joyment in the present analyses. But greater enjoyment was associated with a 28% lower risk of death even after these factors, as well as depression and health behaviors, had been taken into account.

Other factors may be responsible for the remaining association between enjoyment and survival. It may be caused by unmeasured confounding factors such as other pre-existing illnesses. Only 3 health behaviors were assessed, and other aspects such as diet may be relevant. In addition, direct links with health outcomes are plausible, since biological responses such as reduced cortisol output in everyday life and attenuated cardiovascular and inflammatory responses to stress are related to positive well-being.7

The results of this study do not establish that enjoyment of life is causally related to survival. Enjoyment may be a marker of underlying health-related biological, behavioral, or dispositional factors that are responsible for the association. Nonetheless, our findings show that the link between enjoyment and survival at older ages is not fully accounted for by demographic factors or major pre-existing illnesses. These results highlight the importance of positive well-being in older adults and suggest that efforts to improve enjoyment of life, as well to manage and prevent disease, could have beneficial effects on life expectancy.

Andrew Steptoe, DSc
Jane Wardle, PhD


Correspondence: Dr Steptoe, Department of Epidemiology and Public Health, University College London, 1-19 Torrington Pl, London WC1E 6BT, England (a.steptoe@ucl.ac.uk).

Author Contributions: Dr Steptoe had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Steptoe and Wardle. Acquisition of data: Steptoe. Analysis and interpretation of data: Steptoe and Wardle. Drafting of the manuscript: Steptoe and Wardle. Critical revision of the manuscript for important intellectual content: Steptoe and Wardle. Statistical analysis: Steptoe and Wardle. Obtained funding: Steptoe. Administrative, technical, and material support: Wardle. Financial Disclosure: None reported.

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Disclaimer: The views expressed in this article are those of the authors and not necessarily of the funding bodies.


Healthy Eating Index and Mortality in a Nationally Representative Elderly Cohort

The Healthy Eating Index (HEI) is a tool developed by the US Department of Agriculture’s Center for Nutrition Policy and Promotion in 1995 for evaluating diet quality and monitoring changes in dietary practices in the US population.1 Prior studies have demonstrated an association between a “good” HEI score and lower incidence of cardiovascular disease2,3 and accompanying risk factors.4,5 However, literature on the prognostic utility of HEI in an exclusively geriatric population is sparse. We sought to investigate whether there is a correlation between favorable HEI scores and all-cause as well as cardiovascular mortality in the elderly US population.

Methods. The public access data set of the Third National Health and Nutrition Examination Survey between the years 1988 and 1994 (n = 33 994) was analyzed, and a total of 3884 patients aged 65 years or older with HEI data were included in our study. The HEI comprises 10 dietary components that measure diet quality. The original scoring system totals 100 points (optimal diet) and gives equal weight to all 10 components (0-10 each). The HEI accounts for age and sex when creating the index scores based on serving sizes. Details of the HEI score are available at ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/nhanes/nhanes3/6a/hei-acc.pdf. Our study population was stratified into 3 categories according to HEI scores (>80 indicates a “good” diet; 51-80, a diet that “needed improvement” [fair]; and <51, a “poor” diet).6,7 Mortality data up to December 31, 2006, were analyzed using national linkage records and death certificates (mean [SD] follow-up, 161.6 [48] person-months). Cardiovascular causes of mortality were identified using the International Statistical Classification of Diseases, 10th Revision codes. Univariate and multivariate Cox proportional regression analyses were carried out to calculate the hazard ratios (HRs) using all-cause mortality and cardiovascular death as the dependent variables. Baseline age, sex, diabetes, myocardial infarction, congestive heart failure, stroke, hypertension, race, body mass index, total cholesterol level, poverty to income ra-
Similar results were also obtained for cardiovascular death associated with a moderately lowered risk of cardiovascular disease. Studies that reported that HEI scores were associated with healthier lifestyles and better socioeconomic status.9 Similar to the results of our study, higher HEI scores have been previously linked to favorable health behaviors, such as physical activity, non-smoking, and higher use of preventive medical services.3,8 and shown to be associated with a lower body mass index.4 Modest associations between HEI scores and lower blood pressure were observed in the SU.VI.MAX study, but these findings were applicable only to men.9 Likewise, the possibility of a correlation between HEI and plasma biomarkers of chronic inflammation has also been reported.3

