Association of Ideal Cardiovascular Health and Long-term Healthcare Costs

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Introduction: The American Heart Association's (AHA's) 2020 Strategic Impact Goals introduced the concept of ideal cardiovascular (CV) health based on seven health factors and behaviors associated with lower CV disease (CVD) risk. The association between CV health and healthcare costs has not been reported; therefore, we evaluated the association between CV health profile and later-life healthcare costs.

Methods: Cooper Center Longitudinal Study participants (N=4,906; mean age, 56 years) receiving Medicare coverage from 1999 to 2009 were included. CV health behaviors (diet, physical activity, BMI, smoking) and CV health factors (blood pressure, total cholesterol, blood glucose) were categorized as unfavorable (zero to two ideal components); intermediate (two to four); and favorable (five to seven). Healthcare costs were cumulated from Medicare claims data, adjusted for inflation. Associations between midlife CV health status and non–CVD and CVD-related costs were estimated using multivariable quantile regression. Analyses were conducted in 2013 and 2014.

Results: Favorable CV health was prevalent in 14.8% of men and 30.1% of women, with <1% having ideal levels of all health metrics. After 31,945 person-years of Medicare follow-up, individuals with favorable CV health exhibited 24.9% (95% CI=11.7%, 36.0%) lower median annual non-CVD costs and 74.5% (57.5%, 84.7%) lower median CVD costs than those with unfavorable CV health. Annualized differences were greater for non-CVD costs than for CVD costs ($1,175 vs $566).

Conclusions: Having more ideal CV health components in middle age, as outlined by the AHA 2020 Goals, is associated with lower non-CVD and CVD healthcare costs in later life.
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Introduction

Maintaining optimal levels of all major cardiovascular disease (CVD) risk factors (i.e., "low CVD risk") strongly reduces risk for future cardiovascular events and reflects the importance of preventing CVD risk factor development to minimize long-term CVD risk.[1–4] Therefore, the American Heart Association's (AHA's) 2020 Strategic Impact Goals were established for the purpose of defining the concept of "cardiovascular health" and the metrics needed for monitoring it across populations.[5] CV health is composed of four health behaviors (diet, physical activity, smoking, and BMI) and three health factors (cholesterol, blood pressure, and blood glucose) and is assessed according to poor, intermediate, and ideal levels of each component. Overall, ideal CV health is defined by having ideal levels of all seven CV health components. Although the prevalence of ideal CV health has been shown to be low,[6] when present, it is associated with substantially (up to 90%) lower CV event rates compared with individuals that develop one or more traditional CVD risk factors.[7] Owing to the dramatic and inverse association between ideal CV health and CVD risk, the Strategic Impact Goals aim to improve the CV health of all Americans by 20% by 2020.[5]

Although the achievement of this 20% target would translate into obvious improvements in the CV health of the population, the strategy through which this might be realized remain incompletely understood. Achievement of these targets will require continued partnership with policymakers to encourage the drafting of public health policies

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(i.e., smoking legislation, the built environment, and others) that promote favorable health behaviors. Because support for these types of policies depend, at least in part, on a broader appreciation of their economic impact, we sought to characterize the association between ideal CV health metrics in middle age and both non–CVD and CVD-related healthcare costs in older age using data from the Cooper Center Longitudinal Study (CCLS). We hypothesized that ideal CV health would be associated with lower long-term healthcare costs.

Methods

Study Population

The CCLS is an updated continuation of the Aerobics Center Longitudinal Study, an ongoing, prospective study at the Cooper Institute in Dallas, TX, that began in 1970.[8–10] Patients evaluated at the Cooper Clinic and included as participants in the CCLS are generally well-educated, non-Hispanic Caucasians with access to health care. Patients receive a preventive medical examination that includes self-reported medical and lifestyle history, physician-administered physical examination, anthropometric measurements, fasting laboratory studies, and a maximal treadmill fitness assessment. Participants provide informed consent for inclusion in the research database. The study is reviewed and approved annually by the IRB of the Cooper Institute.

A total of 5,051 patients enrolled in the CCLS who had complete information to determine their midlife CV health status, including a 3-day dietary questionnaire collected from 1987 to 1999, and were enrolled in fee-for-service Medicare coverage between 1999 and 2009 were considered for inclusion in the study. After excluding 134 individuals with prior myocardial infarction or stroke and 11 individuals who received Medicare coverage before age 65 years or who had a baseline exam after entering Medicare, a final sample size of 4,906 was included in this analysis. Participants were followed from the date of initiating Medicare coverage until death or end of follow-up on December 31, 2009. Mortality was obtained from the death indicator in the Medicare data.

