Coronary Heart Disease Mortality Among Young Adults in the U.S. From 1980 Through 2002: Concealed Leveling of Mortality Rates
Earl S. Ford, and Simon Capewell

J. Am. Coll. Cardiol. published online Nov 12, 2007;
doi:10.1016/j.jacc.2007.05.056

This information is current as of November 13, 2007

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://content.onlinejacc.org/cgi/content/full/j.jacc.2007.05.056v1
Coronary Heart Disease Mortality Among Young Adults in the U.S. From 1980 Through 2002
Concealed Leveling of Mortality Rates
Earl S. Ford, MD, MPH,* Simon Capewell, MD†
Atlanta, Georgia; and Liverpool, United Kingdom

Objectives
The objective of our study was to examine age-specific mortality rates from coronary heart disease (CHD), particularly those among younger adults.

Background
Trends for obesity, diabetes, blood pressure, and metabolic syndrome among young adults raise concerns about the mortality rates from CHD in this group.

Methods
We used mortality data from 1980 to 2002 to calculate age-specific mortality rates from CHD for U.S. adults age ≥35 years.

Results
Overall, the age-adjusted mortality rate decreased by 52% in men and 49% in women. Among women age 35 to 54 years, the estimated annual percentage change (EAPC) in mortality was 5.4% (95% confidence interval [CI] 5.8 to 4.9) from 1980 until 1989, −1.2% (95% CI −1.6 to −0.8) from 1989 until 2000, and 1.5% (95% CI 3.4 to 6.6) from 2000 until 2002. Among men age 35 to 54 years, the EAPC in mortality was −6.2% (95% CI −6.4 to −5.9) from 1980 until 1989, −2.3% (95% CI −2.6 to −2.1) from 1989 until 2000, and −0.5% (95% CI 3.7 to 2.9) from 2000 until 2002. Among women and men age ≥55 years, the estimated annual percentage decrease in mortality from CHD accelerated in more recent years compared with earlier periods.

Conclusions
The mortality rates for CHD among younger adults may serve as a sentinel event. Unfavorable trends in several risk factors for CHD provide a likely explanation for the observed mortality rates. (J Am Coll Cardiol 2007;50:2128–32) © 2007 by the American College of Cardiology Foundation

In the U.S., mortality rates from coronary heart disease (CHD) have continued to decline steadily since 1968 (1). Nevertheless, CHD remains the leading cause of death and exacts a heavy social and economic toll. Improvements in population risk factors and in medical treatments of patients with CHD both contributed substantially to the declines seen between 1980 and 1990 (2).

Concern had been expressed that the rate of decline in the age-adjusted mortality rate from CHD has slowed during the 1990s compared with the earlier decade (3). The trends in the age-adjusted mortality rate may conceal differences in the trends in the age-specific rates, which have received little attention. The particularly unfavorable trends in several risk factors for CHD among young adults raises the possibility that the trends in the mortality rates from CHD among younger adults declined less than those in older ones (4–9). Therefore, our objective was to examine the trends in the age-specific rates for CHD among U.S. adults from 1980 to 2002, particularly among younger adults.

Methods
Vital statistics data from the U.S. were used (10). We limited our analyses to people age 35 years or older. The underlying cause of death from CHD was determined using the International Classification of Diseases (ICD)-9 codes 410-414 and 429.2 for 1980 to 1998 and ICD-10 codes I20-I25 for 1999 to 2002. Population counts from the U.S. Census were used to calculate rates. We used census counts for the years 1980, 1990, and 2000 and intercensal estimates for the other years. Age adjustment was performed using the direct method to the estimated U.S. population of the year 2000 (11). We used the software Joinpoint, version 3.0 (National Cancer Institute, Bethesda, Maryland), to examine changes in the annual percentage change in mortality rates from CHD.
The overall age-adjusted mortality rate declined from 1980 through 2002 by 52% in men and by 49% in women (Fig. 1). The average annual rate of decline for men was 2.9% during the 1980s, decreasing to 2.6% during the 1990s, and for women, it was 2.6% decreasing to 2.4%. From 2000 through 2002, the average annual rate of decline was 4.4% for both men and women.

