Ineffective Secondary Prevention in Survivors of Cardiovascular Events in the US Population

Report From the Third National Health and Nutrition Examination Survey

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Background: Survivors of myocardial infarction (MI) or stroke are at high risk for subsequent cardiovascular events. There is limited assessment of the effectiveness of risk factor modification through current secondary preventive strategies in the US population. We determined the adequacy of risk factor modification in 1252 survivors of MI, stroke, or both in a nationally representative sample of US adults and identified factors related to inadequate control of risk factors.

Methods: The adequacy of control for hypertension, diabetes mellitus, cigarette smoking, alcohol use, and hypercholesterolemia was assessed by personal interview, blood pressure measurements, and serum glycosylated hemoglobin and cholesterol levels in 17752 US adults who participated in the Third National Health and Nutrition Examination Survey between 1988 and 1994. We also evaluated the role of potentially related factors, including age, sex, race/ethnicity, educational attainment, socioeconomic status, and medical insurance status using multivariate logistic regression analysis.

Results: Of 738 known hypertensive persons, hypertension was uncontrolled in 388 (53%). Previously undiagnosed hypertension was detected in 138 others (11%). Of 289 diabetic persons, serum glucose control was inadequate in 141. Of 1252 survivors, 225 (18%) were currently smoking, and heavy alcohol use was observed in 56 persons. Hypercholesterolemia was poorly controlled in 185 (46%) of 405 persons with known hypercholesterolemia. Undetected hypercholesterolemia was observed in 160 persons (13%). In the multivariate analysis, high-risk profiles were more likely to be observed in persons aged 46 to 65 years, women, and African Americans.

Conclusions: High prevalence of inadequate secondary prevention was found in a subset of the US population at highest risk for stroke and MI. Considerable efforts are required to effectively implement risk factor modification strategies after MI or stroke, particularly in middle-aged persons, African Americans, and women.

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CARDIOVASCULAR diseases (CVDs), including myocardial infarction (MI) and stroke, are a major cause of death and disability in the United States. A history of CVD increases the relative risk of subsequent premature cardiovascular morbidity and mortality by 5 to 7 times. The survival rate among more than 1 million cases of MI that occur annually is approximately 70% to 80%. Among survivors of a first MI, the rate of subsequent MI is increased 3 to 6 times, and the risk of any CVD event may be as high as 80%. Of approximately 500,000 new and recurrent strokes that occur each year in the United States, 80% of the patients survive the event. The risk of subsequent ischemic stroke is as high as 30%, with a 2-fold increase in subsequent cardiovascular events. Because persons with a previous history of cardiovascular events are at high risk for future MI and stroke, aggressive intervention that includes risk factor modification is warranted in this population. Despite advances in medical and surgical management of CVD, long-term survival depends on modification of underlying disease processes. Considerable evidence exists that a secondary prevention program to reduce CVD risk factors can favorably impact CVD morbidity and mortality. Survivors of these events are ideal candidates for secondary prevention efforts because even modest treatment effects could benefit this large at-risk population. Most survivors receive medical evaluation regularly, and risk factor modification can be undertaken in a cost-effective manner. To our knowledge, limited information exists regarding formal assessment of the magnitude of risk factor modification with current secondary preventive strategies outside clinical trials. The present study was under-
PARTICIPANTS AND METHODS

The NHANES III was conducted by the Centers for Disease Control and Prevention between 1988 and 1994 to estimate the prevalence of common chronic conditions and associated risk factors in a nationally representative sample of the civilian, noninstitutionalized US population. The survey included a household interview; a medical examination in a mobile examination center, or at home for those unable to travel; and phlebotomy to measure hematologic factors, including glucose control, cholesterol level, high-density lipoprotein cholesterol level, triglycerides, and apolipoproteins A-I and B. Participants were considered to have experienced a stroke if they reported a physician diagnosis of stroke and an MI if they reported a physician diagnosis of heart attack.