Our results are in agreement with 2 prior large cohorts: the Framingham Heart Study (15,035 participants, aged 53-99 years) and the SU.VI.MAX study (n=5081, aged 35-61 years), higher HEI scores were associated with healthier lifestyles and better socioeconomic status.9 Similar to the results of our study, higher HEI scores have been previously linked to favorable health behaviors, such as physical activity, non-smoking, and higher use of preventive medical services.3,8 and shown to be associated with a lower body mass index.4 Modest associations between HEI scores and lower blood pressure were observed in the SU.VI.MAX study, but these findings were applicable only to men.9 Likewise, the possibility of a correlation between HEI and plasma biomarkers of chronic inflammation has also been reported.3

Our study reveals that only 18% of the American population older than 65 years have a good HEI score, whereas the remaining 82% present opportunities for improvement (poor or fair HEI score). Despite a higher prevalence of comorbidities like hypertension, diabetes, smoking, coronary artery disease, and stroke, along with the advanced age in our study cohort, a good HEI score was found to reduce the risk of death by 37% (HR, 0.63). These results underscore the need for public health intervention in this population subset, with a “never too late” attitude. In addition to raising awareness, providing healthy alternatives and dietary instruction could have a favorable impact on cardiovascular outcomes in the elderly population.

![Figure](https://example.com/figure.png)

**Figure.** Kaplan-Meier curves for cumulative survival from all-cause mortality (A) and cardiovascular mortality (B) in the 3 Healthy Eating Index (HEI) groups.

### Results

The mean (SD) age of the study cohort was 73.5 (0.2) and the mean (SD) HEI score was 68.7 (0.4). In the “good,” “fair,” and “poor” HEI groups, the mean (SD) HEI scores were 85.3 (0.5), 67.2 (0.6), and 43.5 (0.8), respectively. A total of 2738 persons (70.5%) died during the follow-up of 9.6 person-years, with 1315 cardiovascular deaths (34%). The “good” HEI group, compared with the “fair” and “poor” groups, had fewer total deaths (62% vs 71% vs 78%, respectively [P=.001]) and cardiovascular deaths (33% vs 34% vs 36%, respectively [P=.001]). Healthy Eating Index scores were inversely associated with all-cause mortality on both univariate (HR, 0.991; 95% CI, 0.987-0.994 [P<.001]) and multivariate analyses (HR, 0.991; 95% CI, 0.988-0.994 [P<.001]). Similar results were also obtained for cardiovascular death (HR, 0.993; 95% CI, 0.988-0.997 [P=.002]). The figure shows the Kaplan-Meier survival estimates.

### Comment

Our findings suggest that a good HEI score is associated with a lower overall and cardiovascular mortality compared with a poor HEI score in the elderly US population. Interestingly, poverty to income ratio did not seem to affect the eating habits in the study population. Although the HEI has undergone several modifications in the past decade, we used the original HEI to conform to the dietary patterns and risk factors prevalent in the 1980s and 1990s.7

Our results are in agreement with 2 prior large cohort studies that reported that HEI scores were associated with a moderately lowered risk of cardiovascular disease (myocardial infarction or stroke) in men and women.2,3 A similar risk reduction in chronic disease, particularly for cardiovascular disease, was also reported by the same investigators using an “alternate” HEI.8 However, these studies evaluated a cohort of health care professionals who were mostly in their fifties, in contrast to our study that included a nationally representative cohort of elderly individuals.