The age-adjusted rates concealed striking differences in the trends in age-specific rates (Tables 1 and 2, Fig. 2). When the overall time period was split into 2, the robust decrease in mortality rates that was observed for both men and women age 35 to 54 years during the period from 1980 to 1990 decelerated significantly for both genders during the period from 1991 to 2002. For those age ≥55 years, however, the rate of decrease was larger in the later period than the earlier one for both genders.

To provide a more nuanced examination of the data in each gender and age group, changes in the trend during the 23-year period were detected by Joinpoint regression modeling. Among women age 35 to 54 years, mortality decreased significantly by 5.4% from 1980 to 1989, slowed to an annual rate of decrease of 1.2%, and turned positive between 2000 and 2002, albeit with a wide CI that included 0%. Among men age 35 to 54 years, the mortality rate decreased by 6.2% per year from 1980 to 1989, slowed to 2.3% per year from 1989 to 2000, and leveled off between 2000 and 2002. Among women age ≥55 years, the EAPC was −1.5% between 1980 and 1999 and accelerated to −4.8% from 1999 until 2002. Among men age ≥55 years, the EAPC was −2.6% between 1980 and 1990, slowed to 1.9% from 1990 to 1996, and accelerated to −3.7% from 1996 until 2002.

## Discussion

The trends for mortality from CHD among U.S. adults age 35 to 54 years are disquieting. The EAPC slowed markedly from 1980 to 2002 in both men and women. Particularly noteworthy is that the mortality rate among women age 35 to 44 years has been increasing on average by 1.3% (95% CI 0.2 to 2.5) per year since 1997.

Changes in mortality rates generally reflect changes in incidence and case-fatality rate (13). Unfortunately, solid data about incidence of CHD in the U.S. are not readily available. Many studies use hospitalization rates as a rather unsatisfactory proxy that can be difficult to interpret (14). Thus, data from the Worcester Heart study and Olmsted County both reported decreases in incidence from the late 1970s into the late 1980s (15,16). Data from the Nurses’ Health study from 1980 to 1994 also reported a reduction in the incidence of CHD among participants age 34 to 59 years (17). Conversely, an analysis of data from the Atherosclerosis Risk in Communities study reported an increase in the incidence of hospitalizations for myocardial infarction between 1987 and 1994 among residents age 35 to 74 years (18). A subsequent analysis of the data from this same study showed a decrease in the hospitalization rate of non–ST-segment elevation acute coronary syndrome between 1987 and 1994 (19). Among women living in Olmsted County, the incidence of CHD appeared to have increased during the early 1990s (16). An analysis of data from the National Health and Nutrition Examination Survey I Epidemiologic

### Table 1

<table>
<thead>
<tr>
<th>Age Group</th>
<th>EAPC 1980 to 1990</th>
<th>95% CI</th>
<th>EAPC 1991 to 2002</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 35–54 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>−6.0</td>
<td>−6.2 to −5.8</td>
<td>−2.1</td>
<td>−2.4 to −1.8</td>
</tr>
<tr>
<td>Women</td>
<td>−5.2</td>
<td>−5.5 to −5.0</td>
<td>−0.9</td>
<td>−1.4 to −0.5</td>
</tr>
<tr>
<td>Age ≥55 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>−2.6</td>
<td>−2.7 to −2.4</td>
<td>−2.9</td>
<td>−3.3 to −2.5</td>
</tr>
<tr>
<td>Women</td>
<td>−1.5</td>
<td>−1.7 to −1.3</td>
<td>−2.3</td>
<td>−2.7 to −1.8</td>
</tr>
</tbody>
</table>

