0.71)	<0.001	0.58 (0.43–0.80)	0.001	0.43 (0.32–0.58)	<0.001	0.63 (0.48–0.83)	0.001
≥49	0.58 (0.44–0.75)	<0.001	0.43 (0.30–0.61)	<0.001	0.39 (0.29–0.53)	<0.001	0.69 (0.52–0.92)	0.011
P trend	<0.001		<0.001		<0.001		0.001	
Walking score†								
I	Reference		Reference		Reference		Reference	
II	0.79 (0.61–1.01)	0.062	0.71 (0.57–0.90)	0.004	0.57 (0.43–0.75)	<0.001	0.84 (0.68–1.03)	0.093
III	0.53 (0.41–0.69)	<0.001	0.59 (0.46–0.77)	<0.001	0.42 (0.32–0.56)	<0.001	0.62 (0.49–0.78)	<0.001
IV	0.53 (0.40–0.70)	<0.001	0.32 (0.21–0.47)	<0.001	0.34 (0.25–0.46)	<0.001	0.59 (0.44–0.79)	<0.001
P trend	<0.001		<0.001		<0.001		<0.001	
Leisure-time activity, kcal/wk								
I	Reference		Reference		Reference		Reference	
II	0.69 (0.54–0.89)	0.004	0.74 (0.56–0.96)	0.025	0.64 (0.46–0.90)	0.008	0.74 (0.59–0.92)	0.008
III	0.62 (0.48–0.80)	<0.001	0.69 (0.53–0.91)	0.009	0.55 (0.40–0.76)	<0.001	0.69 (0.55–0.87)	0.002
IV	0.74 (0.58–0.95)	0.017	0.65 (0.49–0.87)	0.004	0.62 (0.46–0.84)	0.002	0.76 (0.60–0.97)	0.025
V	0.59 (0.46–0.77)	<0.001	0.55 (0.40–0.76)	<0.001	0.54 (0.40–0.73)	<0.001	0.56 (0.41–0.77)	0.001
P trend	0.003		<0.001		0.003		0.001	
Exercise intensity†								
None	Reference		Reference		Reference		Reference	
Low	0.61 (0.45–0.84)	0.002	0.65 (0.48–0.87)	0.004	0.73 (0.50–1.04)	0.087	0.60 (0.46–0.78)	<0.001
Moderate	0.54 (0.39–0.74)	<0.001	0.58 (0.42–0.79)	0.001	0.63 (0.43–0.92)	0.015	0.54 (0.41–0.72)	<0.001
High	0.49 (0.33–0.73)	<0.001	0.30 (0.15–0.60)	0.001	0.61 (0.39–0.98)	0.040	0.35 (0.21–0.56)	<0.001
P trend	0.001		<0.001		0.022		<0.001	

*For each analysis, participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), sex (male/female), race (white/nonwhite), education (<high school, high school, >high school), income (≤/≥ \$25 000/y), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

†See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined.

exercise intensity, simultaneously in the model, to determine potential independent effects.

Analyses were performed using Stata 10.0 (College Station, TX), 2-tailed $\alpha=0.05$.

Results

At baseline, mean age was 72.5 years (standard deviation=5.5), 61% were women, and 21.7% were nonwhite (Table 1). About 4 in 5 (83%) reported good, very good, or excellent health status. During 41 995 person-years of follow-up between 1989 and 1999, 1182 CVD events occurred.

When we evaluated different aspects of walking, a greater pace, distance, and an overall walking score were each associated with lower risk of CVD (Table 2). In comparison with a

pace <2 mph, those that habitually walked at a pace >3 mph had 50%, 53%, and 50% lower risk of CHD, stroke, and CVD, respectively. Similarly, in comparison with individuals that walked 0 to 5 blocks per week, those that walked ≥49 blocks per week had 36%, 54%, and 47% lower risk of CHD, stroke, and CVD, respectively. When we assessed the combined effects of walking pace and distance by means of a prespecified walking score, a graded inverse relationship was evident with incidence of CHD, stroke, and CVD. Greater leisure-time activity and exercise intensity were also associated with lower risk of CHD, stroke, and CVD. With ischemic stroke, the associations were similar. Significant associations were not observed for hemorrhagic stroke, but comprised only 74

Table 4. Incidence of Coronary Heart Disease According to Different Types of Physical Activity Among Older US Adults, Stratified by Age and Sex*