We evaluated the frequency and characteristics of the defined risk factors of hypertension, diabetes mellitus, hypercholesterolemia, alcohol use, and cigarette smoking in stroke and MI survivors. The prevalence of uncontrolled hypertension (defined as average blood pressure >140/90 mm Hg from 3 consecutive readings) in persons with diagnosed hypertension was estimated. The prevalence of undiagnosed hypertension (defined as average blood pressure >140/90 mm Hg from 3 consecutive readings) in persons with no previous diagnosis of hypertension was also determined. Diabetes mellitus was defined as either a physician diagnosis of diabetes mellitus or sugar diabetes or current use of insulin or oral hypoglycemic agents. Control of diabetes was determined according to serum glycosylated hemoglobin levels. Levels greater than 7.0 were considered indicative of poor control. Current smoking status was categorized as active, previous, or never. Alcohol use was categorized as heavy if the persons reported having more than 9 drinks per day at least 7 days per year or more than 5 drinks per day at least 14 days per year. Uncontrolled hypercholesterolemia, defined as a serum cholesterol level greater than 6.21 mmol/L (>240 mg/dL), was estimated separately for persons with diagnosed hypercholesterolemia. Previously undiagnosed hypercholesterolemia was defined as a serum cholesterol level greater than 6.21 mmol/L (>240 mg/dL). The diagnosis of hypercholesterolemia was based on the guidelines of the National Cholesterol Education Program I (NCEP I), which were available in 1988 at initiation of the study. The updated guidelines (NCEP II) were not used because they were not available until the end of the survey. Physical activity was graded using the response to the question, “Compared with most men/women of your age, would you say that you are more active, less active, or about the same?” Overweight status was defined by a body mass index (calculated as weight in kilograms divided by the square of height in meters) of 27.3 or greater in women and 27.8 or greater in men. As part of the interview, participants were asked whether their physicians prescribed any medication for treatment of hypertension or hypercholesterolemia. Participants were also questioned regarding whether they took the medication as prescribed by their physician to determine the status of compliance with treatment. As a separate analysis, individual components of the dietary intake of survivors were compared with the NCEP I guidelines to determine the adequacy of dietary habits.

Another analysis was performed to identify the strata of high-risk persons who might benefit most from secondary prevention. High-risk profile was defined by the presence of 2 or more of the following characteristics: poorly controlled or undiagnosed hypertension, poorly controlled diabetes mellitus, active smoking, heavy alcohol use, or uncontrolled or undiagnosed hypercholesterolemia. The association of a high-risk profile with age, sex, race/ethnicity, medical insurance status, and educational attainment was evaluated using logistic regression analysis. Age was categorized in 3 groups before entry into the model: younger than 46 years, 46 to 65 years, and older than 65 years. Race/ethnicity was grouped as white, African American, or other. Other variables were dichotomized based on presence or absence. To estimate the extent of medical follow-up and evaluation in participants with and without a high-risk profile, we compared the number of visits to the physician’s office within the past year for each group. We also compared the frequency with which participants with and without high-risk profiles had seen a physician or health professional within the past 6 months.

Economic status was estimated for 948 persons as poverty index. Poverty index was computed as a ratio of 2 components. The numerator was the midpoint of the observed family income category. The denominator was the poverty threshold, the age of the family reference person, and the calendar year in which the family was interviewed. The poverty index allowed income data to be analyzed in a comparable manner across the 6 years of the survey and with previous surveys. A higher poverty index suggests higher income and economic status. A separate logistic regression analysis was performed in participants in whom poverty index was available to analyze the effect of economic status on the presence of multiple uncontrolled risk factors. Poverty index was categorized based on quartiles.

taken to determine the effectiveness of secondary preventive measures in survivors of MI and stroke using data from the Third National Health and Nutrition Examination Survey (NHANES III), a nationally representative sample of US adults, and to identify factors related to inadequate control of risk factors.

