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Activities and Mortality in the Elderly: The Leisure World Cohort Study

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Background. Although physical activity has substantial health benefits and reduces mortality, few studies have examined its impact on survival beyond age 75.

Methods. Using the population-based Leisure World Cohort Study, we explored the association of activity on all-cause mortality in older adults (median age at baseline = 74 years). We followed 8,371 women and 4,828 men for 28 years or until death (median = 13 years) and calculated relative risks for various measures of activity at baseline using Cox regression analysis for four age groups (<70, 70–74, 75–79, and 80+ years) in men and women separately.

Results. Time spent in active activities, even ½ hour/day, resulted in significantly lower (15–35%) mortality risks compared with no time in active activities. This reduction was evident in all sex–age groups except the youngest men. Participants who reported spending 6 or more hours/day in other less physically demanding activities also had significantly reduced risks of death of 15–30%. The beneficial effect of activities was observed in both those who did and those who did not cut down their activities due to illness or injury. Neither adjustment for potential confounders, exclusion of the first 5 years of follow-up, nor exclusion of individuals with histories of chronic disease substantially changed the findings.

Conclusions. Participation in leisure-time activities is an important health promoter in aging populations. The association of less physically demanding activities as well as traditional physical activities involving moderate exertion with reduced mortality suggests that the protective effect of engagement in activities is a robust one.

Key Words: Mortality—Physical activity—Elderly—Exercise—Longitudinal.

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ALTHOUGH physical activity has been shown to have substantial health benefits and to reduce mortality, few studies have examined its impact on survival beyond age 75. Those including these elderly adults (1–21) have rarely reported age-stratified results (2,17) and one of these included only men (2). The relationship between activities and mortality might differ between elderly adults (≥75-year olds) and those who are younger and between men and women. Women on average live longer than men but generally have lower activity levels and engage in different activities. Combining men with women might obscure a relationship between activity and mortality (ie, reduce a positive association between physical activity and longevity). We hypothesized that a protective effect of physical activity might be attenuated in late life and differ between men and women. We therefore explored the association of activity on all-cause mortality in a large cohort (nearly 14,000) of elderly (median = 74 years) men and women with information on many potential confounders and followed for 28 years. Because our sample was large and the age range wide, we were able to look at the effect of activity in several age strata (<70, 70–74, 75–79, and 80+ years) and in both sexes.

Methods

The Leisure World Cohort Study was established to study the effect of modifiable lifestyle practices on longevity and successful aging when all residents of a California retirement community (Leisure World Laguna Hills) were mailed a postal health survey in 1981. New residents who moved into the community after this date were mailed the survey in 1982, 1983, and 1985. Of the 22,910 residents, 13,978 (61%) completed the questionnaire. The population and cohort are mostly Caucasian, well educated, upper-middle class, and elderly. The baseline survey asked demographic information, brief medical history, medication use, personal habits (including cigarette smoking, activities, alcohol consumption), and select food and beverage frequency intake.

Physical Activities

The amount of time spent on physical activities was ascertained by asking, "On the average weekday, how much time do you spend in the following activities?—Active outdoor activities (eg, swimming, biking, jogging, tennis, vigorous walking)—Active indoor activities (eg, exercising, dancing)—Other outdoor activities (eg, sightseeing, boating, fishing, golf, gardening, attending sporting events)—Other indoor activities (eg, reading, sewing, crafts, board games, pool, attending theater or concerts, performing household chores)—Watching TV." For each question, the response categories were 0, 15, 30 minutes, 1, 2, 3–4, 5–6, 7–8, 9 hours or more per day. The time spent per day in active activities was calculated by summing the times spent in active outdoor and active indoor activities; in other less physically demanding activities by summing the times spent in other outdoor and other indoor activities.

Additional questions included "Have you had to cut down or stop any activity you used to do because of some illness or injury?" and the usual number of hours of sleep each night and whether a nap was taken during the day.

Follow-up Questions on Activities

Two follow-up surveys included questions on activities. In 1983 surviving participants were asked, "How many hours a week, on average, do you usually spend in vigorous exercise (vigorous walking, biking, jogging, tennis, swimming, etc.)?" as well the hours per day spent watching TV and sleeping. In a second follow-up in 1985, participants were asked, "When you were 40 years old, did you regularly (at least once a week) engage in vigorous sports or recreational activities (such as swimming, hiking, tennis, basketball, jogging)?"

Potential Confounding Variables

Several factors previously found to be related to mortality in this cohort were included in analyses as potential confounding variables. We estimated daily caffeine intake by summing the frequency of consumption of each beverage and chocolate multiplied by its average caffeine content (milligrams/standard unit) as 115, 3, 50, 50, and 6 for regular coffee, decaffeinated coffee, tea, cola soft drinks, and chocolate, respectively (22). Consumption of alcoholic beverages was asked separately for wine, beer, and hard liquor and combined into number of alcoholic drinks per day (23). Body mass index (weight [kilograms]/height [meters] squared) was calculated based on self-reported height and weight at baseline and categorized according to federal guidelines: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9), and obese (30+) (24,25).

Determination of Outcome

Follow-up of the cohort is maintained by periodic resurvey, review of local hospital discharge data, determination of vital status by search of governmental and commercial death indexes, and ascertainment of death certificates. Participants were followed to death or December 31, 2009, whichever came first. To date 55 cohort members have been lost to follow-up; search of death indices did not reveal that these individuals were deceased.

