Trends in the Prevalence, Awareness, Treatment, and Control of Cardiovascular Disease Risk Factors among Noninstitutionalized Patients with a History of Myocardial Infarction and Stroke

Paul Muntner1,2, Karen B. DeSalvo1,2, Rachel P. Wildman1, Paolo Raggi2, Jiang He1,2, and Paul K. Whelton1,2

1 Department of Epidemiology, Tulane University School of Public Health and Tropical Medicine, New Orleans, LA. 2 Department of Medicine, Tulane University School of Medicine, New Orleans, LA.

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Rates of hypertension, high low density lipoprotein (LDL) cholesterol, and diabetes mellitus awareness, treatment, and control for persons with a history of myocardial infarction and stroke were compared by using two nationally representative samples of the US population: the Third National Health and Nutrition Examination Survey in 1988–1994 (n = 1,004) and the National Health and Nutrition Examination Survey in 1999–2002 (n = 512). Estimated numbers of adult myocardial infarction and stroke survivors increased from 6.32 to 6.78 million and from 3.85 to 4.96 million, respectively. Among such survivors, awareness of a previous diagnosis of hypertension and prevalence of self-reported diabetes mellitus remained stable while awareness of high LDL cholesterol increased from 43.3% to 60.2% (p < 0.01). Among those aware of their diagnosis, pharmacologic treatment for high LDL cholesterol increased from 33.1% to 78.4% and pharmacologic treatment for diabetes mellitus increased from 80.0% to 93.6% during this time (each p < 0.01), while pharmacologic treatment for hypertension increased nonsignificantly. Among those receiving pharmacologic treatment, hypertension and high LDL cholesterol control increased from 48.9% to 59.3% (p = 0.05) and from 5.1% to 33.1% (p < 0.01), respectively. In contrast, glycemic control among diabetics decreased from 45.0% to 33.2% (p = 0.20). The number of US myocardial infarction and stroke survivors increased between 1988–1994 and 1999–2002, and substantial improvements occurred in the awareness, treatment, and control of high LDL cholesterol in this population.

cerebrovascular accident; diabetes mellitus; hypertension; lipoproteins, LDL cholesterol; myocardial infarction

Abbreviations: CVD, cardiovascular disease; LDL, low density lipoprotein; NHANES, National Health and Nutrition Examination Survey; NHANES III, Third National Health and Nutrition Examination Survey.

National US vital statistics indicate that the age-adjusted rate of coronary heart disease mortality declined 52.1 percent (from 503/100,000 to 241/100,000) between 1970 and 2002 (1). Over the same time period, age-adjusted stroke mortality declined 63 percent (from 152/100,000 to 56/100,000). The decline in cardiovascular disease (CVD) mortality in the United States has been reported to be due, in part, to improvements in short-term case fatality (2). While clearly a medical triumph, the consequence of improvements in myocardial infarction and stroke case-fatality rates is a larger pool of persons in need of targeted secondary prevention (3). The continued aging and growth of the US population also is expected to translate into a higher number of myocardial infarction and stroke survivors in the United States in the future.

Previous studies have shown a high prevalence of CVD risk factors in patients with established CVD (4–7). For example, Qureshi et al. (6) reported that 42 percent of...
patients with a history of myocardial infarction and stroke, had poorly controlled or undiagnosed hypertension, 18 percent were current smokers, 43 percent had a body mass index of $\geq 27.3$ kg/m$^2$ ($\geq 27.8$ kg/m$^2$ for men), 28 percent had a total cholesterol level of $\geq 240$ mg/dl, and 11 percent had uncontrolled diabetes mellitus. Additionally, Khot et al. (7) pooled data from 14 randomized controlled trials ($n = 122,458$ participants) of secondary coronary heart disease prevention to study the prevalence of conventional CVD risk factors. Of the men and women in these trials, 38.4 percent and 55.9 percent had hypertension, 41.6 percent and 29.5 percent were current smokers, 34.1 percent and 39.6 percent had hyperlipidemia, and 15.3 percent and 23.2 percent had diabetes mellitus, respectively.