	Hazard Ratios (95% Confidence Intervals) for Coronary Heart Disease							
	<75 y (69.4±2.6)	PValue	≥75 y (79.3±3.9)	PValue	Men	PValue	Women	PValue
No. of incidence/total	448/2926		314/1281		396/1633		366/2574	
Walking pace, mph								
<2	Reference		Reference		Reference		Reference	
2–3	0.65 (0.52–0.80)	<0.001	0.70 (0.55–0.89)	0.004	0.61 (0.49–0.76)	<0.001	0.73 (0.58–0.91)	0.006
>3	0.52 (0.38–0.73)	<0.001	0.40 (0.22–0.73)	0.003	0.47 (0.33–0.68)	<0.001	0.56 (0.36–0.87)	0.010
P trend	<0.001		<0.001		<0.001		0.001	
Walking distance, blocks/wk								
0–5	Reference		Reference		Reference		Reference	
6–12	0.71 (0.50–0.99)	0.044	0.99 (0.72–1.36)	0.950	0.61 (0.42–0.89)	0.010	1.02 (0.76–1.37)	0.912
13–25	0.71 (0.51–0.98)	0.035	0.95 (0.68–1.33)	0.777	0.62 (0.44–0.88)	0.007	0.96 (0.71–1.31)	0.816
26–48	0.54 (0.39–0.75)	<0.001	0.69 (0.46–1.03)	0.068	0.49 (0.35–0.70)	<0.001	0.68 (0.46–0.99)	0.043
≥49	0.60 (0.43–0.84)	0.003	0.63 (0.41–0.97)	0.035	0.48 (0.34–0.68)	<0.001	0.90 (0.61–1.32)	0.582
P trend	0.002		0.012		<0.001		0.149	
Walking score†								
I	Reference		Reference		Reference		Reference	
II	0.88 (0.64–1.22)	0.447	0.94 (0.70–1.26)	0.686	0.68 (0.49–0.95)	0.024	1.09 (0.82–1.44)	0.551
III	0.59 (0.42–0.81)	<0.001	0.76 (0.55–1.06)	0.110	0.49 (0.35–0.68)	<0.001	0.81 (0.59–1.11)	0.193
IV	0.57 (0.40–0.82)	0.002	0.48 (0.30–0.77)	0.003	0.42 (0.29–0.61)	<0.001	0.74 (0.49–1.12)	0.151
P trend	<0.001		0.002		<0.001		0.044	
Leisure-time activity, kcal/wk†								
I	Reference		Reference		Reference		Reference	
II	0.57 (0.42–0.78)	<0.001	0.68 (0.48–0.97)	0.032	0.69 (0.46–0.99)	0.049	0.59 (0.44–0.80)	<0.001
III	0.57 (0.42–0.77)	<0.001	0.79 (0.56–1.11)	0.177	0.59 (0.41–0.86)	0.007	0.72 (0.54–0.97)	0.030
IV	0.63 (0.46–0.85)	0.002	0.76 (0.53–1.09)	0.132	0.69 (0.49–0.99)	0.041	0.70 (0.51–0.96)	0.025
V	0.50 (0.37–0.69)	<0.001	0.66 (0.45–0.98)	0.041	0.58 (0.41–0.83)	0.003	0.53 (0.35–0.80)	0.003
P trend	0.001		0.105		0.028		0.008	
Exercise intensity†								
None	Reference		Reference		Reference		Reference	
Low	0.51 (0.35–0.74)	<0.001	0.58 (0.41–0.83)	0.002	0.68 (0.45–1.03)	0.071	0.47 (0.34–0.66)	<0.001
Moderate	0.51 (0.35–0.75)	0.001	0.51 (0.35–0.74)	<0.001	0.62 (0.41–0.93)	0.022	0.49 (0.35–0.69)	<0.001
High	0.45 (0.28–0.73)	0.001	0.39 (0.19–0.83)	0.013	0.61 (0.36–1.04)	0.070	0.35 (0.19–0.63)	<0.001
P trend	0.044		0.001		0.071		0.003	

*For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), sex (male/female), race (white/nonwhite), education (<high school, high school, >high school), income (≤/\$25 000/y), clinical sites (4 categories), smoking (never, former, current), and body mass index (kg/m²). All physical activity variables were updated over time.

†See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined.

events (Tables I and II in the online-only Data Supplement). Adjustment for factors that could be either potential confounders or mediators, including blood pressure, blood lipid levels, and C-reactive protein, did not appreciably alter the findings (Table III in the online-only Data Supplement).

Results were generally similar when stratified by sex, with similar associations between PA and CVD in both men and women (Tables 3–5). Results were also similar when stratified by age, with similar findings in adults <75 years of age or aged ≥75 at baseline. Findings were not appreciably altered in sensitivity analyses including a 3-year lag between the PA measure and incident CVD (data not shown). To minimize the possibility of reverse causation, we also restricted our analysis to participants reporting only good, very good, or excellent self-perceived overall health status. Findings were not

appreciably different (Figure, Table IV in the online-only Data Supplement). We also conducted post hoc analyses fully stratified by self-perceived health status (excellent, very good, good, fair, poor). Associations appeared very similar in those reporting either excellent, very good, or good health status; and possibly weaker in those reporting only fair health status (Table V in the online-only Data Supplement). Few participants (n=69) reported poor health status to derive meaningful conclusions in this category. Results were also not appreciably altered in several sensitivity analyses (data not shown), including further adjustment for characteristics that could be either confounders or mediators of these relationships (see Methods for listing).

When we mutually adjusted for each type of PA simultaneously, walking score remained significantly associated with lower risk of CHD, stroke, and CVD; exercise intensity

Table 5. Incidence of Stroke According to Different Types of Physical Activity Among Older US Adults, Stratified by Age and Sex*