Table 1. Characteristics of the Cohort by Sex*

	Women (n = 8,371)		Men (n = 4,828)	
	M	*SD*	*M*	*SD*
Age at baseline (y)	73	7.4	74	7.2
Age at last follow-up (y)	88	7.2	86	7.0
Follow-up years	15	7.7	12	7.3
Baseline characteristics				
Activities (h/d)				
Active outdoor	0.52	0.68	0.68	0.87
Active indoor	0.39	0.75	0.37	0.77
Other outdoor	0.75	1.1	1.2	1.6
Other indoor	3.7	2.2	2.4	2.0
Active	0.91	1.1	1.0	1.3
Other	4.4	2.6	3.6	2.7
Watching TV (h/d)	2.9	1.7	2.7	1.8
Sleep (h/night)	7.0	1.3	7.4	1.2
Alcohol (drinks/d)	1.2	1.2	1.6	1.5
Caffeine (mg/d)	169	166	177	172
Body mass index (kg/m^2)	23	3.5	24	2.9
	N	%	*N*	%
Medical history				
High blood pressure	3,410	41	1,755	36
Angina	800	9.6	711	15
Heart attack	554	6.6	793	16
Stroke	306	3.7	342	7.1
Cancer	1,069	13	448	9.3
Diabetes	419	5.0	402	8.3
Rheumatoid arthritis	554	6.6	217	4.5
Smoking				
Never	4,580	55	1,611	33
Past	2,733	33	2,799	58
Current	1,058	13	418	9
Napped during the day	2,748	32	2,371	49
Cut down activity due to illness or injury	2,919	35	1,685	35
Deceased by December 31, 2009	7,561	90	4,625	96

Note: *Differences between women and men were tested for significance using t tests for continuous variables and chi-squared tests for categorical variables; all differences were statistically significant ($p < .001$) except for body mass index ($p = .01$) and cut down activity due to illness or injury ($p = .97$).

Statistical Analysis

Relative risks (RRs) of mortality associated with the different activity variables were estimated using Cox regression analysis (26) with age as the fundamental timescale, age at death as the event of interest, and delayed entry as the age when the survey was completed. This analytic method uses the time from entry to death, not just death itself, in the calculation of the RRs. Analyses were done for four age-at-entry groups (<70, 70–74, 75–79, and 80+ years) in men and women separately.

To control for potential confounding factors, we adjusted in the regression analyses for age at entry (continuous),

Table 2. Relative Risks (RRs) for All-Cause Mortality by Category of Time Spent in Activities, Leisure World Cohort Study, 1981–2009, Women by Age Group*

	Age at Entry <70 y (*n* = 2,585)			Age at Entry 70–74 y (*n* = 2,136)			Age at Entry 75–79 y (*n* = 2,030)			Age at Entry 80+ y (*n* = 1,614)		
Activities h/d	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI
Active activities												
None	388	1.00		371	1.00		459	1.00		572	1.00	
¼	285	0.75	0.63, 0.90	234	0.86	0.73, 1.02	244	0.90	0.77, 1.05	250	0.96	0.82, 1.11
½	426	0.75	0.64, 0.88	401	0.79	0.68, 0.91	416	0.83	0.73, 0.95	284	0.77	0.67, 0.89
¾	269	0.66	0.55, 0.78	205	0.77	0.64, 0.91	193	0.73	0.62, 0.86	118	0.75	0.61, 0.92
1	720	0.64	0.56, 0.74	563	0.71	0.62, 0.81	490	0.77	0.68, 0.88	289	0.71	0.61, 0.82
2+	497	0.65	0.56, 0.76	362	0.72	0.62, 0.84	234	0.79	0.67, 0.92	101	0.68	0.55, 0.84
Other activities												
<2	237	1.00		197	1.00		241	1.00		263	1.00	
2	402	0.91	0.75, 1.09	340	0.94	0.78, 1.12	341	0.92	0.78, 1.09	308	0.77	0.65, 0.91
3	475	0.94	0.78, 1.12	462	0.82	0.69, 0.97	491	0.88	0.75, 1.02	381	0.86	0.74, 1.01
4	406	0.92	0.76, 1.10	285	0.76	0.63, 0.92	278	0.83	0.70, 0.99	188	0.71	0.59, 0.85
5	344	0.84	0.69, 1.01	330	0.77	0.64, 0.91	267	0.84	0.71, 1.00	216	0.73	0.61, 0.88
6+	721	0.86	0.72, 1.01	522	0.68	0.58, 0.81	418	0.80	0.68, 0.94	258	0.69	0.58, 0.82
Watching TV												
<5	518	1.00		406	1.00		372	1.00		266	1.00	
5	853	0.75	0.64, 0.89	673	0.97	0.82, 1.13	647	0.81	0.69, 0.95	530	0.96	0.80, 1.15
6	908	0.83	0.71, 0.96	776	1.02	0.89, 1.18	741	0.84	0.73, 0.97	598	0.99	0.85, 1.16
7+	306	0.84	0.72, 0.97	281	1.07	0.93, 1.23	276	0.94	0.82, 1.08	220	0.95	0.82, 1.11
Sleep at night												
<7	1,682	1.00		1,307	1.00		1,199	1.00		872	1.00	
7–8	719	1.11	1.01, 1.23	690	1.00	0.91, 1.10	667	1.05	0.96, 1.16	568	1.01	0.91, 1.12
9+	184	1.13	0.95, 1.35	139	1.03	0.86, 1.23	170	1.17	0.99, 1.37	174	1.09	0.92, 1.28
Nap												
No	1,996	1.00		1,483	1.00		1,288	1.00		856	1.00	
Yes	589	1.20	1.08, 1.34	653	1.09	0.99, 1.20	748	1.06	0.97, 1.16	758	1.14	1.04, 1.26
Cut down an activities												
No	1,885	1.00		1,431	1.00		1,305	1.00		831	1.00	
Yes	700	1.39	1.26, 1.54	705	1.34	1.22, 1.47	731	1.43	1.30, 1.56	783	1.22	1.11, 1.35

Note: CI, confidence interval.