Because treatment guidelines for patients with established CVD have been published and widely disseminated over the past decade, we sought to determine temporal trends in the prevalence, awareness, treatment, and control of traditional CVD risk factors among patients with established CVD. These trends were investigated over an interval of nearly a decade by using data from two nationally representative samples of the US population: the Third National Health and Nutrition Examination Survey (NHANES III) conducted in 1988–1994 and the National Health and Nutrition Examination Survey (NHANES) conducted in 1999–2002.

MATERIALS AND METHODS

The surveys

NHANES III and NHANES 1999–2002 were nationally representative, cross-sectional surveys of the civilian non-institutionalized population of the United States (8, 9). The procedures involved in these studies have been published in detail and are available online (8, 9).

Each NHANES survey consisted of an in-home interview followed by a medical evaluation at a mobile examination center. The respective participation rates for the questionnaire and examination components were 86 percent and 78 percent for NHANES III and 85 percent and 81 percent for NHANES 1999–2002. Of relevance to the current analysis, information on the following variables was collected during the in-home interview: age, race-ethnicity, gender, cigarette smoking, history of myocardial infarction and stroke, and previous diagnosis of and treatment for hypertension, high cholesterol, and diabetes mellitus. For the current study, participants who reported having been previously told by a physician or other health professional that they had a “heart attack, also called myocardial infarction” or “stroke” were defined as having a history of myocardial infarction and stroke, respectively. Participants who reported having smoked $\geq 100$ cigarettes during their lifetime were classified as current smokers if they answered affirmatively to the question, “Do you smoke cigarettes now?” For all adult study participants, each NHANES examination procedure involved a standardized physical examination that included measurements of height, weight, waist circumference, and blood pressure and a blood sample collection. Body mass index was calculated as weight in kilograms divided by height in meters squared. Overweight and obesity were defined as a body mass index of $\geq 25$ kg/m$^2$ and $\geq 30$ kg/m$^2$, respectively.

In NHANES III and NHANES 1999–2002, up to three blood pressure measurements were taken by a physician using the standard protocol of the American Heart Association during a single visit to a mobile examination center (10). Although three additional blood pressure measurements were taken during the NHANES III home interview, for comparability, only the three blood pressure measurements from the mobile examination center were used in the current analysis. On the basis of the average of all three blood pressure measurements, hypertension was defined as systolic blood pressure of $\geq 140$ mmHg or diastolic blood pressure of $\geq 90$ mmHg and/or self-reported current use of blood pressure–lowering medication. Awareness of hypertension was defined as a self-report of any prior diagnosis of hypertension by a health-care professional. Treatment of hypertension was defined as self-reported current use of pharmacologic medication to manage high blood pressure. Control of hypertension was defined as having an average systolic blood pressure of $< 140$ mmHg and an average diastolic blood pressure of $< 90$ mmHg in the context of pharmacologic treatment of hypertension.

Detailed descriptions of blood collection and processing are provided in the NHANES Laboratory/Medical Technologists Procedures Manual (8, 9). For the subsample of NHANES participants who attended the morning examination session, fasted $\geq 8$ hours prior to their NHANES visit, and had a serum triglyceride level of $< 400$ mg/dl ($n = 393$ and $n = 290$ with a history of myocardial infarction and stroke for NHANES III and NHANES 1999–2002, respectively), low density lipoprotein (LDL) cholesterol was calculated by using the Friedewald equation (11): LDL cholesterol (mg/dl) = total cholesterol (mg/dl) – high density lipoprotein cholesterol (mg/dl) – triglycerides (mg/dl)/5.

For the current analysis, participants were classified as having high LDL cholesterol if their LDL cholesterol concentration was $\geq 100$ mg/dl and/or they reported using cholesterol-lowering medication within 2 weeks of their NHANES study visit (12). Awareness of high LDL cholesterol was defined as a self-report of any prior diagnosis of hypercholesterolemia by a health-care professional. Treatment of high LDL cholesterol was defined as self-reported current use of cholesterol-lowering medication. Controlled LDL cholesterol was defined as an LDL cholesterol concentration of $< 100$ mg/dl in the context of pharmacologic treatment.