	Hazard Ratios (95% Confidence Intervals) for Stroke							
	<75 y (69.4±2.6)	P Value	≥75 y (79.3±3.9)	P Value	Men	P Value	Women	P Value
No. of incidence/ total	326/2926		237/1281		212/1633		351/2574	
Walking pace, mph								
<2	Reference		Reference		Reference		Reference	
2–3	0.74 (0.58–0.96)	0.020	0.66 (0.50–0.87)	0.003	0.75 (0.56–1.02)	0.068	0.68 (0.54–0.86)	0.001
>3	0.50 (0.34–0.74)	0.001	0.36 (0.17–0.75)	0.006	0.45 (0.26–0.76)	0.003	0.48 (0.31–0.75)	0.001
P trend	<0.001		<0.001		0.002		<0.001	
Walking distance, blocks/wk								
0–5	Reference		Reference		Reference		Reference	
6–12	0.61 (0.42–0.90)	0.013	0.61 (0.43–0.86)	0.005	0.40 (0.24–0.64)	<0.001	0.68 (0.50–0.92)	0.011
13–25	0.59 (0.41–0.85)	0.005	0.49 (0.33–0.72)	<0.001	0.40 (0.26–0.62)	<0.001	0.59 (0.42–0.81)	0.001
26–48	0.56 (0.39–0.82)	0.002	0.47 (0.30–0.74)	0.001	0.33 (0.21–0.52)	<0.001	0.61 (0.43–0.87)	0.007
≥49	0.59 (0.40–0.85)	0.005	0.27 (0.15–0.49)	<0.001	0.29 (0.18–0.45)	<0.001	0.62 (0.43–0.91)	0.014
P trend	0.023		<0.001		<0.001		0.005	
Walking score†								
I	Reference		Reference		Reference		Reference	
II	0.64 (0.45–0.90)	0.012	0.55 (0.40–0.76)	<0.001	0.45 (0.29–0.69)	<0.001	0.63 (0.48–0.83)	0.001
III	0.48 (0.34–0.69)	<0.001	0.47 (0.33–0.67)	<0.001	0.36 (0.23–0.55)	<0.001	0.51 (0.37–0.69)	<0.001
IV	0.51 (0.35–0.75)	0.001	0.18 (0.09–0.36)	<0.001	0.27 (0.17–0.44)	<0.001	0.52 (0.35–0.76)	0.001
P trend	0.001		<0.001		<0.001		<0.001	
Leisure-time activity, kcal/wk†								
I	Reference		Reference		Reference		Reference	
II	0.99 (0.69–1.43)	0.954	0.68 (0.47–0.97)	0.031	0.67 (0.40–1.14)	0.142	0.85 (0.64–1.14)	0.273
III	0.72 (0.49–1.06)	0.095	0.57 (0.39–0.83)	0.003	0.60 (0.36–0.99)	0.049	0.60 (0.44–0.83)	0.002
IV	1.02 (0.71–1.47)	0.926	0.44 (0.28–0.68)	<0.001	0.62 (0.38–1.01)	0.057	0.74 (0.54–1.03)	0.074
V	0.76 (0.51–1.14)	0.184	0.37 (0.23–0.60)	<0.001	0.51 (0.31–0.83)	0.006	0.56 (0.37–0.85)	0.007
P trend	0.285		<0.001		0.018		0.002	
Exercise intensity†								
None	Reference		Reference		Reference		Reference	
Low	0.63 (0.40–0.99)	0.049	0.77 (0.50–1.19)	0.238	0.82 (0.43–1.54)	0.532	0.68 (0.47–0.98)	0.039
Moderate	0.55 (0.34–0.89)	0.014	0.58 (0.36–0.93)	0.025	0.75 (0.40–1.41)	0.372	0.53 (0.36–0.78)	0.001
High	0.46 (0.25–0.84)	0.011	0.14 (0.03–0.60)	0.008	0.60 (0.27–1.34)	0.212	0.34 (0.17–0.67)	0.002
P trend	0.016		0.001		0.189		<0.001	

*For each analysis, participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), sex (male/female), race (white/nonwhite), education (<high school, high school, >high school), income (≤/≥ \$25 000/y), clinical sites (4 categories), smoking (never, former, current), and body mass index (kg/m²). All physical activity variables were updated over time.

†See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined.

remained significantly associated with lower risk of CVD, but not CHD and stroke; and leisure-time activity was no longer significantly associated with CHD, stroke, or CVD (Table VI in the online-only Data Supplement).

Discussion

In this large prospective study among US men and women who were on average age 73 years at baseline, greater walking, leisure-time activity, and exercise intensity were inversely associated with CHD, stroke (especially ischemic stroke), and total CVD. To our knowledge, this is the first large prospective

community-based study including a large number of participants >70 years and having updated PA over time, to demonstrate independent associations of PA measures with lower incidence of CHD, stroke, and total CVD. Results were robust in a range of sensitivity analyses. When different types of PA were simultaneously evaluated, greater walking and, to a lesser extent, exercise intensity were independently associated with lower risk, whereas leisure-time activity was not independently associated with risk.

With aging, the risk of developing and dying of chronic diseases such as CVD increases dramatically.²⁶ In many countries in the world, the proportion of the population >60 years

is increasing faster than any other age group, and by 2050, older people are projected to outnumber children worldwide.²⁷ In addition, among older adults >60 years of age, 1 in 5 globally will be >80 years of age by 2050.²⁸ Low PA at least partly defines frailty in the elderly, which is associated with worse health outcomes including loss of mobility, greater number of falls, and hospitalizations.²⁹ It is clear that strategies to maximize health and functional capacity of older adults are needed to optimize health and quality of life, and maintain autonomy and independence, as well. CVD represents one of the greatest challenges to healthy aging, and our findings support a role for moderate PA later in life for reducing CVD risk.

Long-term regular PA provides numerous physiological benefits that provide biological plausibility to our findings. PA has a direct action on cardiac function by improving myocardial contraction, myocardial oxygen supply, and electric stability.³⁰ In addition, most major risk factors for CVD are modified by regular PA, including blood pressure, atherogenic lipoprotein levels, adiposity (especially visceral fat), insulin sensitivity, endothelial function, and inflammation.⁵ Some of the mechanisms

for these benefits include skeletal muscle insulin sensitization, maintenance or building of lean muscle mass, and reduction in visceral fat, which together reduce adipose tissue infiltration of proinflammatory cells, increase the production and liberation of anti-inflammatory myokines, and reduce expression of Toll-like receptors on monocytes and macrophages.³¹

Studies in largely middle-aged populations have suggested that moderate levels of PA, such as regular brisk walking, are associated with lower risk of CVD, including CHD and stroke.^{3,9,32–34} Our results are in agreement with these studies in predominantly middle-aged individuals and with a smaller number of studies focusing on adults >65 years of age.^{7–9,33,35–39} Only 2 previous studies focused on individuals aged ≥75 years,^{38,39} showing lower CHD or total mortality among those performing regular vigorous PA (≥2 times per week) in comparison with no vigorous PA.^{38,39} These 2 studies had a follow-up of only 18 months,³⁹ only assessed vigorous PA and not walking or leisure-time activity, and did not update PA over time using time-varying covariates to reduce misclassification and provide a better measure of habitual PA.