*RRs are adjusted for age at entry.

smoking (never, past, current), alcohol intake (0, ≤1, 2–3, and 4+ drinks/day), caffeine consumption (<50, 50–99, 100–199, 200–399, and 400+ mg/day), body mass index (<18.5, 18.5–24.9, 25–29.9, and 30+ kg/m^2), and seven separate histories (no, yes) of hypertension, angina, heart attack, stroke, diabetes, rheumatoid arthritis, and cancer. In combined analyses for men and women, we adjusted for sex and tested for sex by activity interactions. For ordinal variables, a trend test was used to determine whether risk decreased or increased linearly. Statistical analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC). No adjustment in the *p* values was made for multiple comparisons.

Several additional analyses were performed. To account for the possibility that recent disease development may have altered activity levels as well as be related to mortality, we repeated the analyses excluding the first 5 years of follow-up. We also repeated the analyses excluding persons with major disease (hypertension, angina, heart attack, stroke, diabetes, rheumatoid arthritis, and cancer) at baseline. Additionally, we stratified by whether or not participants reported cutting down or stopping activities due to illness or injury.

Previous reports present details of the methods and validity of exposure and outcome data (27–31). The Institutional Review Boards of the University of Southern California and the University of California, Irvine approved the study.

Results

After excluding 779 participants with missing information on the activity, sleep, or potential confounding variables, we analyzed data on 13,199 participants (8,371 women and 4,828 men). At study entry, the participants ranged in age from 44 to 101 years (median = 74 years). By December 31, 2009, the participants had contributed 181,286 person-years of follow-up (median = 13 years) and 12,212 participants (7,582 women and 4,630 men) had died. Age at death ranged from 59 to 109 years (median = 88 years). Of these 13,199 participants, 9,264 completed the 1983 follow-up survey and 8,502 completed the 1985 follow-up survey.

Table 1 presents selected characteristics for the participants by sex. Differences between men and women were statistically significant ($p \leq .01$) for all variables except cut down activities due to illness or injury. Compared with men, women

Table 3. Relative Risks (RRs) for All-Cause Mortality by Category of Time Spent in Activities, Leisure World Cohort Study, 1981–2009, Men by Age Group*

	Age at Entry <70 y (*n* = 1,220)			Age at Entry 70–74 y (*n* = 1,199)			Age at Entry 75–79 y (*n* = 1,286)			Age at Entry 80+ y (*n* = 1,123)		
Activities h/d	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI
Active activities												
None	177	1.00		206	1.00		189	1.00		304	1.00	
¼	106	1.03	0.79, 1.34	142	0.79	0.63, 0.98	139	0.78	0.62, 0.97	131	0.94	0.76, 1.15
½	223	0.93	0.75, 1.16	204	0.75	0.62, 0.91	282	0.72	0.59, 0.86	226	0.86	0.72, 1.02
¾	132	1.06	0.83, 1.35	90	0.66	0.51, 0.85	101	0.69	0.54, 0.88	94	0.70	0.55, 0.88
1	323	1.01	0.83, 1.24	322	0.72	0.60, 0.86	317	0.68	0.57, 0.81	238	0.74	0.62, 0.88
2+ h	259	0.96	0.78, 1.18	235	0.61	0.50, 0.73	258	0.66	0.54, 0.79	130	0.79	0.64, 0.97
Other activities												
<2	273	1.00		259	1.00		320	1.00		340	1.00	
2	208	0.78	0.64, 0.95	226	0.84	0.70, 1.00	234	0.98	0.83, 1.16	257	0.88	0.74, 1.03
3	191	0.78	0.64, 0.96	218	0.85	0.71, 1.02	239	0.82	0.70, 0.97	194	0.86	0.72, 1.03
4	205	0.87	0.72, 1.06	183	0.74	0.61, 0.90	184	0.88	0.73, 1.06	114	0.94	0.76, 1.16
5	123	0.98	0.78, 1.23	118	0.73	0.58, 0.90	137	0.71	0.58, 0.87	100	1.04	0.83, 1.30
6+	220	0.82	0.67, 0.99	195	0.77	0.64, 0.93	172	0.77	0.64, 0.93	118	0.73	0.59, 0.90
Watching TV												
<5	242	1.00		273	1.00		267	1.00		296	1.00	
5	426	0.85	0.68, 1.05	403	0.88	0.72, 1.08	439	0.80	0.66, 0.98	329	0.82	0.67, 1.00
6	398	0.84	0.69, 1.03	368	0.90	0.74, 1.08	425	0.72	0.59, 0.86	359	0.77	0.63, 0.94
7+	154	0.93	0.76, 1.14	155	1.04	0.86, 1.26	155	0.83	0.69, 0.99	139	0.80	0.66, 0.98
Sleep at night												
<7	835	1.00		791	1.00		845	1.00		684	1.00	
7–8	263	1.02	0.87, 1.18	279	1.12	0.98, 1.29	290	0.96	0.84, 1.10	248	1.05	0.91, 1.21
9	122	1.41	1.16, 1.72	129	1.49	1.24, 1.80	151	1.18	0.99, 1.40	191	1.16	0.98, 1.36
Nap												
No	796	1.00		621	1.00		588	1.00		452	1.00	
Yes	424	1.10	0.98, 1.26	578	1.03	0.92, 1.15	698	1.07	0.96, 1.20	671	1.24	1.10, 1.40
Cut down an activities												
No	884	1.00		832	1.00		812	1.00		615	1.00	
Yes	336	1.54	1.34, 1.76	367	1.52	1.35, 1.73	474	1.49	1.33, 1.67	508	1.58	1.40, 1.78

Note: CI, confidence interval.

