Prevalence of Coronary Heart Disease Risk Factors and Screening for High Cholesterol Levels Among Young Adults, United States, 1999–2006

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ABSTRACT

PURPOSE Previous studies have reported low rates of screening for high cholesterol levels among young adults in the United States. Although recommendations for screening young adults without risk factors for coronary heart disease (CHD) differ, all guidelines recommend screening adults with CHD, CHD equivalents, or 1 or more CHD risk factors. This study examined national prevalence of CHD risk factors and compliance with the cholesterol screening guidelines among young adults.

METHODS National estimates were obtained using results for 2,587 young adults (men aged 20 to 35 years; women aged 20 to 45 years) from the 1999–2006 National Health and Nutrition Examination Surveys. We defined high low-density lipoprotein cholesterol (LDL-C) as levels higher than the goal specific for each CHD risk category outlined in the National Cholesterol Education Program Adult Treatment Panel III guidelines.

RESULTS About 59% of young adults had CHD or CHD equivalents, or 1 or more of the following CHD risk factors: family history of early CHD, smoking, hypertension, or obesity. In our study, the overall screening rate in this population was less than 50%. Moreover, no significant difference in screening rates between young adults with no risk factors and their counterparts with 1 or more risk factors was found even after adjustment for sociodemographic and health care factors. Approximately 65% of young adults with CHD or CHD equivalents, 26% of young adults with 2 or more risk factors, 12% of young adults with 1 risk factor, and 7% with no risk factor had a high level of LDL-C.

CONCLUSIONS CHD risk factors are common in young adults but do not appear to alter screening rates. Improvement of risk assessment and management for cardiovascular disease among young adults is warranted.

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INTRODUCTION

An abnormal lipid profile is a highly common but modifiable risk factor for coronary heart disease (CHD), a leading cause of mortality in the United States. The importance of screening for identification and clinical management of dyslipidemia is recognized by several professional associations and public health organizations. The National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), endorsed by the American Heart Association and the National Heart, Lung, and Blood Institute, recommends universal screening for high cholesterol levels beginning at age 20 years. The US Preventive Services Task Force (USPSTF) advocates a targeted cholesterol screening approach for young adults (men aged 20 to 35 years and women aged 20 to
Among all screened participants for the study cycles were 76% (9,282 of 12,160), 80% (10,477 of 13,156), 76% (9,643 of 12,761), and 77% (9,950 of 12,862), respectively. In this study, to increase the sample size and analytic options, data from the 4 study cycles were combined into 1 data set.

Among 39,352 participants invited to the Mobile Exam Center, 13,875 were randomly selected to fast 8 or more hours (up to 24 hours) for laboratory testing. As did the other subsamples, the fasting subsample has its own designated weight, which takes into account the complex survey design, survey nonresponse, and poststratification in representing the US civilian, noninstitutionalized census population. After exclusion of 10,663 participants aged younger than 20 years, men 35 years or older, or women 45 years or older, our study sample consisted of 3,212 participants. Women who had a positive urine pregnancy test or who reported that they were pregnant (n = 462), as well as participants with missing lipid profile data or blood pressure data (n = 163), were excluded, leaving an analytical sample of 2,587 participants.

**Assessment of CHD Risk Factors**

Participants with a self-reported history of CHD (angina or myocardial infarction) were identified as participants with CHD. Those participants with self-reported stroke or diabetes and those with fasting blood glucose levels of 126 mg/dL or higher were identified as participants with CHD equivalents.

We examined the following 4 CHD risk factors that according to the USPSTF guidelines should be used to determine the eligibility for cholesterol screening in young adults: (1) cigarette smoking (self-reported smoking every day or some days); (2) hypertension (the average of 3 blood pressure measurements from the NHANES physical examination at or exceeding 140/90 mm Hg, or self-reported current use of antihypertensive medication); (3) family history of premature CHD (angina or myocardial infarction) in a first-degree relative younger than 50 years; and (4) obesity (a body mass index of 30 or greater that was calculated as weight in kilograms divided by the square of the height in meters).

**Assessment and Definition of Screening Status**

The cholesterol screening rates were estimated based on the self-reported screening that took place before our study. Participants were asked whether they had ever had their blood cholesterol levels checked and how long it had been since their last cholesterol test. Screening was dichotomized as either (1) never screened or screened 5 or more years ago or (2) screened within the last 5 years.