Measures

The measurements of baseline variables in the CCLS have been well described and were obtained in accordance with standard protocols.[8,9] BMI was calculated from measured height and weight. Seated resting blood pressure was obtained with a mercury sphygmomanometer. Fasting venous blood was assayed for serum cholesterol and glucose using standardized, automated techniques.

As part of a comprehensive medical history questionnaire reviewed by the clinic physician, CCLS participants responded to detailed physical activity questions. Specifically, participants indicated which of the following activities they participated in during the past 3 months: walking, jogging or running, treadmill, bicycling, stationary cycle, swimming, aerobic dance or floor exercise, vigorous activity (e.g., racquetball, singles tennis, skating), and other vigorous activity (e.g., basketball, soccer). For each activity, the number of sessions per week and the average duration of each workout were reported. It was then possible to estimate the amount of physical activity based on the frequency, duration, and intensity for each activity. Frequency and duration data were converted to minutes of activity per week. We weighted this value for each activity by multiplying by estimated METs derived from the Compendium of Physical Activities and summed across all activities.[11] Each participant was categorized according to the MET-minutes of physical activity reported per week (MET-minutes/week). For determination of ideal CV health, physical activity was categorized as unfavorable (0 MET-minutes/week); intermediate (1–499 MET-minutes/week); and ideal ($\geq$500 MET-minutes/week), based on the 2008 Physical Activity Guidelines for Americans.[12] In this context, a reported activity level of $\geq$500 MET-minutes/week is equivalent to the proposed ideal level of $\geq$150 minutes/week moderate or $\geq$75 minutes/week vigorous activity.[12]

As previously reported,[13,14] the nutrition data within the CCLS have been derived from a 3-day dietary record obtained during prior clinic visits from 1987 to 1999. Dietary records have been analyzed using the Food Intake Analysis System, versions 3.00 and 3.99. With these data, intake of fruits, vegetables, whole grains, fish, sodium, and sugar-sweetened beverages could be estimated.[15,16] Intake of the ideal level of each dietary component was scored with 1 point, for a range of 0–5. The dietary CV health metric was categorized as ideal if a dietary score of 4–5 was achieved. Details of the dietary scoring system are shown in Appendix A.

For each individual, a summary measure of all seven CV health components based on the established metrics for CV health defined by the AHA Planning Task Force and Statistics Committee[5] was used to stratify each individual into three mutually exclusive CV health levels: unfavorable (zero to two ideal characteristics); intermediate (three to four); and favorable (five to seven). These metrics as derived from the CCLS are summarized in Table 1.

The Medicare Provider Analysis and Review (MEDPAR) file and Standard Analytic Files (SAFs), obtained from the Center for Medicare and Medicaid Services via the Research Data Assistance Center at the University of Minnesota, contain 100% of claims reimbursed by Medicare. For each service billed to Medicare, records include the date of service, amount reimbursed by Medicare, the amount reimbursed by third-party insurance, and the amount for which the patient is responsible. The MEDPAR file contains costs associated with inpatient and skilled nursing facility claims, whereas the SAFs contain costs associated with provider claims, outpatient services, durable medical equipment, hospice, and home health agencies. Each claim has a principal diagnosis coded to the ICD-9-CM. The MEDPAR file and SAFs also contain information on hospitalizations and length of stay in both acute care hospitals as well as skilled nursing facilities. Claims data were available for CCLS participants who were aged $\geq$65 years during the 1999–2009 period and thus eligible for Medicare benefits.

Healthcare costs were calculated by combining actual amounts paid by Medicare and third-party insurance in addition to the amounts for which patients were liable in order to represent societal costs, consistent with other analyses using these data sets.[17] Healthcare costs were also cumulated for individual diagnoses by primary claim ICD-9 codes. For example, CVD-related costs were attributed to codes 390.x–459.x. Costs were then annualized by dividing by the total number of years of Medicare coverage. To account for inflation, healthcare costs were adjusted to 2009 dollars with the Hospital and Related Services component of the Consumer Price Index.[18]

Statistical Analysis

Means and frequencies of patient characteristics were calculated. Average and median annual costs as well as average lengths of stay for inpatient and skilled nursing facilities were calculated by CV