*RRs are adjusted for age at entry.

spent less time in active activities and sleeping, but more time in other less physically demanding activities or watching TV, and a smaller percentage took naps. Although the Pearson correlations among the four activity variables were all statistically significant ($p < .0001$) except for active outdoor exercise with other indoor exercise, none exceeded .2.

Tables 2 and 3 show the age-adjusted RRs of mortality for the various activity variables in four age strata (<70, 70–74, 75–79, and 80+ years) for women and men, respectively. The results for men and women were generally similar and there was no significant interaction between sex and time spent in activities on mortality risk. Any amount of time spent in active activities, even ¼ hour/day resulted in a lower risk of mortality compared with those who spent no time in active activities in all sex–age groups except the youngest men. This reduction increased as the amount spent in these activities increased up to ¾ hour/day, when the risk reductions ranged from 23% to 34%. After ¾ hour/day, the RRs tended to plateau but were still statistically significant (Figure 1). Participants who reported spending 6 or more hours/day in less physically demanding activities also had significantly reduced (about 15–30%) risks of mortality compared with those who spent less than 2 hours (Figure 2). The magnitude of the reduction increased as the reported time in these activities increased (test for trend, p value < .05 for all age–sex groups except the youngest and oldest men).

Watching TV generally had no significant effect on mortality. Taking a nap during the day was a small but significant risk factor for death in the youngest women and the oldest men and women, increasing risk by about 10–20%. Sleeping 9+ hours/night also increased risk, but the higher risk was significant only in men less than 75 years old, whose risk was about 40% higher compared with men who slept less than 7 hours/night.

The greatest observed risk was seen in participants who reported that they had cut down or stopped their activities due to illness or injury. The risk was increased by half in men and by 20–40% in women. However, the beneficial effect of participating in activities was observed in both those who did and those who did not cut down their activities (Table 4). The effect of participating in activities was greatest (up to 30–35% decreased risk of death for men and women combined) in those who reported the limitation.

Neither exclusion of the first 5 years of follow-up (including 1,804 early deaths) nor exclusion of 7,761 individuals with histories of hypertension, angina, heart attack,

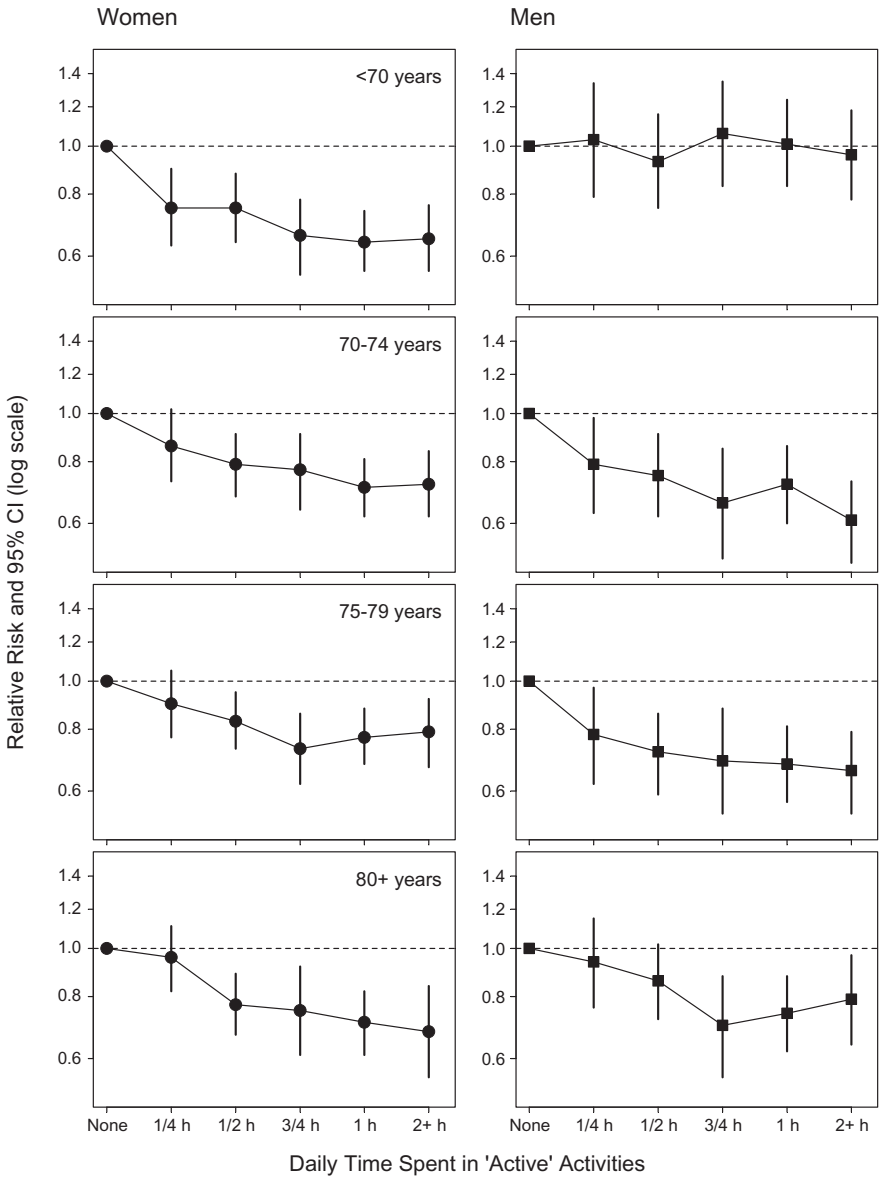

Figure 1. Relative risks of death for time spent in active activities by sex and age group.

stroke, diabetes, rheumatoid arthritis, or cancer substantially changed the findings for active and other less physically demanding activities (Table 5). Adjustment for potential confounders had little effect, attenuating the observed RRs only slightly. The multivariate-adjusted risk estimates changed by less than 10% and most remained statistically significant.