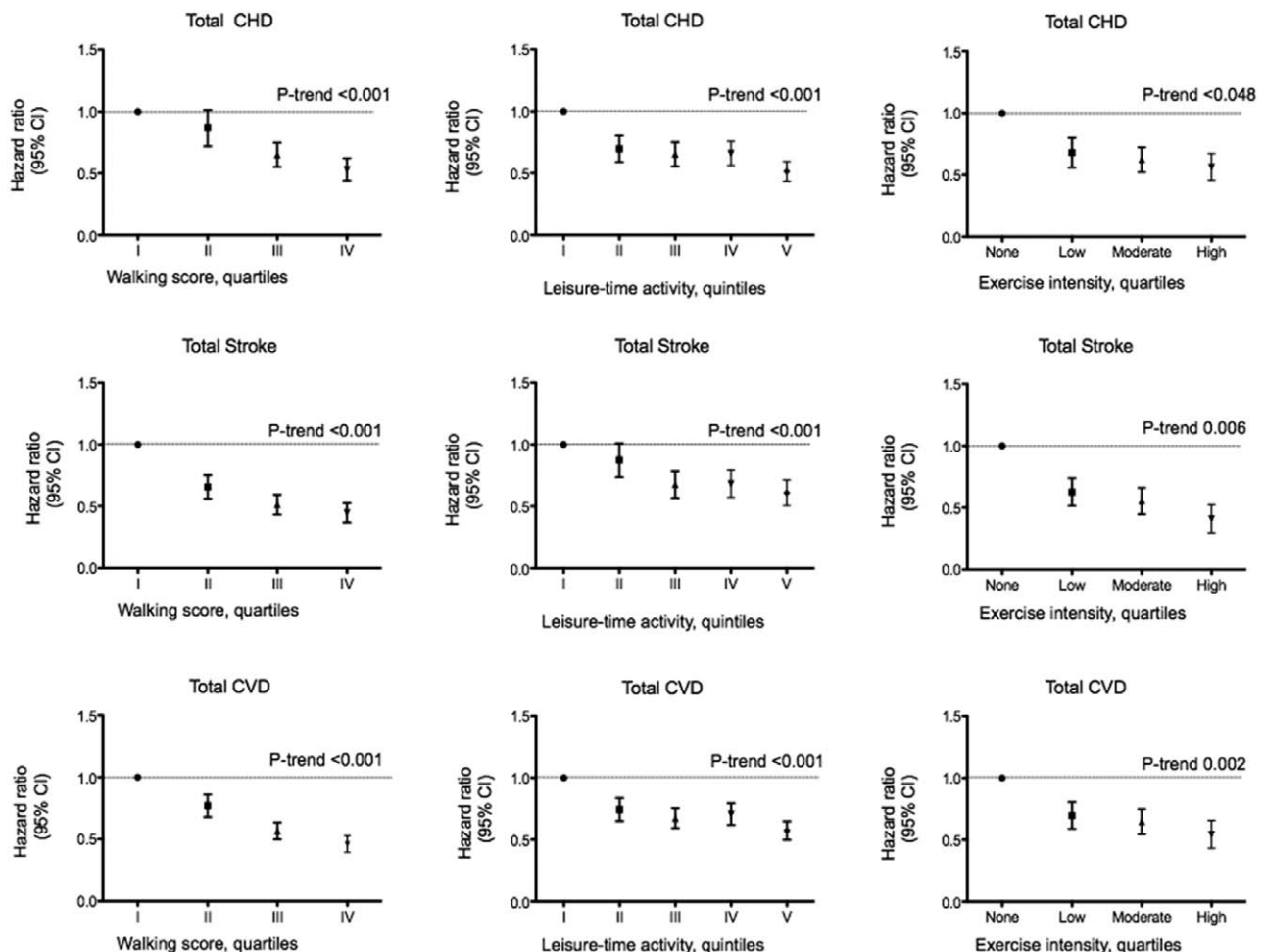


Figure. Incidence of CHD, stroke, and CVD according to different types of physical activity among older US adults, excluding participants with poor or fair self-reported health status at baseline.* Sample size excluded 454 participants in each analysis with missing data on self-reported health status. Values are hazard ratio (95% CI). *For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), sex (male/female), race (white/nonwhite), education (<high school, high school, >high school), income (≤/\$25 000/y), clinical sites (4 categories), smoking (never, former, current), and body mass index (kg/m²). All physical activity variables were updated over time. See text and Figure I in the online-only Data Supplement for details on how the physical activity variables were defined. CHD indicates coronary heart disease; CI, confidence interval; and CVD cardiovascular disease.

Our findings build on and considerably expand these previous results by evaluating cumulatively averaged PA; by assessing different components and types of PA; and by evaluating incidence of CHD, stroke, and total CVD in a well-established, community-based cohort of older US adults.

The American College of Sports Medicine and American Heart Association recommend that older adults engage in at least 30 min/d of moderate PA on most days of the week, 75 to 150 min/wk of vigorous intensity PA, or an equivalent combination of both.²⁶ Our results provide support for these clinical recommendations, providing empirical evidence that moderate PA, in particular walking, is associated with lower risk of CVD later in life, even in those ≥ 75 years of age. The observed benefits for higher exercise intensity are consistent with mechanistic studies suggesting that exercise-induced adaptation of cardiomyocyte maximal oxygen uptake and function/structure depends on exercise intensity.⁴⁰ These results are also in agreement with previous studies where high exercise intensity was associated with lower risk of all-cause mortality among older men (mean age, 66 years)⁷ or CHD among health professionals.⁴¹

Our analysis had several strengths. Participants were randomly selected and enrolled from Medicare eligibility lists in several US communities, providing a community-based sample of older adults, thus increasing generalizability. The distribution of self-reported health in our study is similar to a broad US cross section of contemporary Medicare enrollees,⁴² supporting the generalizability of our findings. Information on PA and other risk factors was prospectively assessed by using standardized methods and updated over time, reducing misclassification and providing a better measure of long-term habits. Adjustment for a wide range of major risk factors minimized the potential impact of residual confounding. CVD events were centrally adjudicated, with little loss to follow-up, reducing the possibility of missed or misclassified events. A large number of CVD, CHD, and ischemic stroke events provided statistical power and allowed confirmation of findings in key demographic subgroups, and sensitivity analyses, as well.

Potential limitations were also present. PA measures were obtained from self-report, and may appropriately reflect relative ordering (ranking) of participants but not precise quantitative levels of energy expenditure. In addition, health status was based on self-report, with similar limitations and strengths. Although a range of covariates were available and evaluated as potential confounders, and findings were similar in several sensitivity analyses, residual confounding remains an alternative explanation for the findings because of unknown or incompletely measured factors that cannot be excluded.