Per the study protocol, plasma glucose was not measured in approximately 50 percent of NHANES 1999–2002 participants. The number of patients with a history of myocardial infarction and stroke as well as concurrent diabetes mellitus was too low to assess awareness, treatment, and control in the current study when limited to the subset of participants for whom fasting plasma glucose measurements were available. To garner the power from the full study sample of NHANES III and NHANES 1999–2002, diabetes mellitus was defined as a previous diagnosis by a health-care provider while the patient was not pregnant. Although this definition results in participants unaware of their diabetes diagnosis being classified as nondiabetic, it provided greater statistical power to compare rates of diabetes treatment.
and control between NHANES 1988–1994 and NHANES 1999–2002. Treatment of diabetes mellitus was defined as self-reported current use of insulin or antidiabetic pills. Glycohemoglobin was measured by using the Boronate Affinity High Performance Liquid Chromatography system at the Diabetes Diagnostic Laboratory at the University of Missouri at Columbia, and glycemic control was defined as a glycated hemoglobin reading of <7.0 percent.

The protocols for NHANES III and NHANES 1999–2002 were approved by the National Center for Health Statistics of the Centers for Disease Control and Prevention’s Institutional Review Board.

Statistical analysis

Crude, age-standardized, and age-specific (20–39, 40–59, 60–74, and ≥75 years) prevalence of myocardial infarction and stroke was calculated for each time period. The number of persons in the United States with a history of myocardial infarction and stroke was also estimated for each time period by using the US Census weights provided in the NHANES data sets. Differences in prevalence and count estimates across the two surveys were compared by using t tests and the Wald chi-square test, taking into account the complex survey design used in NHANES III and NHANES 1999–2002.

Data on persons with a history of myocardial infarction and stroke were pooled for the remainder of the analyses because the treatment recommendations for risk factors in both settings were similar and pooling of data increased the statistical power of the analyses (n = 1,004 for NHANES III and n = 512 for NHANES 1999–2002). Demographic characteristics (age, gender, and race-ethnicity) and the prevalence of CVD risk factors (current smoking, overweight and obesity, hypertension, high LDL cholesterol, and diabetes mellitus) and the metabolic syndrome and its components (abdominal obesity, elevated blood pressure, low high density lipoprotein cholesterol, high triglycerides, and impaired fasting glucose) were calculated for participants with a history of myocardial infarction and stroke in NHANES III and NHANES 1999–2002 after standardization to the age distribution of myocardial infarction and stroke survivors in NHANES 1999–2002.

Next, we calculated the age-standardized proportion of myocardial infarction and stroke survivors with hypertension for NHANES III and NHANES 1999–2002 who 1) were aware of their diagnosis of hypertension, 2) were treated with pharmacologic antihypertensive medication, and 3) had achieved blood pressure control. Analogous calculations were performed for those with high LDL cholesterol or with diabetes mellitus. Awareness of diabetes mellitus was not calculated because the definition of diabetes mellitus used was based on self-report of a previous diagnosis. The proportion of the population aware of their hypertension and high LDL cholesterol was restricted to those with hypertension and high LDL cholesterol, respectively, while the proportion of persons on treatment was limited to those aware of each diagnosis. Hypertension, high LDL cholesterol, and diabetes mellitus control was assessed among all participants with each condition, separately, and among those participants receiving treatment for each respective condition. Analyses of awareness, treatment, and control rates were repeated for subgroups defined by race-ethnicity and sex. Finally, the clustering of no, one, two, and three or more uncontrolled CVD risk factors (cigarette smoking, obesity, and uncontrolled hypertension, high LDL cholesterol, and diabetes mellitus) was determined and compared between NHANES III and NHANES 1999–2002.

Sample weights that account for the unequal probabilities of selection, oversampling, and nonresponse were applied for all analyses by using SUDAAN software (version 8.0; Research Triangle Institute, Research Triangle Park, North Carolina). Standard errors were estimated by using the Taylor series linearization method (13).