**METHODS**

**Study Participants**

NHANES is a continuous survey of the health and nutritional status of the US civilian, noninstitutionalized population; participants are selected through a complex, multistage probability design. Each year, approximately 6,000 participants are selected to participate in the study. Persons who agree to participate are first interviewed in their homes about their health, disease history, and diet. All interviewed participants are invited to a local Mobile Exam Center for administration of additional questionnaires, physical examinations, and laboratory tests. NHANES data are released in 2-year increments, the present analysis was conducted with data from the 4 most recent study cycles: 1999-2000, 2001-2002, 2003-2004, and 2005-2006. The overall response rates for completed examinations among all screened participants for the study cycles were 76% (9,282 of 12,160), 80% (10,477 of 13,156), 76% (9,643 of 12,761), and 77% (9,950 of 12,862), respectively. In this study, to increase the sample size and analytic options, data from the 4 study cycles were combined into 1 data set.

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Lipid Measurements and Definition of High LDL-C Levels

We categorized LDL-C levels based on the ATP III risk categories and goals for therapeutic lifestyle changes and drug therapy (Table 1), and we defined high LDL-C levels as levels above the goal for each risk category. The group of participants with high LDL-C levels included those who were eligible for therapeutic lifestyle change and drug therapy. Details on the classification of the study participants into the 3 ATP III risk categories (high, intermediate, and low) are published elsewhere.5

For all lipid analyses, frozen venous serum samples were shipped on dry ice to the Lipoprotein Analytical Laboratory at the Johns Hopkins University Hospital, Baltimore, Maryland.6 Methods for determining total cholesterol, high-density lipoprotein cholesterol (HDL-C), and triglyceride levels for 1999-2006 NHANES surveys have been described elsewhere.5 LDL-C values were calculated from measured values of total cholesterol, triglycerides, and HDL-C according to the Friedewald calculation. All lipid measurements were standardized through the Centers for Disease Control and Prevention–National Heart, Lung, and Blood Institute Lipid Standardization Program.7

Assessment and Definition of Sociodemographic Characteristics

Information on race/ethnicity, health insurance coverage, education, income, and health care visits was obtained by using a structured questionnaire. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Mexican American, and others. The others group included multiple race and other Hispanic. Because the sample was designed to provide estimates for non-Hispanic white, non-Hispanic black, and Mexican American populations of the United States, we included the others group in the analysis but did not report estimates for this group because of its small sample size, heterogeneity, and nonrepresentative nature.

Participants were classified as insured if they reported having private insurance, Medicaid, or Civilian Health and Medical Program of the Uniformed Services (CHAMPLUS)/Veterans Affairs insurance. The poverty index ratio (total family income divided by the poverty threshold index adjusted for family size, composition, and location at year of interview) was categorized numerically according to the following descriptions: low (1 or less: family income is less than or equal to the poverty threshold index), medium (2 to 3: family income is 2 to 3 times as high as the poverty threshold index), and high (more than 3: family income is more than 3 times as high as the poverty threshold index). Health care access was assessed by responses to the question, “During the past 12 months, how many times have you seen a doctor or other health care professional about your health at a doctor’s office, a clinic, hospital emergency room, at home or some other place?” Participants’ responses were grouped into 4 categories: 0, 1, 2 to 3, and 4 or more times.

Data Analysis

Estimated population prevalence and standard errors were calculated using SUDAAN statistical software to account for nonresponse and the complex sampling design.8 The significance of a difference in prevalence was assessed by χ² test.8 Adjustment for multiple comparisons was made using the Bonferroni method.9 Orthogonal polynomial coefficients that are calculated recursively according to the method of Fisher and Yates were used for testing linear trends.8

| Risk Category | Goal mg/dL | Initiate Therapeutic Lifestyle Changes* mg/dL | Drug Therapyb mg/dL |
|---------------|------------|--------------------------------------------|---------------------|
| High: CHD5 or CHD equivalent6 (10-y risk >20%) | <100 | ≥100 | ≥100 (100<100: consider drug options) |
| Intermediate: ≥2 risk factors1 (10-y risk ≤20%)6 | <130 | ≥130 | ≥130: 10-y risk 10%-20% (100-129: consider drug options) |
| Low: ≤1 risk factor1 | <160 | ≥160 | ≥190 (160-189: LDL-lowering drug optional) |

CHD = coronary heart disease; LDL-C = low-density lipoprotein cholesterol; NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III.

1 Persons at high risk or moderately high risk who have lifestyle-related risk factors (eg, obesity, physical inactivity, elevated triglyceride level, low HDL-C level, or metabolic syndrome) are candidates for therapeutic lifestyle changes to modify these risk factors regardless of LDL-C level.

2 LDL-C lowering drug therapy, when given, should be sufficient to reduce LDL-C levels ≥30%-40%.

3 CHD includes history of myocardial infarction, unstable angina, stable angina, coronary artery procedures (angioplasty or bypass surgery), or evidence of clinically significant myocardial ischemia.