These data provide evidence supporting PA recommendations, in particular walking, as a way to reduce the incidence of CHD, stroke, and CVD among older adults. Our findings for walking distance and pace are especially important given that walking is the most common type of PA later in life; increasing either pace or distance seems to provide benefits. These results support the need for clinicians and policy makers to focus on regular PA as a way to maintain and promote cardiovascular health in older adults.

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Disclosures

None.

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CLINICAL PERSPECTIVE

One in every 3 adults in the United States has ≥ 1 type of cardiovascular disease (CVD); of these, about half are >60 years of age. National guidelines suggest that older adults engage in regular physical activity (PA) to reduce CVD, but surprisingly few studies have evaluated this relationship. Most previous studies were conducted in middle-aged participants, typically averaging 45 to 60 years of age. A small number of studies included individuals with average ages exceeding 65 years, and few data were available for individuals aged ≥ 75 years. We investigated whether usual PA, assessed by walking pace, distance, and overall walking score, leisure-time activity, and exercise intensity, was associated with the incidence of coronary heart disease, stroke, and CVD, among older adults with an average age of 72.5 years at baseline. After multivariable adjustment for major CVD risk factors, greater PA was inversely associated with coronary heart disease, stroke, and total CVD, even in those ≥ 75 years. These findings provide evidence supporting PA recommendations, in particular walking, as a way to reduce the incidence of coronary heart disease, stroke, and CVD among older adults. Our findings for walking distance and pace are especially important given that walking is the most common type of PA later in life; increasing either pace or distance seems to provide benefits. These results support the need for clinicians and policy makers to focus on regular PA as a way to maintain and promote cardiovascular health in older adults.

Physical Activity and Risk of Coronary Heart Disease and Stroke in Older Adults: The Cardiovascular Health Study

Luisa Soares-Miranda, David S. Siscovick, Bruce M. Psaty, W. T. Longstreth, Jr and Dariush Mozaffarian

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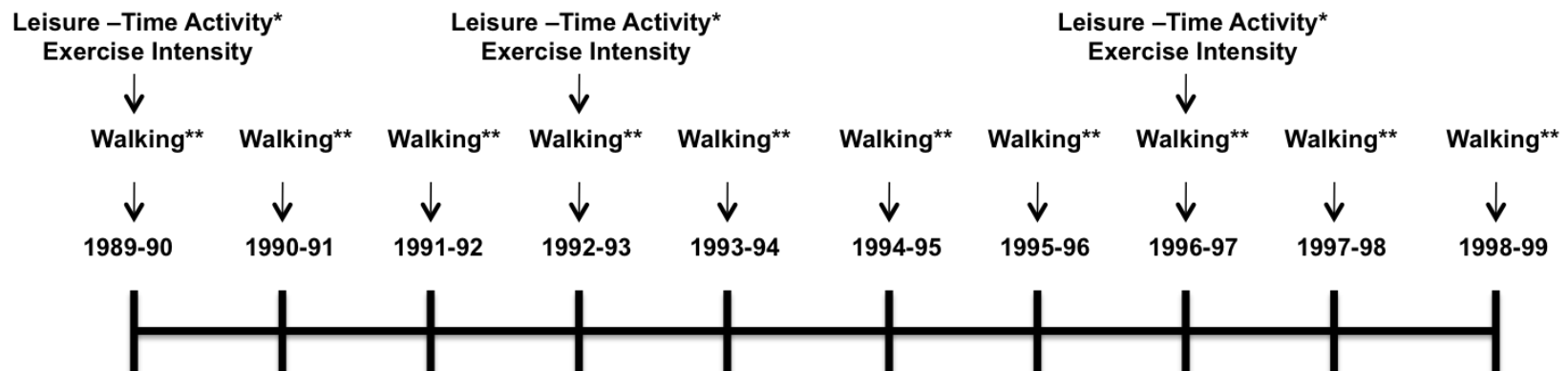
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SUPPLEMENTAL MATERIAL

Supplementary Figure 1. Timeline assessment of physical activity in the Cardiovascular Health Study from 1989/90 to 1998/99.



**Both distance and pace walking were assessed.

The 5,888 study participants were recruited from four U.S. communities and have undergone extensive clinic examinations for evaluation of markers of subclinical cardiovascular disease. The original cohort totaled 5,201 participants. A new cohort was recruited in 1992. The 687 participants in the new cohort are predominately African-American and were recruited at three of the four field centers.

Walking score is an ordinal score based on the combination of walking distance and walking pace. Exercise intensity was based on self-reported intensity of exercise, separately evaluated from kcal/week of leisure-time activity and walking.

Supplementary Table 1. Incidence of ischemic and hemorrhagic stroke according to different types of physical activity among 4,207 older US adults *.

Hazard ratios (95% confidence intervals) for Stroke				
	Ischemic Stroke		Hemorrhagic stroke	
<i>N° of incidence/total</i>	464/4207	<i>p</i>	74/4207	<i>p</i>
Walking pace, mph				
< 2	Reference		Reference	
2-3	0.63(0.51,0.77)	<0.001	1.29(0.76, 2.21)	0.348
> 3	0.47(0.33,0.68)	<0.001	0.40(0.13, 1.22)	0.106
<i>P trend</i>	<0.001		0.392	
Walking distance, blocks/week				
0-5	Reference		Reference	
6-12	0.58(0.44,0.77)	<0.001	0.85(0.40,1.78)	0.660
13-25	0.52(0.39,0.68)	<0.001	0.74(0.34,1.58)	0.435
26-48	0.44(0.32,0.60)	<0.001	0.93(0.43,1.99)	0.846
≥49	0.45(0.33,0.61)	<0.001	0.68(0.30,1.56)	0.363
<i>P trend</i>	<0.001		0.489	
Walking Score [†]				
I	Reference		Reference	
II	0.57(0.44,0.73)	<0.001	0.91(0.45,1.84)	0.791
III	0.42(0.32,0.56)	<0.001	0.81(0.39,1.68)	0.570
IV	0.39(0.28,0.54)	<0.001	0.63(0.27,1.50)	0.295
<i>P trend</i>	<0.001		0.272	
Leisure-time activity, kcal/week [†]				
I	Reference		Reference	
II	0.84(0.64,1.11)	0.228	0.55(0.26,1.17)	0.119
III	0.61(0.45,0.82)	0.001	0.79(0.40,1.57)	0.505
IV	0.72(0.54,0.97)	0.032	0.63(0.30,1.32)	0.223
V	0.58(0.42,0.80)	0.001	0.52(0.23,1.17)	0.114
<i>P trend</i>	0.001		0.216	
Exercise Intensity [†]				
None	Reference		Reference	
Low	0.74(0.52,1.05)	0.095	0.59(0.24,1.41)	0.236
Moderate	0.62(0.43, 0.90)	0.012	0.51(0.20,1.27)	0.149
High	0.39(0.22,0.69)	0.001	0.65(0.20,2.10)	0.474
<i>P trend</i>	0.001		0.445	

