Protective Role of Resting Heart Rate on All-Cause and Cardiovascular Disease Mortality

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Abstract

Objective: To study the protective role of lower resting heart rate (RHR) in cardiovascular disease (CVD) and all-cause mortality.

Patients and Methods: Patients (n=53,322) who received a baseline medical examination between January 1, 1974, and December 31, 2002, were recruited from the Cooper Clinic, Dallas, Texas. They completed a medical questionnaire and underwent clinical evaluation. Patients with CVD or cancer or who had less than 1 year of mortality follow-up were excluded from the study. Relative risks and 95% CIs for all-cause and CVD mortality across RHR categories were estimated using Cox proportional hazards models.

Results: Highest cardiorespiratory fitness with lower mortality was found in individuals with an RHR of less than 60 beats/min. Similarly, patients with a higher RHR (≥80 beats/min) were at greater risk for CVD and all-cause mortality compared with an RHR of less than 60 beats/min. This analysis was followed by stratification of the data by hypertension, where hypertensive individuals with high RHRs (≥80 beats/min) were found to be at greater risk for CVD and all-cause mortality compared with those with hypertension and lower RHRs (<60 beats/min). In addition, unfit individuals with high RHRs had the greatest risk of CVD and all-cause mortality. The unfit with low RHR group had a similar risk for CVD and all-cause mortality as the fit with high RHR group.

Conclusion: Lower cardiorespiratory fitness levels and higher RHRs are linked to greater CVD and all-cause mortality.

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Heart rate is an important factor that is widely used in determining the health of an individual, especially overall cardiovascular (CV) health.[1] Tachycardia is a well-known predictor of CV disease (CVD) and related morbidity and mortality, with and without other CV risk factors, such as hypertension (HTN).[2] Two decades of epidemiologic data have suggested a significant association between higher CVD morbidity and mortality and increasing resting heart rate (RHR).[3-6] The RHR has been established as a parameter of great prognostic value, with high RHR serving as an indicator of increased CVD and all-cause mortality after controlling for platelet count, hemoglobin concentration, white blood cell count, total protein level, and other associated factors.[7] In patients with coronary heart disease (CHD), high RHR serves as an indicator of total and CVD mortality, irrespective of other major CHD risks factors.[3] High RHR has also been linked to higher numbers of deaths and CVD complications in patients with type 2 diabetes mellitus.[8] Several benefits are associated with lower RHR, which can potentially be achieved by regular physical activity (PA), which acts via the autonomic nervous system, with an increased relationship between vagal and sympathetic tone.[9]

Cardiorespiratory fitness (CRF) is a well-studied marker for assessing the risk of CVD and determining CV health in adults, adolescents, and children.[10-12] Daily PA, which can increase CRF, has significant positive effects on the musculoskeletal and CV systems and beneficial effects on metabolic, physiologic, endocrine, and immune mechanisms and function.[13] Lack of PA causes approximately 250,000 deaths per year in the United States,[14] whereas regular PA decreases the risk of CVD, delays the onset of high blood pressure (BP), and reduces BP in patients with HTN. In addition, lower CRF is associated with higher RHR.[15] Most large epidemiologic studies do not have objective measures of PA, but we

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have reported that a maximal treadmill exercise test can be a good indicator of habitual PA and is a strong predictor of mortality.[16]

In the present study, we assessed the relationship between RHR and CVD and all-cause mortality in fit and unfit patients with and without HTN in a large cohort from the Aerobics Center Longitudinal Study (ACLS).

PATIENTS AND METHODS

Study Population

Participants were recruited from the patients of Cooper Clinic, Dallas, Texas, who received a baseline medical examination between January 1, 1974, and December 31, 2002. The clinic serves anyone who elects to come for an examination, and patients come from all 50 states. Of 57,242 participants 20 years or older at baseline, we excluded individuals with CVD or cancer (n=2785) and those who had less than 1 year of follow-up for mortality (n=1135). These exclusion criteria were used to minimize potential bias due to underlying subclinical conditions that might affect mortality. The final analysis for the present study included 53,322 men and women. The ACLS was reviewed and approved annually by the institutional review board at the Cooper Institute. Participants read and signed an approved informed consent form before the baseline and follow-up medical examinations.

Instruments and Procedures

Medical Examination. Participants completed a medical history questionnaire consisting of questions about demographic characteristics, lifestyle habits (eg, smoking, drinking, and PA), and chronic disease history (eg, HTN, diabetes, and hypercholesterolemia). Participants also underwent a clinical evaluation including a treadmill maximum exercise test, body composition assessment, blood chemistry analysis, BP measurement, and a physical examination by a physician.

Self-reported Medical Information. As part of the medical questionnaire, participants self-reported the following: smoking status (current smoker or noncurrent smoker), alcohol use (heavy drinker if >14 drinks per week were consumed for men or >7 drinks per week were consumed for women), and PA (sedentary classification if no leisure time PA in the 3 months before the medical examination). High BP was defined as a measured systolic BP of 140 mm Hg or higher or diastolic BP of 90 mm Hg or higher. Participants also self-reported whether they were currently diagnosed as having HTN or diabetes or had a personal or parental history of CVD (myocardial infarction or stroke) or cancer.

Clinical Evaluation. Participants' clinical evaluations were completed after a 12-hour fast and have been described in detail elsewhere.[17,18] Briefly, height and weight were measured in light clothing and without shoes using a standard clinical scale and stadiometer. Body mass index was calculated as weight in kilograms divided by height in meters squared. Resting BPs were measured using mercury manometers following the American Heart Association protocol,[19] and measurement began after at least 5 minutes of seated rest. Two or more readings separated by 2 minutes were averaged. If the first 2 readings differed by more than 5 mm Hg, additional readings were obtained and averaged. The RHR was measured with the participants recumbent after a 5-minute rest and was obtained from the electrocardiogram. Fasting serum samples were analyzed for lipid and glucose levels using automated bioassays and in accordance with the Centers for Disease Control and Prevention Lipid Standardization Program. Cardiorespiratory fitness was quantified by the total time of a maximal symptom-limited treadmill test using a modified Balke protocol.[20] Participants were encouraged to reach their maximum effort, and the test was terminated once the participant requested to stop because of exhaustion or when the physician stopped the test for medical reasons. Classification of CRF was determined on the basis of quintiles of treadmill time for men and women in each age group (20-39, 40-49, 50-59, and ≥60 years) from the entire ACLS population, with the lowest 20% classified as "unfit" on the basis of earlier studies.[21,22]

Mortality Surveillance

For mortality surveillance, participants were followed up from the baseline examination through the date of death for decedents or December 31, 2003, for survivors. The National Death Index was the primary data source

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