RESULTS

Of 17752 adults older than 18 years who underwent complete interview and examination in the NHANES III, 1252 survivors of MI, stroke, or both were identified. A total of 828 participants reported a physician diagnosis of MI, 560 reported a previous diagnosis of stroke, and 136 reported a history of both. The mean±SD interval between the event and the present NHANES III evaluation was 10.6±9.4 years for MI and 8.0±9.6 years for stroke.

Hypertension had been previously diagnosed in 738 persons (59%). According to our criteria, hypertension was controlled in 280 participants (38%) and uncontrolled in 388 (53%). Blood pressure readings were not available for 70 persons (9%). The distribution of systolic and diastolic blood pressure among survivors of MI and stroke is shown in Figure 1 and Figure 2, respectively. Most participants with elevated systolic blood pressure had readings between 140 and 180 mm Hg.
Analysis of the data for 388 persons with uncontrolled hypertension revealed that noncompliance (n=49) and lack of prescribed medication or treatment advice (n=7) contributed minimally to poor control. Of the 388 participants, 350 reported evaluation by a medical physician or other health professional within the past 6 months. Previously undiagnosed hypertension was detected in 138 survivors, of whom 117 reported evaluation by a physician or other health professional within the past 6 months. A total of 289 participants were known diabetics; 110 required insulin treatment, 128 used oral hypoglycemic agents, 16 used both, and 67 were not using any medication. Serum glucose control, as reflected by glycosylated hemoglobin levels, was adequate in 136 persons with diabetes (47%) and inadequate in 141 (49%). Levels were not available for 12 persons (4%). Of 1252 survivors, 225 (18%) were currently smoking and 530 (42%) reported a past history of smoking. Heavy alcohol use was observed in 56 persons (4%). Hypercholesterolemia previously diagnosed in 405 survivors (32%) was considered to be adequately controlled in 199 (49%) and poorly controlled in 185 (46%) based on our criteria. Cholesterol levels were not available for 21 persons. Distribution of serum total cholesterol levels in survivors of MI and stroke is shown in Figure 3. Most participants with elevated concentrations of cholesterol had levels between 6.21 and 7.24 mmol/L (240 and 280 mg/dL). Of 185 persons with poorly controlled hypercholesterolemia, noncompliance to medication was reported by 23 and no prescribed treatment was reported by 12; 176 had seen a medical professional in the past 6 months. Previously undiagnosed hypercholesterolemia was detected in 160 persons, of which 133 reported a recent (<6 months) evaluation by a health professional. Low-density lipoprotein cholesterol level was evaluated in 417 participants (Figure 4); 236 (57%) had levels greater than 3.36 mmol/L (>130 mg/dL). Physical activity compared with their peers was graded as more active by 28% of respondents, about the same by 38%, and as less active by 34%. A total of 543 participants (43%) were considered overweight.

Table 1 compares inadequately controlled risk factors in persons with vs without previous stroke or MI in the NHANES III. The group with previous MI or stroke was older and had a higher proportion of men and whites. The frequency of participants with inadequately controlled hypertension, hypercholesterolemia, and diabetes mellitus was higher in persons with previous stroke or MI. The proportions of current smokers and heavy alcohol users were lower in persons with previous stroke or MI. The comparison does not adjust for demographic differences between the 2 groups.

Analysis of dietary consumption revealed that the following components were not in accordance with NCEP I guidelines: total fat greater than 30% of total calories (n=646), saturated fatty acid greater than 10% of total calories (n=580), polyunsaturated fatty acid greater than 10% of total calories (n=181), monounsaturated fatty acid greater than 15% of total calories (n=278), cholesterol...
level greater than 7.76 mmol/L (>300 mg/dL) (n = 328), and carbohydrates greater than 60% of total calories (n = 228).