* For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

[†] See text and Supplementary Figure 1 for details on how the physical activity variables were define.

Supplementary Table 2. Incidence of ischemic stroke according to different types of physical activity among older US adults, stratified by age and gender *.

Hazard ratios (95% confidence intervals) for Ischemic Stroke								
<i>N° of incidence/total</i>	272/2926		192/1281		180/1633		284/2574	
	<75 years (69.4±2.6)	<i>p</i>	≥75 years (79.3±3.9)	<i>p</i>	Men	<i>p</i>	Women	<i>p</i>
Walking pace, mph								
< 2	Reference		Reference		Reference		Reference	
2-3	0.68(0.52,0.90)	0.006	0.58(0.42,0.79)	0.001	0.62(0.45,0.87)	0.005	0.65(0.50,0.84)	0.001
> 3	0.50(0.33,0.77)	0.002	0.37(0.17,0.82)	0.014	0.48(0.28,0.82)	0.008	0.46(0.28,0.75)	0.002
<i>P trend</i>	0.001		<0.001		0.002		<0.001	
Walking distance, blocks/week								
0-5	Reference		Reference		Reference		Reference	
6-12	0.60(0.40,0.91)	0.015	0.60(0.40,0.89)	0.010	0.38(0.22,0.64)	<0.001	0.67(0.48,0.94)	0.019
13-25	0.52(0.350,0.78)	0.001	0.53(0.35,0.81)	0.003	0.39(0.24,0.62)	<0.001	0.57(0.40,0.81)	0.002
26-48	0.48(0.32,0.72)	<0.001	0.41(0.24,0.68)	0.001	0.31(0.19,0.51)	<0.001	0.51(0.34,0.77)	0.001
≥49	0.52(0.35,0.79)	0.002	0.32(0.17,0.58)	<0.001	0.28(0.17,0.45)	<0.001	0.62(0.41,0.94)	0.025
<i>P trend</i>	0.005		<0.001		<0.001		0.003	
Walking Score [†]								
I	Reference		Reference		Reference		Reference	
II	0.62(0.43,0.91)	0.013	0.56(0.39,0.80)	0.001	0.43(0.27,0.68)	<0.001	0.64(0.47,0.86)	0.004
III	0.43(0.29,0.63)	<0.001	0.45(0.30,0.68)	<0.001	0.33(0.21,0.52)	<0.001	0.46(0.33,0.66)	<0.001
IV	0.47(0.31,0.71)	<0.001	0.20(0.10,0.42)	<0.001	0.25(0.15,0.42)	<0.001	0.52(0.34,0.79)	0.002
<i>P trend</i>	<0.001		<0.001		<0.001		<0.001	
Leisure-time activity, kcal/week [†]								
I	Reference		Reference		Reference		Reference	
II	1.10(0.74,1.64)	0.637	0.66(0.44,0.99)	0.044	0.70(0.40,1.25)	0.228	0.89(0.65,1.23)	0.479
III	0.68(0.44,1.06)	0.089	0.60(0.40,0.90)	0.015	0.59(0.34,1.02)	0.058	0.60(0.42,0.87)	0.006
IV	1.04(0.69,1.56)	0.856	0.46(0.28,0.74)	0.001	0.63(0.37,1.07)	0.087	0.77(0.54,1.11)	0.162
V	0.76(0.49,1.18)	0.229	0.42(0.25,0.72)	0.001	0.53(0.32,0.90)	0.018	0.57(0.36,0.91)	0.019
<i>P trend</i>	0.219		<0.001		0.037		0.008	
Exercise Intensity [†]								
None	Reference		Reference		Reference		Reference	
Low	0.61(0.40,1.00)	0.050	0.90(0.55,1.48)	0.671	0.87(0.43,1.75)	0.694	0.71(0.47,1.07)	0.103
Moderate	0.56(0.34,0.93)	0.026	0.65(0.38,1.11)	0.116	0.83(0.41,1.67)	0.604	0.55(0.35,0.85)	0.007
High	0.39(0.20,0.77)	0.006	0.20(0.05,0.88)	0.033	0.53(0.21,1.33)	0.179	0.34(0.16,0.72)	0.005
<i>P trend</i>	0.018		0.005		0.210		0.001	

* For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

[†] See text and Supplementary Figure 1 for details on how the physical activity variables were define.

