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ORIGINAL ARTICLE

The Effect of Resistance Exercise on All-Cause Mortality in Cancer Survivors

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Abstract

Objective: To examine the independent associations of leisure-time aerobic physical activity (PA) and resistance exercise (RE) on all-cause mortality in cancer survivors.

Patients and Methods: Patients included 2863 male and female cancer survivors, aged 18 to 81 years, who received a preventive medical examination between April 8, 1987, and December 27, 2002, while enrolled in the Aerobics Center Longitudinal Study in Dallas, Texas. Physical activity and RE were assessed by self-report at the baseline medical examination. Cox proportional hazards regression analysis was performed to determine the independent associations of PA and RE with all-cause mortality in participants who had a history of cancer.

Results: Physical activity in cancer survivors was not associated with a lower risk of all-cause mortality. In contrast, RE was associated with a 33% lower risk of all-cause mortality (95% CI, 0.45-0.99) after adjusting for potential confounders, including PA.

Conclusion: Individuals who participated in RE during cancer survival had a lower risk for all-cause mortality. The present findings provide preliminary evidence for benefits of RE during cancer survival. Future randomized controlled trials examining RE and its effect on lean body mass, muscular strength, and all-cause mortality in cancer survivors are warranted.

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Cancer is the second leading cause of death and accounts for 23% of all deaths in the United States.[1] In 2013, it was estimated that approximately 1.6 million new cancer cases would be diagnosed and 68% of survivors would live more than 5 years.[1] The number of cancer survivors will continue to increase each year with improvements to early detection and treatment. Although commonly associated with the period after treatment, *cancer survival* is defined as the time between cancer diagnosis and mortality. Cancer survival is associated with a decrease in health status, and it increases the risk for all-cause mortality.[2] Physical activity (PA) is a modifiable risk factor known to decrease the occurrence of disease and all-cause mortality[3] and may improve a cancer survivor's quantity and quality of life.[4-6]

Individuals who receive a diagnosis of cancer have an approximately 50% higher risk of noncancer mortality than the general population.[7] There is growing evidence to suggest that PA is beneficial for individuals who received a diagnosis of cancer.[8-13] Regular PA during cancer survival can lead to the maintenance of and/or improvements in body composition, physical function, and overall quality of life.[9] In addition, PA after diagnosis reduces the risk of cancer-specific mortality in breast cancer survivors[14-16] and decreases all-cause mortality in colorectal and prostate cancer survivors.[17,18] It is rational to think that resistance exercise (RE) training may also have similar benefits in cancer survivors as in healthy populations[19]; however, there is limited research on the effect of RE on all-cause mortality in cancer survivors. Furthermore, many questions remain on which type of PA may be most beneficial for cancer survivors. Therefore, the purpose of this study was to examine the effects of leisure-time aerobic PA and RE on all-cause mortality in cancer survivors. It was hypothesized that both PA and RE would be associated with a decreased risk of all-cause mortality in cancer survivors.

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PATIENTS AND METHODS

Study Population

Between April 8, 1987, and December 27, 2002, 3388 men and women aged 18 to 81 years with a previous diagnosis of cancer received a comprehensive preventive medical examination at the Cooper Clinic in Dallas, Texas, and were enrolled in the Aerobics Center Longitudinal Study, a prospective epidemiological investigation. It should be noted that specific information related to cancer diagnosis and treatment (ie, type, stage, and location) was not available at the time of baseline examination and therefore anyone who responded positively to the question "have you had any type of cancer" was included in the present analysis. Detailed information about the study population has been published previously.[20] Participants were sent to the clinic by their employers for examination, referred by their personal physician, or self-referred. Participants were volunteers and did not receive monetary assistance for participation. The study protocol was approved annually by the institutional review board of the Cooper Institute.

Participants were excluded from the final analysis if they were underweight (body mass index [BMI] <18.5 kg/m^2; n=101); had myocardial infarction (n=127) or stroke (n=32); died during first year of follow-up (n=115); or had missing data on RE (n=78) or PA (n=72). These criteria resulted in 2863 participants (859 women), who were followed until the date of death or December 31, 2003. Participants were predominantly white, well-educated, and within the middle to upper socioeconomic strata.[21]

Baseline Examination

Participants completed a comprehensive medical examination that included a physical evaluation by a physician, personal and family medical history questionnaire, anthropometry, blood pressure, and fasting blood chemistry. Detailed procedures regarding baseline measurements have been described previously.[20] Height and weight were measured, and BMI was computed as weight per square meter. Resting blood pressure was measured by trained technicians using standard ausculatory methods in a seated position and was recorded as the first and fifth Korotkoff sounds, respectively. Two readings separated by 1 minute were averaged. Overnight fasting serum concentrations of total cholesterol, triglyceride, and glucose were analyzed using standardized automated bioassays at the Cooper Clinic chemistry laboratory.

Baseline medical conditions were determined as having a physician diagnosis or measured phenotypes that met clinical thresholds. *Hypercholesterolemia* was defined as having total cholesterol levels of 240 mg/dL (6.2 mmol/L) or higher or physician diagnosis. *Diabetes* was defined as having fasting glucose levels of 126 mg/dL (7.0 mmol/L) or higher, the use of insulin, or physician diagnosis. *Hypertension* was defined as having a resting systolic blood pressure of 140 mm Hg or higher, a diastolic blood pressure of 90 mm Hg or higher, or physician diagnosis. Parental history of cancer, smoking habits (current smoker or not), and alcohol intake (number of drinks per week) were obtained from the medical questionnaire. Heavy drinking was defined as consuming 7 drinks or more per week for women and 14 drinks or more per week for men.

Leisure-Time Aerobic PA

Self-reported PA during the past 3 months was obtained from the medical questionnaire at baseline examination. Detailed procedures regarding the assessment of PA have been described previously.[22] In brief, a metabolic equivalent of task (MET) value was assigned to each PA contained within the medical questionnaire and then multiplied by the frequency and duration of each PA performed. Physical activity values were summated and represent the total volume of PA, which is expressed as the total MET-minutes per week. Meeting the current PA guidelines was defined as performing 500 or more MET-minutes/wk. In addition, we grouped participants into physically active and inactive on the basis of walking and jogging because they were the most common activities for the Aerobics Center Longitudinal Study population.[23]

Resistance Exercise

Resistance exercise was assessed by self-report on the medical history questionnaire. Participants were asked to provide yes or no answers to the following questions: (1) Are you currently involved in a muscle-strengthening program? (2) Can you specify the muscle-strengthening activity as "Calisthenics," "Free weights," "Weight training machines," or "Other"? (3) How many

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