CI = confidence interval; EAPC = estimated annual percentage change.
Figure 2  Trends in Age-Specific Mortality Rates From Coronary Heart Disease

Among adults age 35 to 44 years, the mortality rate from coronary heart disease changed little among women (squares) since the late 1980s and showed evidence of leveling off in more recent years among men (triangles). Among adults age 45 to 54 years, the rate of decline in the mortality rate from coronary heart disease slowed around 1990 in both men and women.
Follow-up study suggested that both reductions in incidence and case-fatality rates contributed to the decline in cardiovascular disease between 1971 and 1992, as in other industrialized countries (20). Data from the Framingham Heart study showed declines in mortality from sudden cardiac death and nonsudden CHD between 1950 and 1999, suggesting that both primary and secondary prevention contributed to the declines (21). Reductions in the case-fatality rate for CHD have been reported consistently (15,16,18,19,22–25).

Unfortunately, data concerning the incidence and case-fatality rates of CHD among young adults are not readily available. However, the unfavorable trends during the 1990s in mortality rates from CHD among young adults coincided with a substantial deterioration in several risk factors for CHD. Considerable increases in abdominal obesity, diabetes, and hypertension in younger adults (4,5,8,9) have been compounded by stasis in cholesterol concentrations (6,7).

The increases in the prevalence of obesity and diabetes in the U.S. since 1976 to 1980 (26–28) and the increases in the prevalence of the metabolic syndrome and hypertension during the 1990s (5,8) are potential warning signs that the hard-fought gains in mortality improvements might be arrested or even reversed. In addition, the decline in concentrations of total cholesterol slowed during the 1990s, even as the use of cholesterol-lowering medications escalated (6,7). However, the prevalence of smoking continues to decline (29), and a slight decrease in the proportion of U.S. adults who are totally sedentary during leisure time has also occurred during the late 1990s (30). As a result of the conflicting trends in the various risk factors, the risk of CHD as determined by the National Cholesterol Education Program risk score for CHD has not changed (31).

The adverse mortality trends in young adults have occurred despite the increasing wide use of evidence-based therapies such as angioplasty, thrombolysis, angiotensin-converting enzyme inhibitors, statins, and antiplatelet agents. This suggests that a vigorous public health response is needed to address lifestyle behaviors. Efforts to accelerate the past declines in smoking must be continued. Increased efforts to improve diet are now urgently required (32,33). Policy change at the national and state levels potentially offers the most effective and cost-effective interventions (33,34). To prevent obesity, energy intake must be less than energy expenditure. For many, messages of caloric restriction and increased physical activity, therefore, need to be amplified. Clinicians should also be aware of the unfavorable trends in coronary heart disease among younger adults in recent years and vigorously screen for risk factors for cardiovascular disease as recommended by guidelines and provide counsel about appropriate lifestyle behaviors. For patients found to have 1 or more risk factors, clinicians should optimally manage these risk factors according to prevailing guidelines.

Timely actions could potentially transform the abhorrent risk factor profile that currently characterizes much of the U.S. population and counteract the adverse trends that are now killing younger adults. Complacency runs a high risk: mortality rates among younger adults may represent the leading edge of a brewing storm.

Reprint requests and correspondence: Dr. Earl S. Ford, Centers for Disease Control and Prevention, 4770 Buford Highway, MS K66, Atlanta, Georgia 30341. E-mail: eford@cdc.gov.

REFERENCES


APPENDIX

For the annual percent changes in mortality rates from CHD among U.S. adults age ≥35 years by gender and age group, please see the online version of this article.
Coronary Heart Disease Mortality Among Young Adults in the U.S. From 1980 Through 2002: Concealed Leveling of Mortality Rates
Earl S. Ford, and Simon Capewell

*J. Am. Coll. Cardiol.* published online Nov 12, 2007;
doi:10.1016/j.jacc.2007.05.056

This information is current as of November 13, 2007