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The association of physical activity with all-cause, cardiovascular, and cancer mortalities among older adults

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ABSTRACT

Objective. To evaluate the association of physical activity with all-cause, cardiovascular, and cancer mortalities among older adults.

Methods. A study sample consisting of 77,541 community-dwelling Taipei citizens aged ≥65 years was selected based on data obtained from the government-sponsored Annual Geriatric Health Examination Program between 2006 and 2010. Subjects were asked how many times they had physical activity for ≥30 min during the past 6 months. Mortality was determined by matching cohort identifications with national death files.

Results. Compared to subjects with no physical activity, those who had 1–2 times of physical activity per week had a decreased risk of all-cause mortality [hazard ratio (HR): 0.77; 95% confidence interval (CI): 0.71–0.85). Subjects with 3–5 times of physical activity per week had a further decreased risk of all-cause mortality (HR: 0.64; 95% CI: 0.58–0.70). An inverse dose–response relationship was observed between physical activity and all-cause, cardiovascular, and cancer mortality. According to stratified analyses, physical activity was associated with a decreased risk of mortality in most subgroups.

Conclusions. Physical activity had an inverse association with all-cause, cardiovascular, and cancer mortality among older adults. Furthermore, most elderly people can benefit from an active lifestyle.

Introduction

The health benefits of physical activity, including increased longevity or postponed premature mortality, have been supported by evidences from many epidemiological studies (Bellavia et al., 2013; Moore et al., 2012; Nocon et al., 2008; Wannamethee and Shaper, 2001; Wannamethee et al., 2001). Low cardiorespiratory fitness, which is closely related to physical activity, was observed to be responsible for the highest proportion of deaths in a large longitudinal study across age groups (Stofan et al., 1998; Sui et al., 2007; Sui et al., 2013). Although the association between physical activity and mortality has been examined extensively in the past years, most of the evidence has been derived from studies involving a combination of middle-aged and elderly subjects (Arrieta and Russell, 2008; Autenrieth et al., 2011; Bellavia et al., 2013; Moore et al., 2012; Nocon et al., 2008; Oguma et al., 2002; Wen et al., 2011). Fewer studies have been conducted to focus on only the older population (Balboa-Castillo et al., 2011; Bembom et al., 2009; Knoops et al., 2004; Schooling et al., 2006; Sundquist et al., 2004; Ueshima et al., 2010). Although physical activity may result in favorable physiological changes in all age groups, the association of physical activity and mortality among the elderly remains inconsistent. Furthermore, the magnitude of benefit for postponing premature mortality is unknown. Possible adverse effects of physical activity have been reported (Maron, 2000). The benefit of exercise has been reported to be attenuated in those aged 75 years or older who are extremely active (Sherman et al., 1994). Given the aging populations worldwide, the survival of older adults would be a major concern to caregivers and can also pose a burden to public health.

Many studies have been conducted to evaluate the association of physical activity with all-cause mortality. However, the evidence regarding the association between physical activity and cardiovascular disease (CVD) and cancer mortalities remains limited. Autenrieth et al. revealed that physical activity has a protective effect on all-cause, CVD, and cancer mortalities among participants aged 25–74 years (Autenrieth et al., 2011). However, Ueshima et al. observed that

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physical activity among older adults had an inverse association with all-cause and CVD mortalities, but the association between physical activity and cancer mortality remains unclear (Ueshima et al., 2010). Further studies are needed to examine the possible effects of physical activity on cancer mortality among older adults.

Older population has a higher incidence of multiple chronic diseases, which consists of a heterogeneous group of risk factors for mortality. It might be appropriate to evaluate them by using subgroups of diverse clinical characteristics. Furthermore, the clinical characteristics of older adults with different physical activity levels remain an interesting topic to investigate.

In this study, we analyzed a large cohort of 77,541 elderly people who were enrolled in the Annular Geriatric Health Examinations Program using detailed information regarding demographic, lifestyle, body mass index (BMI), cognitive and mood status, blood pressure, and laboratory data. We followed-up on the participants' vital status for 5 years, which totals 254,211 person-years of observation. The objective of this study was to evaluate the association of physical activity with all-cause, CVD, and cancer mortality among older adults. Furthermore, the large sample size of 77,541 older adults allowed us to focus on older people and perform stratified analyses to investigate the associations among each clinical characteristic subgroup.

Methods

Study population

Data for this study were obtained from the Taipei Geriatric Health Examination Database. A cohort consisting of 77,541 participants aged ≥65 years, including 39,365 men and 38,176 women, was evaluated. The participants were enrolled in the annual physical examination program for older adults, which is managed by the Taipei City Government, between May 1, 2006 and December 31, 2010. Participants voluntarily took part in the physical examination program and were encouraged to participate in the program on a yearly basis for a routine physical examination; however, only the results from the initial visit were used for analyses. Demographic informations, including marital status, educational level, smoking history, and alcohol consumption, were collected through self-administered questionnaires. During the medical check-up, measurements of height, body weight, and blood pressure were obtained in addition to a blood sample used for laboratory analyses. Identification data of the participants were encrypted before being analyzed by the researchers. The study was approved by the institutional review board of Taipei City Hospital (IRB No.: TCHIRB-1020417-E).