Report of hours spent in vigorous exercise, watching TV, and sleeping on a follow-up questionnaire completed approximately 2 years after the baseline survey showed that participants generally became less active (58% less active, 11% more active), slept longer (34% more sleep, 18% less sleep), and watched TV more (42% more TV, 15% less TV). However, those who reported having regularly engaged in vigorous activities at age 40 were twice as likely to have spent time in active activities at baseline (percentage spending 0, <1, 1, 2+ hours/day in active activities at baseline were 10%, 36%, 31%, 23% for those who engaged in vigorous activities at age 40 vs 22%, 41%, 24%, 13% for those who did not). Similarly, participation in vigorous exercise at the time of the 1983 follow-up survey differed between the two groups (16%, 45%, 30%, 9% vs 30%, 50%, 16%, 4% for 0, <1, 1, 2+ hours/day of vigorous exercise in 1983).

Discussion

Our study extends the available literature on the survival benefits of physical activity in the very old. We confirmed the suggestion of a beneficial effect of spending time in physical activities on all-cause mortality in elderly adults

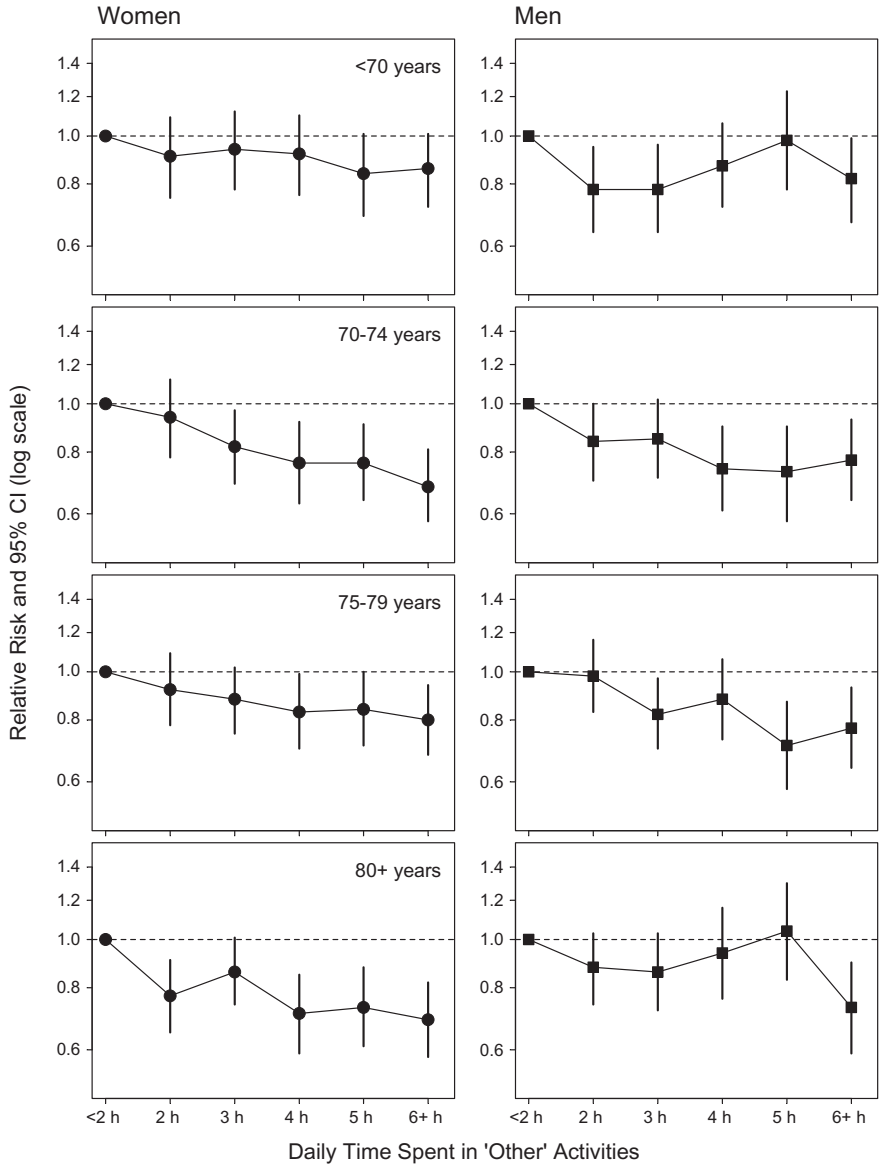

Figure 2. Relative risks of death for time spent in other less physically demanding activities by sex and age group.

observed in previous studies and additionally showed that engagement in other less physically demanding activities is associated with decreased risk. Our 28-year follow-up study found that all-cause mortality is lower among participants with daily participation of 15 minutes or more in active activities versus none and with participation of 6 hours or more in less physically demanding activities versus less than 2 hours.

Physical activity has well-documented health benefits, and its relationship with mortality has been explored by a large number of studies (reviewed in 32–34). A meta-analysis of 55 analyses (31 studies) reported an RR of death of 0.80 for physical activity (32). Most found a significantly decreased risk of mortality with increasing levels of physical activity (measured in vastly different ways). The inverse dose–response relationship has been shown in both men and women and in studies conducted in diverse countries (United States, Australia, Britain, Spain, The Netherlands, Denmark, Sweden, Finland, and other European countries) (1–21).