Supplementary Table 3. Incidence of CHD, stroke and CVD according to different types of physical activity among older US adults, adjusting for blood pressure, blood lipid levels, and C-reactive protein.*

	Hazard ratios (95% confidence intervals)					
	Total CHD		Total Stroke		Total CVD	
<i>N° of incidence/total</i>	680/3815	<i>p</i>	513/3815	<i>p</i>	1069/3815	<i>p</i>
Walking-pace, mph						
< 2	Reference		Reference		Reference	
2-3	0.69(0.59,0.82)	<0.001	0.69(0.57,0.84)	<0.001	0.69(0.60,0.79)	<0.001
> 3	0.55(0.41,0.74)	<0.001	0.47(0.33,0.67)	<0.001	0.52(0.41,0.65)	<0.001
<i>P-trend</i>	<0.001		<0.001		<0.001	
Walking-distance, blocks/week						
0-5	Reference		Reference		Reference	
6-12	0.87(0.68,1.11)	0.253	0.57(0.44,0.75)	<0.001	0.71(0.58,0.85)	<0.001
13-25	0.90(0.71,1.15)	0.416	0.53(0.40,0.69)	<0.001	0.71(0.59,0.86)	<0.001
26-48	0.64(0.49,0.84)	0.001	0.53(0.40,0.70)	<0.001	0.58(0.47,0.71)	<0.001
≥49	0.71(0.54,0.93)	0.013	0.49(0.36,0.66)	<0.001	0.57(0.46,0.70)	<0.001
<i>P-trend</i>	0.002		<0.001		<0.001	
Walking-Score [†]						
I	Reference		Reference		Reference	
II	0.99(0.79,1.26)	0.984	0.57(0.45,0.73)	<0.001	0.77(0.64,0.92)	0.004
III	0.72(0.56,0.92)	0.010	0.47(0.36,0.61)	<0.001	0.57(0.47,0.69)	<0.001
IV	0.65(0.49,0.87)	0.003	0.43(0.31,0.58)	<0.001	0.50(0.40,0.62)	<0.001
<i>P-trend</i>	<0.001		<0.001		<0.001	
Leisure-time activity, kcal/week [†]						
I	Reference		Reference		Reference	
II	0.60(0.47,0.77)	<0.001	0.77(0.59,1.00)	0.048	0.68(0.56,0.82)	<0.001
III	0.66(0.52,0.84)	0.001	0.58(0.44,0.77)	<0.001	0.64(0.53,0.77)	<0.001
IV	0.69(0.54,0.88)	0.002	0.71(0.54,0.93)	0.013	0.71(0.58,0.86)	<0.001
V	0.56(0.43,0.73)	<0.001	0.53(0.39, 0.72)	<0.001	0.56(0.47,0.70)	<0.001
<i>P-trend</i>	0.001		<0.001		<0.001	
Exercise Intensity [†]						
None	Reference		Reference		Reference	
Low	0.56(0.43,0.74)	<0.001	0.68(0.48,0.96)	0.028	0.63(0.49,0.79)	<0.001
Moderate	0.53(0.40,0.70)	<0.001	0.55(0.38,0.78)	0.001	0.55(0.43,0.70)	<0.001
High	0.45(0.30,0.68)	<0.001	0.41(0.25,0.69)	0.001	0.44(0.31,0.62)	<0.001
<i>P-trend</i>	0.001		<0.001		<0.001	

CVD cardiovascular disease; CHD, coronary heart disease. *Sample size included fewer participants in each analysis due to missing data on blood pressure, blood lipid levels, and C-reactive protein. For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

† See text and Supplementary Figure 1 for details on how the physical activity variables were defined.

Supplementary Table 4. Incidence of CHD, stroke and CVD according to different types of physical activity among older US adults, excluding participants with poor or fair self-reported health status at baseline*.

	Hazard ratios (95% confidence intervals)					
	Total CHD		Total Stroke		Total CVD	
<i>N° of incidence/total</i>	578/3376	<i>p</i>	435/3376	<i>p</i>	911/3376	<i>p</i>
Walking-pace, mph						
< 2	Reference		Reference		Reference	
2-3	0.63(0.53,0.76)	<0.001	0.68(0.55,0.84)	<0.001	0.64(0.56,0.75)	<0.001
> 3	0.47(0.35,0.64)	<0.001	0.46(0.32,0.66)	<0.001	0.47(0.37,0.60)	<0.001
<i>P</i> -trend	<0.001		<0.001		<0.001	
Walking-distance, blocks/week						
0-5	Reference		Reference		Reference	
6-12	0.82(0.62,1.08)	0.163	0.57(0.42,0.78)	<0.001	0.69(0.55,0.85)	0.001
13-25	0.83(0.63,1.09)	0.172	0.57(0.42,0.77)	<0.001	0.68(0.55,0.84)	<0.001
26-48	0.61(0.45,0.82)	0.001	0.50(0.36,0.69)	<0.001	0.55(0.44,0.70)	<0.001
≥49	0.64(0.47,0.86)	0.003	0.48(0.34,0.66)	<0.001	0.53(0.42,0.67)	<0.001
<i>P</i> -trend	0.001		<0.001		<0.001	
Walking-Score [†]						
I	Reference		Reference		Reference	
II	0.92(0.71,1.21)	0.560	0.61(0.46,0.81)	0.001	0.76(0.62,0.93)	0.008
III	0.67(0.51,0.88)	0.005	0.48(0.36,0.65)	<0.001	0.56(0.45,0.69)	<0.001
IV	0.55(0.40,0.75)	<0.001	0.42(0.30,0.59)	<0.001	0.45(0.35,0.58)	<0.001
<i>P</i> -trend	<0.001		<0.001		<0.001	
Leisure-time activity, kcal/week [†]						
I	Reference		Reference		Reference	
II	0.65(0.49,0.87)	0.002	0.87(0.64,1.17)	0.353	0.73(0.59,0.91)	0.004
III	0.67(0.51,0.87)	0.003	0.64(0.47,0.88)	0.005	0.66(0.54,0.82)	<0.001
IV	0.66(0.50,0.86)	0.003	0.72(0.53,0.99)	0.041	0.70(0.56,0.86)	0.001
V	0.53(0.40,0.70)	<0.001	0.57(0.41, 0.80)	0.001	0.56(0.45,0.71)	<0.001
<i>P</i> -trend	<0.001		0.001		<0.001	
Exercise Intensity [†]						
None	Reference		Reference		Reference	
Low	0.64(0.46,0.89)	0.007	0.69(0.46,1.02)	0.062	0.68(0.52,0.89)	0.005
Moderate	0.62(0.45,0.87)	0.005	0.62(0.42, 0.93)	0.021	0.63(0.48,0.83)	0.001
High	0.56(0.36,0.87)	0.009	0.44(0.25,0.76)	0.003	0.52(0.36,0.75)	<0.001
<i>P</i> -trend	0.048		0.006		0.002	

CVD cardiovascular disease; CHD, coronary heart disease. * Sample size included 454 fewer participants in each analysis due to missing data on self-reported health status. For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

† See text and Supplementary Figure 1 for details on how the physical activity variables were defined.