Of 1060 survivors with complete data for multivariate analysis, 366 (35%) had a high-risk profile, defined as the presence of 2 or more poorly controlled risk factors. In the multivariate analysis, those aged 46 to 65 years (odds ratio [OR], 2.5; 95% confidence interval [CI], 1.3-4.8), women (OR, 1.6; 95% CI, 1.3-2.1), and African Americans (OR, 1.4; 95% CI, 1.0-1.9) were at significantly higher risk for having a high-risk profile (Table 2). The probability of having a high-risk profile was not affected by educational attainment or medical insurance status. In a separate analysis, poverty index was not associated with a high-risk profile. The mean ± SD number of evaluations regarding socioeconomic status (SES).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>With Previous Stroke or MI (n = 1252)</th>
<th>Without Previous Stroke or MI (n = 16500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SD, y</td>
<td>70.0 ± 13.4†</td>
<td>46.0 ± 19.6</td>
</tr>
<tr>
<td>Men</td>
<td>718 (57)†</td>
<td>7574 (46)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>945 (75)†</td>
<td>11096 (67)</td>
</tr>
<tr>
<td>African American</td>
<td>289 (23)†</td>
<td>4840 (29)</td>
</tr>
<tr>
<td>Other</td>
<td>19 (2)†</td>
<td>559 (3)</td>
</tr>
<tr>
<td>Poorly controlled or undiagnosed</td>
<td>526 (42)†</td>
<td>3271 (20)</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncontrolled diabetes mellitus</td>
<td>141 (11)†</td>
<td>586 (4)</td>
</tr>
<tr>
<td>Current smoking</td>
<td>225 (18)†</td>
<td>4277 (26)</td>
</tr>
<tr>
<td>Poorly controlled or undiagnosed</td>
<td>345 (28)†</td>
<td>2894 (18)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy alcohol use</td>
<td>56 (4)†</td>
<td>2312 (14)</td>
</tr>
<tr>
<td>Physical inactivity‡</td>
<td>417 (33)†</td>
<td>3521 (21)</td>
</tr>
<tr>
<td>Overweight§</td>
<td>543 (43)†</td>
<td>6378 (39)</td>
</tr>
</tbody>
</table>

*NHANES III indicates Third National Health and Nutrition Examination Survey; CI, confidence interval.†Poverty index was not used in the final model because the values for 112 persons were not available. The values presented in the table are derived from a separate analysis that included patients with complete information regarding socioeconomic status (SES).

**COMMENT**

**SALIENT FINDINGS OF THE STUDY**

Efforts aimed at secondary prevention in survivors of MI, stroke, or both are inadequate. The NHANES III represents one of the largest recent national population-based assessments of CVD risk factors in the United States.11 Therefore, these data afford a unique opportunity to evaluate the status of various socioeconomic, clinical, and hematologic factors in a representative population. Our results call for major efforts directed toward secondary prevention in a subset of the population at highest risk for...
CVD events. The magnitude of inadequate risk factor control was high, with almost half of persons with hypertension, diabetes mellitus, and hypercholesterolemia having inadequate risk factor control. One fifth of MI and stroke survivors were currently smoking. This ineffectiveness was in part the result of patient attitudes toward risk factor modification, as evident from medication noncompliance and active cigarette smoking. However, a large proportion of undetected hypertension and hypercholesterolemia also suggests the inadequacy of regular medical evaluation regarding secondary prevention in this population. Almost 90% of the high-risk group reported that they had seen a physician or other health professional in the past 6 months. Participants reported an average of 7 consultations with physicians or other health professionals within the past year.