Far fewer studies have focused specifically on elderly adults. The Adventist Mortality Study of 9,484 men found that moderate activity was associated with a protective effect on mortality and decreased with increasing age (2). The hazard ratios were 0.60, 0.75, 0.75, 0.96, and 0.90 for moderate activity level versus low activity level for age groups 50–59, 60–69, 70–79, 80–89, and 90–99 years, respectively, and 0.63, 0.81, 0.92, 1.11, and 0.92 for high activity level versus low. As part of the Italian Silver Network Home Care project, 2,757 elderly adults with a health problem were

Table 4. Relative Risks (RRs) for All-Cause Mortality by Category of Time Spent in Activities, Leisure World Cohort Study, 1981–2009, Men and Women Combined, by Whether or Not Cut Down or Stopped Activities Due to Illness or Injury*

	Cut Down or Stopped Activity Due to Illness or Injury					
	No			Yes		
Activities h/d	*N*	RR	95% CI	*N*	RR	95% CI
Active activities						
None	1,350	1.00		1,316	1.00	
¼	890	0.90	0.83, 0.99	641	0.90	0.82, 0.99
½	1,614	0.88	0.81, 0.95	848	0.79	0.72, 0.86
¾	8,27	0.81	0.74, 0.88	375	0.76	0.67, 0.86
1	2,337	0.84	0.78, 0.90	925	0.70	0.64, 0.77
2+	1,577	0.84	0.78, 0.91	499	0.65	0.58, 0.72
Other activities						
<2	1,283	1.00		847	1.00	
2	1,473	0.90	0.83, 0.97	843	0.86	0.78, 0.95
3	1,701	0.88	0.82, 0.95	950	0.85	0.77, 0.93
4	1,269	0.88	0.81, 0.96	574	0.78	0.70, 0.87
5	1,074	0.83	0.76, 0.90	561	0.80	0.72, 0.90
6+	1,795	0.83	0.77, 0.89	829	0.68	0.61, 0.75

Note: CI, confidence interval.

*RRs are adjusted for age at entry and sex.

followed for at least 1 year (17). Active participants (physical activity for 2 or more hours per week) were 50% less likely to die compared with those with no or very low levels of physical activity. This inverse relationship was still significant in those greater than 80 years old. Although we found no evidence of an attenuation in the association of physical activity and reduced mortality in late life, we did find that high activity level (1+ hours/day) showed no greater reduction in risk than moderate activity (¼ to ¾ hour/day).

Likewise, few studies have analyzed the effect of less physically demanding activities on mortality in elderly adults and the different classifications used make comparisons difficult. The New Haven site of the Epidemiological Studies of the Elderly classified activities as "social" (attending church, going to movies, theater, or sporting events, playing games, etc.) and "productive" (gardening, preparing meals, shopping, community work, and employment) (10). In this study of 2,761 men and women aged 65 and older increased participation in either type of activity was associated with decreased mortality. In the Swedish Panel Study of Living Conditions of the Oldest Old, a 4-year follow-up analysis of 463 participants aged 77 and older, leisure activities were classified as "social-friendship" (visiting with friends), "social-cultural" (going to movies, theaters, concerts or museums, eating out, and participating in study groups), "solitary-sedentary" (reading and solving crossword puzzles), and "solitary-active" activities (gardening and engaging in hobbies) (35). Greater participation in "solitary-active" activities was associated with a significant reduction in mortality. The Aging in Manitoba Study of 2,291 participants aged 67–95 years followed for 6 years, classified these types of activities as "social activities" (visiting family and friends, church-related activities, travel, and sports), "solitary activities" (hobbies, handwork, music, art, theater, reading, and writing), and "productive activities" (volunteer work, housework, gardening, and yard work) (36). Greater overall activity level was associated with reduced mortality. Individually, only church-related activities and light housework or gardening were significantly associated with decreased mortality.

Current surveillance data indicate that approximately 50% of adults aged 65–74 years and 65% of those aged 75 years and older do not meet recommended levels of regular physical activity (37,38). In fact, using a national sample of

Table 5. Relative Risks (RRs) for All-cause Mortality by Category of Time Spent in Activities, Leisure World Cohort Study, 1981–2009, Men and Women Combined

	All Participants*			All Participants With Adjustment for Potential Confounders†			Excluding First 5 y of Follow-up*			Excluding Those With Disease at Baseline*		
Activities h/d	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI	*N*	RR	95% CI
Active activities												
None	2,666	1.00		2,666	1.00		2,058	1.00		954	1.00	
¼	1,531	0.88	0.83, 0.94	1,531	0.89	0.83, 0.95	1,290	0.93	0.86, 0.99	578	0.88	0.79, 0.98
½	2,462	0.81	0.76, 0.86	2,462	0.84	0.80, 0.89	2,150	0.87	0.81, 0.92	969	0.79	0.72, 0.87
¾	1,202	0.75	0.70, 0.81	1,202	0.79	0.74, 0.85	1,072	0.80	0.74, 0.87	519	0.76	0.68, 0.85
1	3,262	0.75	0.71, 0.79	3,262	0.78	0.74, 0.83	2,944	0.81	0.76, 0.86	1,412	0.78	0.72, 0.85
2+ h	2,676	0.73	0.69, 0.78	2,676	0.79	0.74, 0.84	1,881	0.79	0.74, 0.84	1,006	0.76	0.69, 0.84
Other activities												
<2	2,130	1.00		2,130	1.00		1,627	1.00		811	1.00	
2	2,316	0.88	0.83, 0.94	2,316	0.90	0.84, 0.95	1,945	0.92	0.86, 0.98	898	0.88	0.80, 0.98
3	2,651	0.86	0.81, 0.91	2,651	0.88	0.83, 0.93	2,315	0.93	0.87, 0.99	1,093	0.91	0.82, 1.00
4	1,843	0.83	0.78, 0.89	1,843	0.87	0.81, 0.93	1,652	0.90	0.84, 0.97	789	0.86	0.77, 0.95
5	1,635	0.81	0.76, 0.87	1,635	0.85	0.79, 0.91	1,457	0.87	0.81, 0.94	691	0.83	0.74, 0.92
6+	2,624	0.77	0.72, 0.81	2,624	0.79	0.75, 0.84	2,399	0.83	0.77, 0.88	1,156	0.80	0.72, 0.88

Note: CI, confidence interval.