Measurement of physical activity

Physical activity data were collected through self-administered questionnaires. The participants were asked the number of times (0 times/week, 1–2 times/week, and 3–5 times/week) they performed physical activity for ≥30 min during the past 6 months.

Controlled variables

Baseline data, including age, sex, marital status (single, married/cohabiting), educational level (none, 1–6 years, 7–12 years, >12 years), smoking (frequently, occasionally, none), and alcohol consumption (frequently, occasionally, none), were collected. BMI was calculated as weight in kilograms divided by height in meters squared. The World Health Organization BMI categories were used for categorizing participants who were underweight (15–18.4 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥30 kg/m^2). Cognitive impairment was measured by the Short Portable Mental Status Questionnaire (SPMSQ), a widely used 10-item cognitive screening instrument (Pfeiffer, 1975; Wu et al., 2014). The 5-item Brief Symptom Rating Scale was used to screen subjects for possible depression and anxiety (Lung and Lee, 2008; Wu et al., 2014).

Height, weight, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured. Laboratory data, including fasting blood sugar (FBS), total cholesterol (TC), triglycerides (TG), aspartate transaminase (AST), alanine transaminase (ALT), albumin, creatinine, blood urea nitrogen (BUN), and hemoglobin levels were obtained. These measures of health were referred to as the clinical characteristics of the participants.

Outcome variables

Endpoints of this study included mortality data obtained between May 1, 2006 and December 31, 2010. Vital statistics of the participants were obtained by matching cohort identifications with computerized national death files. Information on the cause of deaths was coded according to 2 versions of the International Classification of Diseases (ICD); the 9th version was used for data from 2006 to 2008 (ICD-9 codes: 001–998) and the 10th version was used for data from 2009 to 2010 (ICD-10 codes: A00–Z99). Deaths attributed to CVD (ICD-9 codes: 390–459; ICD-10 codes: I00–I99) and cancer (ICD-9 codes: 140–239; ICD-10 codes: C00–D49) were coded as cause-specific.

Statistical analyses

Baseline characteristics were presented as means and standard deviations (SD) for continuous variables. Categorical variables were expressed as relative frequencies and compared with Chi square tests. Trend analysis was used to examine differences in clinical characteristics among physical activity levels. A Cox proportional hazards model was used to calculate the hazard ratios (HRs) for mortality. The proportional hazards assumption was proven to be sufficient after being tested by inspection [log ((−log)event) vs. log of event times]. The time of entry was the initial examination date (between May 1, 2006 and December 31, 2010), and the time of exit was the end of the follow-up period (December 31, 2010) or the date of death, whichever was earlier. The HR for different physical activity levels was calculated using a reference group (i.e., no physical activity group). Possible effect modification was assessed using further stratified analyses to evaluate the mortality risk of subgroups. HRs were also calculated to examine the association between physical activity level and cause-specific death from CVD and cancer, after controlling for demographics, socioeconomic data, lifestyle factors, and health status.

All analyses were conducted using the SAS 9.3 (SAS Institute Inc., Cary, NC, USA) and STATA 12.0 (STATA Corp., College Station, TX, USA) statistical software packages.

Results

The baseline characteristics of all participants are shown in Table 1. There were 77,541 participants with a mean age of 73.1 (SD = 6.6) years. The 5-year study period consisted of 254,211 person-years of observation with an average follow-up of 3.28 (SD = 1.30) years. Participants with more physical activity were likely to have the following characteristics: younger, male, married/cohabiting, higher educational level, non-smoker, drinker, normal weight, no cognitive impairment, and no depression.

The clinical characteristics of the participants for each physical activity level are presented in Table 2. Participants who had more physical activity had a lower SBP, DBP, FBS, TC, TG, and BUN and higher AST, ALT, albumin, and hemoglobin levels.

According to the Kaplan–Meier analysis, a reduction in survival probability was associated with a lower level of physical activity (Fig. 1). The 4-year survival rates for participants with 0 times/week, 1–2 times/week, and 3–5 times/week of physical activity were 89.7%, 93.6%, and 95.1%, respectively (log-rank test for equality of survivor functions, $P < 0.001$).

The results of the Cox proportional hazards model for all-cause mortality risk are shown in Table 3. As observed in model 1, participants with higher physical activity levels had a significantly lower risk of mortality compared to those without any physical activity. The association of physical activity on mortality, which attenuated after adjusting for demographics, socioeconomics, lifestyle, and clinical characteristics, was included in models 2 and 3. In the Cox regression analysis of model 3, participants who engaged in physical activity 1–2 times/week had a decreased mortality risk compared to those who had no physical activity (HR: 0.77; 95% confidence interval [CI], 0.71–0.85); participants who had physical activity 3–5 times/week had a further decrease in the mortality risk (HR: 0.64;