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Cardiorespiratory Fitness in Middle Age and Health Care Costs in Later Life

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ABSTRACT

BACKGROUND Low cardiovascular risk factor burdens in middle age are associated with lower health care costs in later life. However, there are few data regarding the effect of cardiorespiratory fitness on health care costs independent of these risk factors.

OBJECTIVES This study sought to evaluate the association of health care costs in later life with cardiorespiratory fitness in midlife after adjustment for cardiovascular risk factors.

METHODS We studied 19,571 healthy individuals in the Cooper Center Longitudinal Study who underwent cardiorespiratory fitness assessment at a mean age of 49 years and received Medicare coverage from 1999 to 2009 at an average age of 71 years. Cardiorespiratory fitness was estimated by maximal metabolic equivalents (METs) calculated from treadmill time. The primary outcome was average annual health care costs obtained from Medicare standard analytical files.

RESULTS Over 126,388 person-years of follow-up, average annual health care costs were significantly lower for participants aged 65 years or older with high midlife fitness than with low midlife fitness in both men ($7,569 vs. $12,811; $p < 0.001$) and women ($6,065 vs. $10,029; $p < 0.001$). In a generalized linear model adjusted for cardiovascular risk factors, average annual health care costs in later life were incrementally lower per MET achieved in midlife in men (6.8% decrease in costs per MET achieved; 95% confidence interval: 5.7% to 7.8%; $p < 0.001$) and women (6.7% decrease in costs per MET achieved; 95% confidence interval: 4.1% to 9.3%; $p < 0.001$). These associations persisted when participants were separated into those who died during Medicare follow-up and those who survived.

CONCLUSIONS Higher cardiorespiratory fitness in middle age is strongly associated with lower health care costs at an average of 22 years later in life, independent of cardiovascular risk factors. These findings may have important implications for health policies directed at improving physical fitness. (J Am Coll Cardiol 2015;66:1876–85)

Physical inactivity is a global pandemic, with more than 30% of adults failing to achieve a meaningful level of daily activity (1). Moreover, physical inactivity is estimated to account for 6% to 10% of deaths from major noncommunicable diseases, such as coronary heart disease and type 2 diabetes (2). As such, physical inactivity represents a major burden on health care costs. The Medicare Board of Trustees has projected that Medicare costs will grow from 3.7% of the current U.S. gross domestic product to 5.7% by 2035 (3). Preventive health strategies with the potential to decrease health care costs, particularly with regard to Medicare, are of critical importance in the United States.

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Cardiorespiratory fitness is an objective measure of habitual physical activity and has been shown to be a risk factor for morbidity and mortality (4). Existing reports have examined the effects of fitness and physical activity on health care use and costs in the short term (5–7). Both cardiovascular risk factors (8) and an elevated body mass index (BMI) (9) in middle age are associated with increased health care costs in later life, suggesting that risk factor shifts in middle age could have implications for health care costs decades later.

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Because of the strong, independent association between fitness and long-term risk for both cardiovascular and noncardiovascular illnesses (4), we hypothesized that higher fitness levels in midlife would be associated with a lower burden of health care costs in later life. To test this hypothesis, we merged individual participant fitness data from the Cooper Center Longitudinal Study (CCLS) with Medicare administrative claims data, which allowed us to evaluate the association between fitness measured in midlife and health care costs decades later, in older age.

METHODS

STUDY POPULATION. The CCLS is an ongoing, prospective study at The Cooper Institute in Dallas, Texas that began in 1970 (10,11). Participants in the CCLS are self-referred or referred by other providers to the Cooper Clinic and are generally well-educated whites with access to health care. All patients seen at the Cooper Clinic are invited to participate in the study. CCLS participants receive a preventive medical examination that includes self-reported medical and lifestyle history, physical examination by a physician, anthropometric measurements, fasting laboratory studies, and a maximal treadmill exercise test. Participants sign an informed consent for inclusion in the research database. The study is reviewed and approved annually by the institutional review board of The Cooper Institute.

The study cohort initially consisted of 32,978 CCLS participants eligible for fee-for-service Part A and Part B Medicare coverage between 1999 and 2009 and who had been linked to Medicare research identifiable files. After excluding 4,019 participants who did not have a baseline exercise treadmill test between 1971 and 2009, we also excluded the following participants: 3,570 participants who lacked complete baseline data; 3,738 participants who did not have continuous fee-for-service Medicare coverage or received care from health maintenance organizations; 1,417 patients with previous myocardial infarctions, strokes, or cancer; and 663 participants who received Medicare coverage before age 65 years or who had a baseline examination after entering Medicare. This yielded a final study sample of 19,571 participants. Costs incurred after a participant changed to managed care or discontinued Part B Medicare coverage were censored. Participants were followed from the date of initiating Medicare coverage until death or the end of follow-up on December 31, 2009. Mortality data were obtained from the death indicator in Medicare data.

ABBREVIATIONS AND ACRONYMS

BMI = body mass index
CI = confidence interval
CVD = cardiovascular disease
MET = metabolic equivalent

MEASUREMENTS. Because of its objective nature and availability of data over decades in the CCLS, fitness was chosen as the primary explanatory risk factor. Cardiorespiratory fitness levels were estimated from the maximal time on a treadmill test using the modified Balke protocol (12). The test was terminated by volitional exhaustion reported by the participant or by the physician for medical reasons. The time on the treadmill with this protocol is highly correlated ($r = 0.92$) with measured maximal oxygen uptake in both men and women. Maximal metabolic equivalents (METs) (1 MET = 3.5 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$) were estimated by regression from the final treadmill speed and grade (13).

In accordance with standard approaches to the analysis of fitness data, the CCLS has historically compared treadmill times with age- and sex-specific normative data on treadmill performance so that each participant can be classified into age- and sex-specific quintiles of fitness (Online Table 1). These quintiles were then combined into 3 mutually exclusive fitness groupings: “low fit”: quintile 1 (Q1); “moderate fit”: quintiles 2 to 3 (Q2 to Q3); and “high fit”: quintiles 4 to 5 (Q4 to Q5). Due to their historical use in multiple CCLS papers, the MET cutpoints for the entire CCLS (Online Table 1) were applied to the cohort in this study (11,14). Although no uniform consensus for the precise range of low fitness exists, in previous work, the low-fit category was the most highly associated with increased morbidity and mortality (15). The measurements of other baseline variables in the CCLS have been well-described and were obtained in accordance with standard protocols (11).

HEALTH CARE COSTS. CCLS participant data were matched via direct identifiers (Social Security numbers, dates of birth) to the Medicare Provider Analysis and Review file (which contains inpatient and skilled nursing facility claims) and the Carrier, Durable Medical Equipment, Home Health Agency, Hospice, and Outpatient standard analytical files