*RRs are adjusted for age at entry and sex.

†RRs are adjusted for age at entry, sex, plus smoking, alcohol, caffeine, body mass index, high blood pressure, angina, heart attack, stroke, diabetes, rheumatoid arthritis, and cancer.

more than 3,000 adults from the Americans' Changing Lives study, Shaw and colleagues (39) found steady declines in leisure-time physical activity, beginning in midlife (about age 33) and growing steeper at progressively older ages. In addition, sex differences in physical activity widened over time with no narrowing in later life. This is consistent with our findings that 2+ hours/day participation in active activities declined more steeply with age in women (19%, 17%, 12%, and 6% for those aged <70, 70–74, 75–79, and 80+ years, respectively) than in men (21%, 20%, 20%, and 12%). Much of the excess decline in leisure-time physical activity among women found by Shaw and colleagues was due to sex differences in time-varying health factors. These may involve differences in the kinds of health conditions that men and women experience as they age. For example, rheumatoid arthritis, a condition which can limit physical activity substantially, is more common in older women than older men; 7% versus 4% in our study. However, our finding that participation in activities had a greater reduction in mortality among those who had cut down or stopped any activity due to illness or injury than those who had not suggests the importance of maintaining activity. Attending to health-related barriers faced by older women and men may help them to maintain an active lifestyle and prolong life.

Although our question about vigorous activity at age 40 was retrospective and subject to recall bias, those were active at age 40 were twice as likely to engage in active activities at older ages than those who did not. Recent promotion of physical activities to improve health (38) in young and middle-aged adults would thus appear to have not only short-term benefits but also help maintain physical activity in old age.

Like most previous studies reporting on the association of potential risk factors and mortality, our investigation is an observational study. Because in the general population health-promoting habits often cluster, individuals in observational studies who exercise may differ from those who do not in smoking, alcohol intake, medical history, etc. However, adjusting for other risk and potential confounding factors did not materially change the RRs observed for physical activity. Nonetheless, unrecognized and uncontrolled confounders cannot be ruled out in this or any observational study.

We acknowledge several limitations in our study. The indices of physical activities used are crude and self-reported and their reliability and validity were not ascertained. Although our data on potential confounders are also self-reported, previous studies in our population and others support the reliability of medical history of major chronic disease (27,30) and of self-reported height and weight (27). Another limitation is that changes over time in all potential risk factors may affect outcome. Additionally, as our participants were mostly white, highly educated, and of middle social–economic class, they may not be representative of the general population. Although this may limit the generalizability of our results, it offers the advantage of reduced potential confounding by race, education, social–economic class, and presumed access to health care.

This cohort also has the advantages of population-based prospective design, large sample size, and substantial data on important confounders, including factors previously found to be related to mortality and exercise. The long and almost complete follow-up resulted in a large number of outcome events. In addition, we had information on activities not often asked in an exercise survey.

Conclusions

Results in this large elderly cohort with long follow-up showing a decreased risk of mortality with physical activity suggest that participation in leisure-time activities is an important health promoter in aging populations. However, no additional benefit appears to accrue from more than a moderate amount of time spent in daily active activities. The beneficial effect seen for less physically demanding activities as well as for traditional physical activities involving moderate exertion suggests that the protective effect of engagement in activities is a robust one.

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References

1. Kaplan GA, Seeman TE, Cohen RD, Knudsen LP, Guralnik J. Mortality among the elderly in the Alameda County Study: behavioral and demographic risk factors. *Am J Public Health*. 1987;77:307–312.
2. Lindsted KD, Tonstad S, Kuzma JW. Self-report of physical activity and patterns of mortality in Seventh-Day Adventist men. *J Clin Epidemiol*. 1991;44:355–364.
3. Rakowski W, Mor V. The association of physical activity with mortality among older adults in the Longitudinal Study of Aging (1984–1988). *J Gerontol*. 1992;47:M122–M129.
4. Simonsick EM, Lafferty ME, Phillips CL, et al. Risk due to inactivity in physically capable older adults. *Am J Public Health*. 1993;83:1443–1450.
5. Sherman SE, D'Agostino RB, Cobb JL, Kannel WB. Does exercise reduce mortality rates in the elderly? Experience from the Framingham Heart Study. *Am Heart J*. 1994;128:965–972.
6. Ruigómez A, Alonso J, Antó JM. Relationship of health behaviors to five-year mortality in an elderly cohort. *Age Ageing*. 1995;24:113–119.
7. LaCroix AZ, Leveille SG, Hecht JA, Grothaus LC, Wagner EH. Does walking decrease the risk of cardiovascular disease hospitalizations and death in older adults? *J Am Geriatr Soc*. 1996;44:113–120.
8. Fried LP, Kronmal RA, Newman AB, et al. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. *JAMA*. 1998;279:585–592.
9. Bijnen FCH, Feskens EJM, Caspersen CJ, Nagelkerk N, Mosterd ML, Kromhout D. Baseline and previous physical activity in relation to mortality in elderly men: The Zutphen Elderly Study. *Am J Epidemiol*. 1999;150:1289–1296.