**COMPARISON WITH OTHER STUDIES**

Table 3 compares our results with those of similar studies conducted within and outside the United States.17-20 The proportion of undetected hypertension and current smoking was similar among studies. The hyperlipidemia profile varies in studies depending on the age and sex distributions. The higher proportion of inadequately controlled hyperlipidemia in the Heart and Estrogen/Progestin Replacement Study and the Health Education and Research Trial might also be attributed to use of low-density lipoprotein cholesterol level to define hyperlipidemia. Some data for secondary prevention are also available from recent trials evaluating the effect of cholesterol lowering in patients with coronary heart disease and high or average cholesterol levels in the Scandinavian Simvastatin Survival Study,21 the Cholesterol and Recurrent Events trial,22 and the Long-term Intervention With Pravastatin in Ischaemic Disease Study.23 However, study inclusion criteria limit the extrapolation of these data to reflect the secondary prevention status in the general population.

**RISK REDUCTION WITH SECONDARY PREVENTION**

Uncontrolled hypertension (systemic blood pressure >140/90 mm Hg) was observed in 53% of participants with

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Table 3. Comparison of Studies Evaluating the Cardiovascular Risk Factor Status in Survivors of Cardiovascular Disease*

<table>
<thead>
<tr>
<th>Study and Year(s)</th>
<th>Study Site</th>
<th>Participants</th>
<th>Age, y</th>
<th>Elevated BP (&gt;140/90 mm Hg), %</th>
<th>Current Smokers, %</th>
<th>Elevated Total or LDL Cholesterol, %†</th>
<th>Elevated Blood Glucose, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Action on Secondary Prevention by Intervention to Reduce Events study,17 1991-1995</td>
<td>9 European countries</td>
<td>4863 Consecutive patients with a previous history of coronary artery disease</td>
<td>&lt;70</td>
<td>53</td>
<td>19</td>
<td>14‡</td>
<td>...</td>
</tr>
<tr>
<td>Heart and Estrogen/Progestin Replacement Study,18 1993-1994</td>
<td>18 US medical centers</td>
<td>2763 Postmenopausal women with coronary artery disease (those with poorly controlled hypertension and diabetes mellitus were excluded)</td>
<td>&lt;80 (range, 44-79)</td>
<td>...</td>
<td>13</td>
<td>64§</td>
<td>...</td>
</tr>
<tr>
<td>Health Education and Research Trial,19 1993-1995</td>
<td>5333 Persons screened in 4 midwestern medical centers in the US</td>
<td>603 Patients with cardiovascular disease</td>
<td>27-70</td>
<td>...</td>
<td>12</td>
<td>55§</td>
<td>...</td>
</tr>
<tr>
<td>Action on Secondary Prevention through Intervention to Reduce Events study,20 1996</td>
<td>24 Hospitals and clinics in the United Kingdom</td>
<td>2583 Patients with a previous history of coronary artery disease</td>
<td>≤70</td>
<td>Diastolic &gt;90 mm Hg: 27; systolic &gt;160 mm Hg: 17</td>
<td>19</td>
<td>27</td>
<td>6.5 (≥10 mmol/L)</td>
</tr>
<tr>
<td>Third National Health and Nutrition Examination Survey, 1988-1994</td>
<td>Household screening of 17,752 US adults</td>
<td>1252 Persons with myocardial infarction or stroke</td>
<td>≥18</td>
<td>47</td>
<td>18</td>
<td>30‡</td>
<td>49</td>
</tr>
</tbody>
</table>