RESULTS

In NHANES 1999–2002, a history of myocardial infarction and stroke was reported by 3.29 percent and 2.41 percent, respectively, of adults in the United States (table 1). Before and after age standardization and within-age groupings, the prevalences of myocardial infarction and stroke were similar in 1988–1994 and 1999–2002. Overall, there were 6.777 million persons with a history of myocardial infarction and 4.959 million persons with a history of stroke in the United States during 1999–2002 (table 2). Between

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Crude</td>
<td>3.44 (0.21)</td>
<td>3.29 (0.22)</td>
<td>0.622</td>
</tr>
<tr>
<td>Age adjusted</td>
<td>3.43 (0.18)</td>
<td>3.03 (0.21)</td>
<td>0.148</td>
</tr>
<tr>
<td>Age specific (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–39</td>
<td>0.24 (0.09)</td>
<td>0.35 (0.14)‡</td>
<td>0.509</td>
</tr>
<tr>
<td>40–59</td>
<td>2.78 (0.31)</td>
<td>2.63 (0.42)</td>
<td>0.774</td>
</tr>
<tr>
<td>60–74</td>
<td>10.29 (0.76)</td>
<td>8.40 (0.74)</td>
<td>0.075</td>
</tr>
<tr>
<td>≥75</td>
<td>14.07 (0.84)</td>
<td>13.67 (1.13)</td>
<td>0.776</td>
</tr>
<tr>
<td><strong>Prevalence of stroke</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude</td>
<td>2.09 (0.15)</td>
<td>2.41 (0.16)</td>
<td>0.145</td>
</tr>
<tr>
<td>Age adjusted</td>
<td>2.12 (0.13)</td>
<td>2.00 (0.19)</td>
<td>0.602</td>
</tr>
<tr>
<td>Age specific (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–39</td>
<td>0.24 (0.10)</td>
<td>0.46 (0.13)‡</td>
<td>0.180</td>
</tr>
<tr>
<td>40–59</td>
<td>1.45 (0.27)</td>
<td>1.67 (0.29)</td>
<td>0.579</td>
</tr>
<tr>
<td>60–74</td>
<td>5.23 (0.49)</td>
<td>5.36 (0.58)</td>
<td>0.864</td>
</tr>
<tr>
<td>≥75</td>
<td>11.36 (0.68)</td>
<td>11.68 (0.98)</td>
<td>0.788</td>
</tr>
</tbody>
</table>

* Standardized to the age distribution of the US population in 2000.
† NHANES III, Third National Health and Nutrition Examination Survey; NHANES, National Health and Nutrition Examination Survey.
‡ Fewer than 20 people reported myocardial infarction and stroke, resulting in a potentially unstable estimate.


![Graph](https://example.com/graph.png)

**TABLE 2.** Estimated number (standard error)* of persons with a history of myocardial infarction, stroke,† or either in the United States during 1988–1994 (NHANES III) and 1999–2002 (NHANES 1999–2002)

<table>
<thead>
<tr>
<th></th>
<th>Myocardial infarction</th>
<th>Stroke</th>
<th>Either</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHANES III</td>
<td>(1988–1994)</td>
<td>6,323 (466)</td>
<td>3,846 (312)</td>
</tr>
<tr>
<td>NHANES 1999–2002</td>
<td>6,777 (522)</td>
<td>4,959 (396)</td>
<td>10,769 (709)</td>
</tr>
</tbody>
</table>

* Numbers and standard errors are expressed in thousands.
† p = 0.033 comparing number of persons with a history of stroke between the Third National Health and Nutrition Examination Survey (NHANES III) and the National Health and Nutrition Examination Survey (NHANES 1999–2002).