10. Glass TA, Mendes de Leon C, Marottoli RA, Berkman LF. Population based study of social and productive activities as predictors of survival among elderly Americans. *Br Med J*. 1999;319:478–483.
11. Lee I-M, Paffenbarger RS Jr. Associations of light, moderate, and vigorous intensity physical activity with longevity. The Harvard Alumni Health Study. *Am J Epidemiol*. 2000;161:293–299.
12. Aijo M, Heikkinen E, Schroll M, Steen B. Physical activity and mortality of 75-year-old people in three Nordic localities: a five-year follow-up. *Aging Clin Exp Res*. 2002;14(3 suppl):83–89.
13. Schroll M. Physical activity in an ageing population. *Scand J Med Sci Sports*. 2003;13:63–69.
14. Gregg EW, Cauley JA, Stone K, et al. Relationship of changes in physical activity and mortality among older women. *JAMA*. 2003;289:2379–2386.
15. Sunquist K, Qvist J, Sundquist J, Johansson S-E. Frequent and occasional physical activity in the elderly. A 12-year follow-up study of mortality. *Am J Prev Med*. 2004;27:22–27.
16. Knoops KTB, de Groot LCPGM, Kromhout D, et al. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE Project. *JAMA*. 2004;292:1433–1439.
17. Landi F, Cesari M, Onder G, et al. Physical activity and mortality in frail, community-living elderly patients. *J Gerontol A Biol Sci Med Sci*. 2004;59A:M833–M837.
18. Ahmad R, Bath PA. Identification of risk factors for 15-year mortality among community-dwelling older people using Cox regression and a genetic algorithm. *J Gerontol A Biol Sci Med Sci*. 2005;60A:1052–1058.
19. Yates LB, Djousse L, Kurth T, Buring JE, Gaziano JM. Exceptional longevity in men. Modifiable factors associated with survival and function to age 90 years. *Arch Intern Med*. 2008;168:284–290.
20. Ford J, Spallek M, Dobson A. Self-rated health and a healthy lifestyle are the most important predictors of survival in elderly women. *Age Ageing*. 2008;37:194–200.
21. Bembom O, van der Laan M, Haight T, Tager I. Leisure-time physical activity and all-cause mortality in an elderly cohort. *Epidemiol*. 2009;20:424–430.
22. Paganini-Hill A, Kawas CH, Corrada M. Non-alcoholic beverage and caffeine consumption and mortality: the Leisure World Cohort Study. *Prev Med*. 2007;44:305–310.
23. Paganini-Hill A, Kawas CH, Corrada M. Type of alcohol consumed, changes in intake over time and mortality: the Leisure World Cohort Study. *Age Ageing*. 2007;36:203–209.
24. National Heart, Lung, and Blood Institute. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report*. Bethesda, MD: National Heart, Lung, and Blood Institute; 1998. www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf. Accessed January 24, 2011.
25. Corrada M, Kawas CH, Mozaffar F, Paganini-Hill A. Association of body mass index and weight change with all-cause mortality in the elderly. *Am J Epidemiol*. 2006;163:938–949.
26. Cox DR. Regression models and life tables (with discussion). *J R Stat Soc B*. 1972;34:187–220.
27. Paganini-Hill A, Ross RK. Reliability of recall of drug usage and other health-related information. *Am J Epidemiol*. 1982;116:114–122.
28. Paganini-Hill A, Ross RK, Henderson BE. Prevalence of chronic disease and health practices in a retirement community. *J Chron Dis*. 1986;39:699–707.
29. Paganini-Hill A, Chao A, Ross RK, Henderson BE. Exercise and other factors in the prevention of hip fracture: the Leisure World Study. *Epidemiology*. 1991;2:16–25.
30. Paganini-Hill A, Chao A. Accuracy of recall of hip fracture, heart attack, and cancer: a comparison of postal survey data and medical records. *Am J Epidemiol*. 1993;183:101–106.
31. Paganini-Hill A. Risk factors for Parkinson's disease: the Leisure World Cohort Study. *Neuroepidemiol*. 2001;20:118–124.
32. Katzmarzyki PT, Janssen I, Ardern CI. Physical inactivity, excess adiposity and premature mortality. *Obes Rev*. 2003;4:257–290.
33. Lee I-M, Skerrett PJ. Physical activity and all-cause mortality: what is the dose-response relation? *Med Sci Sports Exerc*. 2001;3:S459–S471.
34. Blair SN, Cheng Y, Holder JS. Is physical activity or physical fitness more important in defining health benefits? *Med Sci Sport Exerc*. 2001;33:S379–S399.
35. Lennartsson C, Silverstein M. Does engagement with life enhance survival of elderly people in Sweden? The role of social and leisure activities. *J Gerontol B Psychol Sci Soc Sci*. 2001;56B:S335–S342.
36. Menec VH. The relation between everyday activities and successful aging: 6-year longitudinal study. *J Gerontol B* Psychol Sci *Soc Sci*. 2003;58B:S74–S82.
37. Center for Disease Control and Prevention. Prevalence of self-reported physically active adults—United States, 2007. *MMWR*. 2008;57:1297–1300.
38. U.S. Department of Health and Human Services. *Healthy People 2010, Volume II, Chapter 22 Physical Activity and Fitness*, 2nd ed. Washington, DC: U.S. Government Printing Office;2000.
39. Shaw BA, Liang J, Krause N, Gallant M, McGreever K. Age differences and social stratification in the long-term trajectories of leisure-time physical activity. *J Gerontol B Psychol Sci Socl Sci*. 2010;65:756–766.