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Physical activity, sedentary behavior and all-cause mortality among blacks and whites with diabetes

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ABSTRACT

Purpose: The study objective was to examine the role of physical activity (PA) and sedentary time (ST) on mortality risk among a population of low-income adults with diabetes.
Methods: Black (n = 11,137) and white (n = 4508) men and women with diabetes from the Southern Community Cohort Study self-reported total PA levels and total ST. Participants were categorized into quartiles of total PA and total ST. Hazard ratios (HRs) and 95% confidence intervals (CIs) for subsequent mortality risk were estimated from Cox proportional hazards analysis with adjustment for potential confounders.
Results: During follow-up, 2370 participants died. The multivariable risk of mortality was lower among participants in the highest quartile of PA compared with those in the lowest quartile (HR, 0.64; 95% CI: 0.57–0.73). Mortality risk was significantly increased among participants in the highest compared with the lowest quartile of ST after adjusting for PA (HR, 1.21; 95% CI: 1.08–1.37). Across sex and race groups, similar trends of decreasing mortality with rising PA and increasing mortality with rising ST were observed.
Conclusions: Although causality cannot be established from these observational data, the current findings suggest that increasing PA and decreasing ST may help extend survival among individuals with diabetes irrespective of race and sex.

Diabetes is the seventh leading cause of death in the United States [1]. When compared with those without diabetes, people with diabetes have a two-fold increase in relative risk of death [1,2]. Therefore, strategies to reduce premature death related to diabetes have important public health implications. Along with self-management behaviors such as dietary alterations and medication adherence, health care providers often recommend increased physical activity (PA) to those with diabetes [3,4]. Increased levels of PA have been found to increase insulin sensitivity and glucose tolerance, as well as positively impact serum lipid levels among individuals with type 2 diabetes [5].

Previous studies on the relationship between PA and all-cause mortality (hereafter referred to as mortality) among individuals with diabetes reported strong, inverse dose-response associations. However, these studies were conducted primarily among white males and populations with a low prevalence or absence of risk factors such as hypertension, obesity, hyperlipidemia, and poor glycemic control [6,7]. Moreover, most previous study populations comprised individuals from higher socioeconomic backgrounds, and thus, the results may not be generalizable to persons with diabetes of lower socioeconomic status.

Previous research conducted in the Southern Community Cohort Study (SCCS) examined the mortality experience among those with diabetes and reported that mortality risk was approximately 80% higher for those with versus without diabetes [8]. This study also observed that blacks with diabetes had a slightly lower mortality

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risk compared with whites with diabetes and similarly low socioeconomic status [8]. Herein, we examine the impact of PA and sedentary behavior on that mortality experience among a racially diverse population of low-income male and female adults with diabetes.

Methods

Subjects for this study were participants in the SCCS, an ongoing, prospective cohort study designed to examine health disparities in the incidence and mortality of chronic illnesses. Details of study methods are provided elsewhere [9–11]; in brief, study participants were 40–79 years of age at enrollment and recruited from community health centers (85%) and general population mailings (15%) across a 12-state area of the southeastern United States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia) between March 2002 and September 2009. On entry into the SCCS, personal computer-assisted interviews were conducted at the community health centers, while the general population recruits completed and mailed back an identical self-administered study questionnaire. The questionnaire ascertained information about demographic, socioeconomic, and anthropometric characteristics; personal and family medical history; PA; sedentary behaviors, tobacco and alcohol use; medication use; and other factors. The study population is unique, with black participants making up two-thirds of the study population and both black and white participants having similar, primarily low socioeconomic characteristics.

To be eligible for inclusion in the present analyses, subjects must have self-reported diabetes on the baseline questionnaire (responded yes to the question "Have you ever been told by a doctor that you had diabetes or high blood sugar or were treated for diabetes or high blood sugar?"). Participants were included in current analyses if they were diagnosed with diabetes after the age of 18 years and self-reported race as either "black" or "white." If participants were missing information regarding the age of diabetes diagnosis ("What was your age at first diagnosis for diabetes or high blood sugar?"), diabetes medication use ("Are you currently taking prescription medication, including insulin, to lower your blood sugar?"), total PA (summary measure of all activity), total sitting time (summary measure of all sitting behavior times), or demographics (age, sex, or race) they were excluded from all analyses. Thus, after excluding participants due to missing data ($n = 735$), the final analytic cohort was comprised 15,645 SCCS participants with adult-onset diabetes.