There are several studies to explain the observed mortality benefit with a good HEI score. In the Supplementation en Vitamines et Mineraux Antioxydants (SU.VI.MAX) study (n=5081, aged 35-61 years), higher HEI scores were associated with healthier lifestyles and better socioeconomic status.9 Similar to the results of our study, higher HEI scores have been previously linked to favorable health behaviors, such as physical activity, non-smoking, and higher use of preventive medical services.3,8 and shown to be associated with a lower body mass index.4 Modest associations between HEI scores and lower blood pressure were observed in the SU.VI.MAX study, but these findings were applicable only to men.9 Likewise, the possibility of a correlation between HEI and plasma biomarkers of chronic inflammation has also been reported.3

Our study reveals that only 18% of the American population older than 65 years have a good HEI score, whereas the remaining 82% present opportunities for improvement (poor or fair HEI score). Despite a higher prevalence of comorbidities like hypertension, diabetes, smoking, coronary artery disease, and stroke, along with the advanced age in our study cohort, a good HEI score was found to reduce the risk of death by 37% (HR, 0.63). These results underscore the need for public health intervention in this population subset, with a “never too late” attitude. In addition to raising awareness, providing healthy alternatives and dietary instruction could have a favorable impact on cardiovascular outcomes in the elderly population.
The rising prevalence of overweight and obesity at older ages is projected to result in escalating Medicare spending. Although prior research on excess Medicare costs associated with overweight and obesity has assumed that these costs are similar over time, the health effects of excess weight may be changing, with significant implications for health care costs. For example, mortality associated with obesity has declined, while the association between obesity and disability has increased. It is unclear how changes in the health of the obese population have affected obesity-associated health care costs. Available evidence is conflicting and is based on estimated expenditures from the Medical Expenditure Panel Surveys (MEPS), which substantially underestimate spending. Using Medicare claims data, we examined whether trends in Medicare Part A and B spending differed by body mass index (BMI) over time (1997-2006).

Methods. The Medicare Current Beneficiary Survey (MCBS) is an institutional review board–approved, ongoing, nationally representative survey of Medicare beneficiaries that links up to 3 years of survey data to Medicare Part A and B claims. Community-dwelling MCBS respondents between 1997 and 2006 were included if they were 65 years and older and were covered by both Part A and B. Underweight participants and participants with missing data were excluded, yielding an analytic sample comprising 29,413 individuals, contributing 66,176 person-years of observations. All analyses were weighted to provide estimates that are nationally representative of beneficiaries meeting inclusion criteria.

Medicare expenditures were calculated as total Medicare payments for services covered by Part A and B and converted to 2006 dollars. Body mass index (calculated as weight in kilograms divided by height in meters squared) was corrected for self-report following methods described by Cawley and Burkhauser and was categorized as normal weight (18.5-24.9), overweight (25.0-29.9), or obese (≥30.0).

Demographic and socioeconomic covariates included age, sex, self-reported race/ethnicity, marital status, education, income in relation to the Federal poverty line, prior Social Security Disability Insurance status, census region, metropolitan status, and a mortality variable indicating whether participants died over the follow-up period. We predicted spending for each person-year using a generalized linear model with a gamma distribution and log link and used robust variance estimators to correct standard errors for repeated observations within individuals. Regression models predicted spending based on BMI categories, a continuous time term, and their interaction, controlling for demographic and economic covariates. Additional models controlled for 10 chronic conditions commonly linked to obesity (diabetes, hypertension, ischemic heart disease, hyperlipidemia, heart failure, chronic lung disease, osteoarthritis, hypothyroidism, gastroesophageal reflux disease, and sleep apnea) to explore whether changes in spending were accounted for by changes in comorbidity over time. All analyses were conducted using Stata statistical software (version 10; StataCorp).

Results. The prevalence of obesity increased from 21% in 1997 to 29% in 2006. Obese participants in the later period were more likely to be male, were less likely to be widowed, and had higher education and income levels than those in the earlier period. They were also more likely to have chronic conditions such as diabetes and hypertension relative to obese participants in 1997.

The Figure shows average Medicare spending by BMI status and time in constant 2006 dollars. In 1997, the mean

![Figure. Mean Medicare expenditures by body mass index category and time: Medicare Beneficiaries, 1997-2006. *In 2006 constant dollars.](https://archinte.jamanetwork.com/)

**Changes in the Association Between Body Mass Index and Medicare Costs, 1997-2006**

The Figure shows average Medicare spending by BMI status and time in constant 2006 dollars. In 1997, the mean

**Table:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Normal</th>
<th>Overweight</th>
<th>Obese</th>
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<tbody>
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<td>1997</td>
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**Figure:** Mean Medicare expenditures by body mass index category and time: Medicare Beneficiaries, 1997-2006. *In 2006 constant dollars.