Supplementary Table 5. Incidence of cardiovascular disease according to different types of physical activity among older US adults, stratified by health status*.

Hazard ratios (95% confidence intervals) for Cardiovascular Heart Disease					
<i>N° of incidence/total</i>	149/643	256/1051	436/1369	194/578	29/69
	Excellent	Very good	Good	Fair	Poor
Walking pace, mph					
< 2	Reference	Reference	Reference	Reference	Reference
2-3	0.73(0.48,1.12)	0.75(0.56,1.00)	0.59(0.48,0.72)	0.98(0.72,1.33)	1.03(0.29,3.64)
> 3	0.57(0.33,0.97)	0.61(0.39,0.95)	0.41(0.27,0.63)	1.34(0.69,2.63)	1.58 x10 ⁻¹⁵ (0,.)
<i>P trend</i>	0.04	0.02	<0.001	0.727	0.986
Walking distance, blocks/week					
0-5	Reference	Reference	Reference	Reference	Reference
6-12	0.62(0.29,1.29)	0.78(0.50,1.22)	0.60(0.45,0.82)	0.86(0.57,1.30)	0.42(0.06,2.81)
13-25	0.84(0.45,1.57)	0.81(0.52,1.25)	0.65(0.48,0.87)	0.73(0.47,1.11)	9.13(1.92,43.37)
26-48	0.85(0.45,1.60)	0.68(0.43,1.09)	0.46(0.33,0.64)	0.75(0.46,1.22)	3.01(0.20,46.5)
≥49	0.55(0.29,1.05)	0.61(0.38,0.99)	0.53(0.39,0.74)	0.79(0.47,1.34)	27.4(2.37,318.1)
<i>P trend</i>	0.135	0.045	<0.001	0.220	0.013
Walking Score [†]					
I	Reference	Reference	Reference	Reference	Reference
II	1.12(0.54,2.32)	0.83(0.54,1.28)	0.69(0.53,0.92)	0.86(0.59,1.25)	0.88(0.23,3.33)
III	0.95(0.47,1.92)	0.68(0.44,1.07)	0.47(0.35,0.64)	0.65(0.42,1.02)	4.09(0.80,20.8)
IV	0.60(0.28,1.28)	0.58(0.35,0.96)	0.45(0.32,0.63)	0.98(0.57,1.67)	5.21(0.37,72.9)
<i>P trend</i>	0.023	0.017	<0.001	0.362	0.115
Leisure-time activity, kcal/week [†]					
I	Reference	Reference	Reference	Reference	Reference
II	1.33(0.70,2.51)	0.40(0.26,0.61)	0.84(0.62,1.14)	0.81(0.53,1.25)	0.44(0.09,2.10)
III	0.84(0.44,1.63)	0.62(0.43,0.91)	0.69(0.51,0.94)	0.74(0.47,1.16)	0.66(0.11,3.97)
IV	1.04(0.56,1.92)	0.46(0.31,0.69)	0.80(0.58,1.10)	1.03(0.65,1.63)	1.58(0.34,7.36)
V	0.73(0.38,1.39)	0.39(0.25,0.61)	0.67(0.48,0.93)	0.86(0.51,1.43)	5.37(1.26,22.85)
<i>P trend</i>	0.121	<0.001	0.026	0.904	0.084
Exercise Intensity [†]					
None	Reference	Reference	Reference	Reference	Reference
Low	1.44(0.45,4.65)	0.43(0.26,0.72)	0.68(0.47,0.97)	0.69(0.43,1.11)	0.57(0.43,1.11)
Moderate	1.54(0.48,4.93)	0.40(0.24,0.67)	0.65(0.44,0.94)	0.55(0.33,0.91)	1.92(0.33,0.91)
High	1.15(0.33,4.00)	0.25(0.12,0.54)	0.66(0.40,1.08)	0.94(0.35,2.54)	3.46 x10 ⁻¹⁶ (0,.)
<i>P trend</i>	0.879	0.005	0.136	0.069	0.473

* For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

† See text and Supplementary Figure 1 for details on how the physical activity variables were define.

Supplementary Table 6. Incidence of CHD, stroke and CVD according to mutual adjusted analyses to different types of physical activity PA among 4,207 older US adults *.

	Hazard ratios (95% confidence intervals)					
	Total CHD		Total Stroke		Total CVD	
<i>N° of incidence/total</i>	762/4207	<i>p</i>	464/4207	<i>p</i>	1182/4207	<i>p</i>
Walking Score [†]	0.83(0.76,0.91)	<0.001	0.74(0.72,0.87)	<0.001	0.79(0.73,0.85)	<0.001
Leisure-time activity, kcal/week	0.98(0.92,1.06)	0.660	1.00 (0.92,1.09)	0.996	1.00(0.94,1.06)	0.939
Exercise intensity [‡]	0.89(0.79,1.00)	0.059	0.86(0.73,1.00)	0.054	0.88(0.80,0.97)	0.008

Mutually-adjusted analyses for walking score, leisure-time activity and exercise intensity. CVD cardiovascular disease; CHD, coronary heart disease. * For each analysis participants with prevalent disease at baseline were excluded. All analyses are adjusted for age (years), gender (male/female), race (white/nonwhite), education (< high school, high school, > high school), income (≤/ > \$ 25,000/yr), clinical sites (four categories), smoking (never, former, current), body mass index (kg/m²). All physical activity variables were updated over time.

[†] See text and Supplementary Figure 1 for details on how the physical activity variables were defined.