*BP indicates blood pressure; LDL, low-density lipoprotein; and ellipses, data not provided in study report.
†Elevated total cholesterol level is defined as >6.21 mmol/L (>240 mg/dL) and elevated LDL cholesterol level is defined as >3.36 mmol/L (>130 mg/dL).
‡Defined by serum cholesterol level.
§Defined by serum LDL cholesterol level.
previously diagnosed hypertension. An additional 138 survivors (11%) had hypertension that was previously undetected. Noncompliance and lack of prescribed medication or treatment advice contributed minimally to poor control. Participants in the Hypertension Detection and Follow-up Program who had a previous history of MI had a 20% reduction in the total mortality rate. Uncontrolled hypertension in survivors of stroke is associated with poor prognosis. Direct evidence suggesting a link between stroke recurrence reduction and blood pressure reduction is lacking. A study comparing aggressive antihypertensive treatment with standard care demonstrated a 20% stroke reduction in patients with previous evidence of end-organ damage, including stroke. Poor control of diabetes mellitus was observed in 49% of participants with diabetes. Stroke survivors with diabetes have a 2-fold higher risk of subsequent stroke and MI than do those without diabetes. Whether aggressive glucose control reduces the risk of CVD events is debated. Reduction of CVD risk might depend more on control of other coexisting risk factors, such as obesity, hypertension, and lipid abnormalities. However, poor glycemic control can exacerbate or cause dyslipidemia. Smoking remains the most modifiable risk factor for MI and stroke survivors. Cessation of smoking after MI results in a 50% reduction in subsequent CVD events (compared with those who continue to smoke) independent of other factors. A 70% reduction in MI and death was reported in men and women older than 55 years with angiographically demonstrated coronary artery disease who quit smoking.

A high frequency of uncontrolled hypercholesterolemia was also observed in survivors. Cholesterol lowering for secondary prevention after MI has been shown to reduce the risk of subsequent MI. In the Coronary Drug Project, the mortality rate over a 15-year period was 11% lower in the niacin therapy group than in the placebo group. The maximum benefit was observed after 12 years of follow-up. In the West of Scotland Coronary Prevention Study, participants with or without previous coronary heart disease were randomized to receive pravastatin or placebo. The study concluded that the absolute benefit of pravastatin treatment for hypercholesterolemia was most prominent when used for secondary prevention of MI. The role of hypercholesterolemia is less well defined for secondary prevention of stroke. An overview analysis of 16 trials evaluating antilipemic medications demonstrated a significant reduction in cardiovascular events and death and stroke. The beneficial effect was seen in patients with or without previous coronary artery disease.

IMPACT OF RECENT CLINICAL TRIALS AND GUIDELINES

In recognition of the importance of this issue, the NCEP has carried out a variety of educational activities to develop and implement guidelines for treatment of elevated cholesterol levels. The first guidelines were available in 1988 at initiation of the study. The guidelines were updated in 1993 before completion of the present survey. Recent studies have also documented the benefits of antihypertensive treatment in patients with isolated systolic hypertension and diabetes mellitus. The physicians’ practices might have been affected by these studies since data collection in the NHANES III. Therefore, the effect of the updated guidelines and recent clinical trials might be undermined in the present study. More recent studies still continue to demonstrate the inadequacy of secondary prevention (Table 3). Frolkis et al reported that 36% of hospitalized patients and 46% of patients who should be treated for hyperlipidemia at discharge from coronary care units according to NCEP II guidelines were not treated. The study concluded that physicians are poorly compliant with NCEP guidelines.

INADEQUATE DIETARY INTAKE

In our study, a large proportion of participants had dietary habits that were not in accordance with NCEP I guidelines. This observation might have important implications as accumulating evidence suggests the role of diet in modification of hypertension and hypercholesterolemia. In the Lyon Diet Heart Study, the risk of cardiac death or nonfatal MI was lower in the Mediterranean dietary group than in the prudent Western-type dietary group. The protective effect was maintained for 4 years after the first MI.

FACTORS RELATED TO INADEQUATE SECONDARY PREVENTION

Our analysis suggests that attitudes toward risk factor modification, as seen in participants who were noncompliant with medications or continued to smoke, were a determinant of inadequate secondary prevention. Patient education and awareness efforts might favorably impact this issue. However, the analysis also suggests that a substantial proportion of survivors had hypertension or hypercholesterolemia that was not previously diagnosed. This observation highlights the importance of regular medical evaluation and follow-up in survivors of MI or stroke. Three population subsets were more likely to have an inadequately controlled CVD risk factor profile: middle-aged persons (46-65 years), African Americans, and women. The present study was not designed to determine the underlying reasons behind the association of age or sex with poor control of risk factors. However, the analysis identifies persons who might benefit most from risk factor modification efforts. Educational attainment and access to medical care as reflected by medical insurance status were not related to risk factor status. Furthermore, almost 90% of persons with poorly controlled risk factors had seen a medical professional in the past 6 months. Persons with high-risk profiles reported an average of 7 visits to the physician’s office within the past year. These observations emphasize the lack of implementation of secondary preventive strategies despite frequent medical evaluations.