<table>
<thead>
<tr>
<th>Demographic characteristics (mean or percentage (standard error))</th>
<th>NHANES III (1988–1994)</th>
<th>NHANES 1999–2002</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current smoking</td>
<td>30.6 (2.4)</td>
<td>23.3 (3.1)</td>
<td>0.063</td>
</tr>
<tr>
<td>Overweight</td>
<td>67.3 (2.5)</td>
<td>78.1 (2.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obese</td>
<td>30.9 (2.7)</td>
<td>42.1 (3.5)</td>
<td>0.011</td>
</tr>
<tr>
<td>Hypertension</td>
<td>55.6 (2.8)</td>
<td>60.1 (3.5)</td>
<td>0.315</td>
</tr>
<tr>
<td>High low density lipoprotein cholesterol</td>
<td>79.3 (3.1)</td>
<td>87.1 (2.5)</td>
<td>0.050</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>21.1 (1.7)</td>
<td>18.9 (2.2)</td>
<td>0.429</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>54.5 (2.7)</td>
<td>60.3 (3.3)</td>
<td>0.174</td>
</tr>
<tr>
<td>Elevated blood pressure</td>
<td>68.1 (2.8)</td>
<td>69.7 (4.1)</td>
<td>0.747</td>
</tr>
<tr>
<td>Low high density lipoprotein cholesterol</td>
<td>53.4 (2.9)</td>
<td>51.7 (3.4)</td>
<td>0.704</td>
</tr>
<tr>
<td>High triglycerides</td>
<td>57.2 (2.4)</td>
<td>45.0 (4.1)</td>
<td>0.010</td>
</tr>
<tr>
<td>Impaired fasting glucose</td>
<td>27.2 (2.1)</td>
<td>34.5 (3.2)</td>
<td>0.056</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>51.0 (2.6)</td>
<td>49.2 (4.1)</td>
<td>0.710</td>
</tr>
</tbody>
</table>

* NHANES III, Third National Health and Nutrition Examination Survey; NHANES, National Health and Nutrition Examination Survey.
† Metabolic syndrome and each of its components was defined by using the National Cholesterol Education Program’s Adult Treatment Panel III guidelines (11).
control increased between 1988–1994 and 1999–2002 from 48.9 percent to 59.3 percent among treated hypertensives \( (p < 0.049) \) and from 37.9 percent to 46.5 percent among all hypertensives \( (p = 0.089) \). High LDL cholesterol control increased between 1988–1994 and 1999–2002 from 5.1 percent to 15.5 percent among all patients with high LDL cholesterol \( (p < 0.001) \). In contrast, glycemic control among treated and all persons with diabetes mellitus was lower in 1999–2002 than in 1988–1994 \( (45.0 \text{ percent to } 46.5 \text{ percent} \) among treated hypertensives \( p < 0.001 \)). No differences in diabetes control were noted across subgroups defined by race-ethnicity and sex. Hypertension awareness was significantly higher but control rates lower among non-Hispanic Blacks (95.5 percent and 37.5 percent, respectively) compared with non-Hispanic Whites (80.2 percent and 69.2 percent, respectively; each \( p < 0.001 \) comparing non-Hispanic Blacks and Whites). Hypertension awareness was higher among women (92.6 percent) compared with men (80.0 percent; \( p < 0.001 \)), although hypertension control rates were higher among men (68.7 percent) compared with women (43.0 percent; \( p < 0.001 \)). No differences in diabetes awareness, treatment, and control were noted across subgroups defined by race-ethnicity and sex. Too few persons with a history of myocardial infarction and stroke had valid LDL cholesterol measurements to assess high LDL cholesterol awareness, treatment, and control stratified by gender and race-ethnicity.

Figure 2 shows the age-adjusted prevalence of no, one, two, and three or more uncontrolled risk factors (cigarette smoking, obesity, uncontrolled hypertension, high LDL cholesterol, and diabetes mellitus) among persons with a history of myocardial infarction and stroke in 1988–1994 and 1999–2002. The age-adjusted percentage of this population with no uncontrolled risk factors increased from 3.0 percent to 10.6 percent between 1988–1994 and 1999–2002 \( (p < 0.001) \). In contrast, the percentage of persons with two uncontrolled risk factors was lower in 1999–2002 than in 1988–1994 \( (p = 0.015) \).

**DISCUSSION**

Over the past 10 years, a large body of clinical trial evidence has documented the benefits of treating and controlling hypertension, high LDL cholesterol, and diabetes mellitus. This evidence is reflected in statements and guidelines from the National Institutes of Health, American Diabetes Association, American Heart Association, and American College of Cardiology (12, 14–17). The current analysis documents a positive trend of increasing control of hypertension and awareness and control of high LDL cholesterol.
cholesterol among myocardial infarction and stroke survivors, suggesting that the evidence from clinical trials is being translated into clinical practice.