Assessment of PA

PA was assessed at baseline using the SCCS physical activity questionnaire, which was specifically developed for the SCCS to assess PA at home, work, and for leisure [12]. Time spent conducting light, moderate, and strenuous activity at home and work were assessed for weekdays and weekends, both separately and combined using weighted averages. Participants were asked how much time they "typically" spent doing an activity involving light, moderate, or strenuous work, and about time spent doing moderate or vigorous sports. The physical activity questionnaire also assessed sedentary time (ST) by asking how much time per day was typically spent sitting for five separate activities: in a car or bus, at work, watching television or movies, using a computer, or other sitting activities (i.e., talking on the phone, reading, or sitting at meals).

Physically active times were converted from hours per day into a summary measure of metabolic equivalent tasks (METs)—hours per day. MET-hour was chosen as the measurement of PA frequency and intensity because it is independent of weight [13]. MET values were based on the values suggested by the Compendium of Physical Activities [14]. The exposure for the analysis was calculated as total PA (total of light, moderate, and strenuous household and/or occupational work and moderate and vigorous leisure-time PA) in MET-hours per day. All sitting times were summed into total hours per day spent in ST.

Participants were categorized by quartiles of total PA and ST as calculated from the distribution among all included participants, rather than according to standard cutoffs which were developed based on younger, predominately white populations. However, we have conducted sensitivity analyses using the cutoffs recommended by the 2008 Physical Activity Recommendations, and the results were not substantially different.

Mortality ascertainment

The primary outcome was defined as death from any cause. Vital status and date of death were ascertained through linkage of the SCCS cohort with the Social Security Administration vital status service for epidemiologic researchers and the National Death Index through December 31, 2011 [8].

Statistical analysis

Person-years of follow-up began on the date of enrollment into the SCCS cohort and concluded on the date of death, date of loss to follow-up, or the end of the study period (December 31, 2011), whichever came first. Descriptive statistics for the study population were calculated, including means and standard deviations for continuous variables as well as counts and percentages for categorical or dichotomous variables. Values for blacks and whites were compared using χ^2 tests and one-way analysis of variance tests.

Cox proportional hazards models, using days of follow-up as the time scale, were constructed to estimate hazards ratios (HRs) and 95% confidence intervals (CIs) for mortality in relation to total PA and total ST, first separately and then mutually adjusted to determine whether the associations were independent of each other. The proportionality assumptions were tested using the goodness-of-fit testing and the log-log survival plots. The results did not indicate a violation of the proportional hazards assumption. Fully adjusted models included age at enrollment; race (black or white; not included in race-stratified models); sex (not included in sex-stratified models); body mass index ($<$25, 25–29.9, 30–39.9, and $\geq$40 kg/m^2); educational attainment (less than high school, high school graduate, and beyond high school); annual household income ($<$\$15, \$15–\$50K, and $\geq$\$50K); insulin use (yes or no); smoking (current, former, and never); hypertension, high cholesterol, or cardiovascular disease (myocardial infarction and/or bypass and stroke) prevalent at baseline (all yes or no); and duration of diabetes (years). Covariates were selected for inclusion in the model based on a thorough review of the relevant literature. Certain covariates, such as marital status, were not included if they did not impact the associations between PA or ST and mortality. Information regarding activity limitations was not readily available, and we thus adjusted for comorbid conditions which may limit the frequency or type of activity conducted.

The dose-response trend for total PA or total ST was evaluated by entering the categorical form of the variable as a continuous variable into a proportional hazards model with death as the outcome. The *P* value for the likelihood ratio test was used to test the interactions of PA or ST with race or sex. To explore whether PA and ST jointly influence mortality, we examined the joint associations for these exposures using tertiles.

Sensitivity analyses were conducted to evaluate the potential effect of exposure outliers for PA and ST. To determine whether