ECONOMIC IMPACT OF SECONDARY PREVENTION

The economic burden of CVD in the United States is estimated to be $286.5 billion dollars annually. Light-
wood and Glantz\(^45\) estimated that a 1% reduction per year in the prevalence of smoking could result in savings of $3.2 billion over 7 years. Grover et al\(^46\) estimated that treatment of hypercholesterolemia in persons with CVD could result in an estimated 4.65 years of life saved. Similarly, treatment of hypertension could increase life expectancy by approximately 1.26 years. In their analysis, the forecasted benefits were prominent in primary prevention only when persons had multiple risk factors. However, the forecasted benefit was observed in secondary prevention in persons with single or multiple risk factors. We hope that our analysis encourages policymakers to increase funding to support secondary preventive efforts. At the individual physician level, a more thorough effort toward ensuring patient understanding of the importance of risk factor modification and regular medical evaluation might ensure compliance and early detection of new-onset hypertension or hypercholesterolemia.

ISSUE RELATED TO DATA INTERPRETATION

There are certain potential limitations to this study. The definitions of MI and stroke used to identify participants with previous CVDs were based on self-reported physician diagnoses. Previous studies have suggested that self-reported MI in the NHANES surveys is reasonably accurate to justify its use in assessment of risk factor and prevalence studies. A study\(^47\) was conducted in the early years of the National Health Survey to measure the accuracy and completeness of health interviews that concluded that the frequency of underreporting or overreporting was low for heart diseases. Bergmann et al\(^48\) compared interview reports with hospitalization records for 10,523 participants from NHANES I. The interview consisted of the same question for MI as used in NHANES III with a similar study population. A true-positive rate of 83% (95% CI, 78%-87%) was observed for the 294 self-reported MIs. O’Mahony et al\(^49\) validated the accuracy of assessing lifetime history of stroke in a random sample of 2000 persons aged 45 years and older in a mailed questionnaire. Participants were asked whether they ever had a stroke. Response accuracy was confirmed by review of medical records. The question had a sensitivity of 95% and a specificity of 96%. Similarly, high sensitivity (74%-100%) and specificity (94%-99%) have been reported for estimation of prevalent MI by means of mailed questionnaires.\(^50\)\(^51\) The status of certain risk factors such as smoking and compliance to medication was based on self-report without independent confirmation, which might undermine the prevalence of current smoking and compliance to medication. Similarly, the definition of undetected hypertension and hypercholesterolemia based on self-report is affected by participants’ awareness of such a diagnosis in addition to detection by a physician. Because the study was not longitudinal, there is a possibility that control of risk factors might have improved after the event compared with risk factor status before the event but might not have achieved the optimal level defined in our study. The number of participants available for analysis was relatively small (n=1252) but was comparable to that in other studies (Table 3).

CONCLUSIONS

Our analysis shows a high prevalence of inadequate secondary prevention in a subset of the US population at highest risk for stroke and MI. Strong motivation and regular access to medical care make MI and stroke survivors ideal candidates for education programs and medical treatment. Secondary prevention strategies are cost-effective because high-risk individuals are already identified by the medical system, and small efforts can make a large impact on outcome because of the large number of expected events. Most efforts need to be focused on African Americans, women, and persons aged 46 to 65 years. Unless risk factor modification efforts in survivors of MI and stroke are more effective, the high incidence of CVD and related mortality will continue.

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