Although mortality from CVD in the United States has declined over the past several decades, the population with a history of myocardial infarction and stroke has increased substantially (18–21). The current study documents an increase of 454,000 and 1.1 million myocardial infarction and stroke survivors, respectively, in the United States between 1988–1994 and 1999–2002. It is interesting to note that this increase occurred in the setting of an age-adjusted prevalence of stroke and myocardial infarction that did not change substantially between 1988–1994 and 1999–2002. As such, the increase in the number of persons with a history of myocardial infarction and stroke appears to be due to the increased size and aging of the US population. Reducing morbidity and mortality in this large and growing segment of the US population should be a key priority for the health-care community.

Convincing evidence has demonstrated that reductions in blood pressure decrease morbidity and mortality from coronary heart disease and stroke (14, 22–24). For example, in a meta-analysis of secondary prevention in persons with a history of CVD, beta blockers were estimated to result in 9- and 5-mmHg reductions in systolic and diastolic blood pressures, respectively (25). The summary relative risk comparing beta blockers with placebo was 0.78 for both fatal and nonfatal ischemic heart disease. The benefits of antihypertensive therapy are not limited to beta blockers; meta-analyses comparing angiotensin-converting enzyme inhibitors and calcium-channel blockers with placebos have reported these treatments to be associated with 19 percent and 21 percent reductions in reinfarction, respectively (25). In a separate meta-analysis of secondary prevention limited to participants with a history of stroke or transient ischemic attack, the rates of coronary heart disease and stroke incidence for persons randomly assigned to receive low-dose diuretics versus placebo were reduced 21 percent and 24 percent, respectively (26). Among the high-risk population of myocardial infarction and stroke survivors in the current study, hypertension awareness and treatment was substantially higher, 84.5 percent and 91.4 percent, respectively, than awareness and treatment rates, 68.9 percent and 58.4 percent, respectively, reported previously for the general population. Furthermore, hypertension control rates were higher for both treated (59.3 percent) and all hypertensives (46.5 percent) with a history of myocardial infarction and stroke compared with the general US population of treated (53.1 percent) and all hypertensives (31.0 percent) (27).

Several large, randomized controlled trials published during the 1990s provided irrefutable evidence of the benefits of hepatic hydroxymethylglutaryl coenzyme A reductase inhibitors (statin) therapy in lowering the risk of coronary heart disease (28–31). In a recent prospective meta-analysis including 14 randomized controlled trials, a 22 percent (95 percent confidence interval: 16 percent, 26 percent) risk reduction in the incidence of major coronary events was observed for participants with established CVD randomly assigned to statin therapy compared with their counterparts randomly assigned to placebo (32). On the basis of these findings, the National Cholesterol Education Program of the National Heart, Lung, and Blood Institute issued guidelines in 1995 and 2001 recommending the use of hepatic hydroxymethylglutaryl coenzyme A reductase inhibitors to lower LDL cholesterol levels to <100 mg/dl in patients with clinical CVD (12, 33). More recently, high-dose versus moderate-dose statin therapy, aimed at lowering LDL cholesterol to <70 mg/dl in patients with coronary disease was shown to result in a 16 percent (95 percent confidence interval: 5 percent, 26 percent) reduction in the risk of the composite endpoint of death from any cause, myocardial infarction, documented unstable angina requiring rehospitalization, revascularization (performed at least 30 days after randomization), or stroke (34). Data from the general US population for 1999–2000 indicate low rates of high total cholesterol awareness (35.0 percent), treatment (12.0 percent), and control (5.4 percent) (35). In the current study of myocardial infarction and stroke survivors, the rates of awareness, treatment, and control of high LDL cholesterol were 60.2 percent, 78.4 percent, and 33.1 percent, respectively. The remarkable increase in high cholesterol awareness, use of pharmacotherapy, and high-cholesterol control in the context of patients with CVD should be considered a major achievement.

In 1995, the American Diabetes Association recommended that patients with diabetes mellitus maintain a glycated hemoglobin level of <7.0 percent (36). A recent meta-analysis of observational studies showed that lower glycated hemoglobin levels are associated with a lower CVD risk (37). However, the benefits of pharmacologic treatment from FIGURE 2. Age-standardized prevalence of 0, 1, 2, and ≥3 uncontrolled cardiovascular disease risk factors among persons with a history of myocardial infarction and stroke in the United States during 1988–1994 (Third National Health and Nutrition Examination Survey (NHANES III)) and 1999–2002 (NHANES 1999–2002). Uncontrolled risk factors: 1) hypertension (systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg), 2) diabetes (glycated hemoglobin ≥7.0%), 3) high low density lipoprotein cholesterol (≥100 mg/dl), 4) obesity (body mass index ≥30 kg/m²), and 5) current cigarette smoking. p < 0.001 comparing the prevalence of zero risk factors in NHANES III and NHANES 1999–2002. Prevalence was standardized to the age distribution of the population in NHANES 1999–2002 with a history of myocardial infarction and stroke.
randomized controlled trials are less convincing, with little data available from studies including patients with established CVD (38). In one study, the Diabetes Mellitus Insulin-Glucose Infusion in Acute Myocardial Infarction (DIGAMI) trial, patients with diabetes mellitus were randomly assigned to receive an insulin-glucose infusion during the initial 24 hours of hospitalization for myocardial infarction followed by subcutaneous insulin four times daily for a minimum of 3 months or to a usual-care control group (39). The net decline in glycated hemoglobin level was only 0.3 percent greater in the treatment compared with the control group. Although myocardial infarction rates were not lower in the treatment, compared with the control, group (relative risk = 0.99, 95 percent confidence interval: 0.68, 1.44), the risk of cardiovascular mortality was reduced by 53 percent (relative risk = 0.47, 95 percent confidence interval: 0.24, 0.92). However, a follow-up study did not support this intensive treatment (40). Despite the dearth of evidence from randomized controlled trials, given the large body of epidemiologic data, tight glycemic control remains a recommendation for the primary and secondary prevention of CVD. The diabetes mellitus control rates were low in the current study, with only 36.0 percent of patients with diabetes mellitus achieving the recommended glycemic levels. In addition, a potentially important decline in glycemic control rates occurred between 1988–1994 and 1999–2002.

Findings in the current study must be considered within the context of the study’s limitations. First, the prevalence of CVD may be overestimated because history of myocardial infarction and stroke was based on self-report. However, because hypertension, high cholesterol, and diabetes awareness, treatment, and control rates are lower in the general population, such misclassification, if present, indicates that rates of awareness, treatment, and control among persons with established CVD may be even higher than we report. Second, the number of participants with a history of myocardial infarction and stroke in NHANES 1999–2002 was limited. We pooled the experience in these groups for the analyses of awareness, treatment, and control of hypertension, high LDL cholesterol, and diabetes mellitus. After pooling data on these groups, the available sample size satisfied the NHANES analytic guidelines of 20 or more participants in each cell, except for the prevalence estimates for myocardial infarction and stroke survivors less than 40 years of age (41). Finally, we relied on self-report to define diabetes. The impact of this decision is underestimation of the prevalence of diabetes among myocardial infarction/stroke survivors because undiagnosed diabetes cases were categorized as nondiabetic. In contrast, using self-report to define diabetes may have resulted in overestimation of the percentage of patients receiving treatment and controlling their diabetes. Nonetheless, there is little reason to suspect that these effects are different for NHANES III and NHANES 1999–2002.

The current study documents that an increased US population size has resulted in a large increase in the number of myocardial infarction and stroke survivors—from 9.2 million in 1988–1994 to 10.7 million in 1999–2002. In addition to improvements in hypertension control, substantial increases in the treatment and control of high LDL cholesterol were observed over this same time period. Despite these improvements, only 10.6 percent of US adults with a history of myocardial infarction and stroke have achieved control of their risk factors. Continued updating and intensive dissemination of evidence-based guidelines for the prevention, awareness, treatment, and control of risk factors in the context of patients with CVD are warranted as part of efforts aimed at delaying morbidity and mortality.

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