4 CHD equivalents include clinical manifestations of noncoronary forms of atherosclerotic disease (peripheral arterial disease, abdominal aortic aneurysm, and carotid artery disease, such as transient ischemic attacks or stroke of carotid origin or >50% obstruction of a carotid artery), diabetes, and ≥2 risk factors with a 10-year risk for hard CHD >20%.

5 CHD risk factors include cigarette smoking, hypertension (blood pressure >140/90 mm Hg or taking antihypertensive medication), low high-density lipoprotein cholesterol (<40 mg/dL), family history of premature CHD (CHD in male first-degree relative aged <55 years; CHD in female first-degree relative aged <65 years), and age (men ≥45 years; women ≥55 years). Electronic 10-year risk calculators are available at http://www.nhlbi.nih.gov/guidelines/cholesterol.

6 Almost all persons with ≥1 risk factor have a 10-year risk <10%; thus, a 10-year risk assessment is unnecessary.
Because the prevalence of screening was less than 50%, Cox regression was used to calculate prevalence proportion ratios and their 95% confidence intervals (CIs) to examine the association between screening and the predictors. Although Cox regression is used to estimate the cumulative incidence ratio for longitudinal data, it also can be used to estimate the prevalence proportion ratio for cross-sectional data when a risk period is constant (each observation has equal follow-up time).10

RESULTS

Table 2 shows the distribution of sociodemographic characteristics and risk categories in the population of interest. About 82% of the population had at least a high school education, 85% had an income above the poverty level, 73% had medical insurance, and 78% had accessed health care during the last 12 months. About 60% of the population had 1 or more CHD risk factors. A higher proportion of women had medical insurance (79% vs 65%, P <.05) and received health care 1 or more times during the last 12 months (87% vs 65%, P <.05) when compared with men. The prevalence of risk factors and NCEP ATP III risk categories was similar among women and men, except for obesity (31% vs 24%, respectively, P <.05).

Table 3 displays the rate of cholesterol screening by risk categories. Although the rate of screening for high cholesterol levels among persons without CHD

| Characteristic | Total No. | All % (SE) | Men % (SE) | Women % (SE) |
|----------------|-----------|------------|------------|--------------|
| **Sex**        |           |            |            |              |
| Male           | 1,041     | 38.8 (1.1) | 100        |              |
| Female         | 1,546     | 61.2 (1.3) | 100        |              |
| **Race/ethnicity** |         |            |            |              |
| Non-Hispanic White | 1,110   | 65.6 (1.7) | 62.3 (2.3) | 67.7 (1.7)   |
| Non-Hispanic black | 587      | 12.6 (1.1) | 11.5 (1.4) | 13.3 (1.2)   |
| Mexican-American | 651      | 10.5 (1.0) | 13.5 (1.3) | 8.6 (0.9)    |
| Other          | 239       | 11.3 (1.4) | 12.7 (1.9) | 10.4 (1.4)   |
| **Education**  |           |            |            |              |
| Less than high school | 657    | 18.2 (1.1) | 20.9 (1.7) | 16.6 (1.3)   |
| High school    | 633       | 25.7 (1.3) | 29.6 (2.0) | 23.2 (1.4)   |
| More than high school | 1,294 | 56.0 (1.6) | 49.5 (1.8) | 60.2 (2.0)   |
| **Poverty index** |         |            |            |              |
| 1              | 475       | 15.0 (0.9) | 13.7 (1.1) | 15.8 (1.2)   |
| 2-3            | 1,007     | 39.4 (1.4) | 43.5 (2.1) | 36.7 (1.4)   |
| ≥3             | 921       | 45.7 (1.5) | 42.8 (2.0) | 47.4 (1.5)   |
| **Medical insurance** |       |            |            |              |
| Yes            | 1,746     | 73.1 (1.2) | 64.8 (1.8) | 84.8 (1.3)   |
| No             | 841       | 26.9 (1.2) | 35.2 (1.8) | 21.6 (1.3)   |

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| Characteristic | Total No. | All % (SE) | Men % (SE) | Women % (SE) |
|----------------|-----------|------------|------------|--------------|
| **Risk factors** |         |            |            |              |
| High blood pressure | 286 | 10.9 (0.7) | 11.2 (1.2) | 10.6 (0.9)   |
| Smoking† | 557 | 24.1 (1.0) | 26.9 (1.4) | 22.3 (1.3)   |
| Family history‡ | 356 | 15.9 (0.8) | 13.8 (1.3) | 17.2 (1.1)   |
| Obesity§ | 791 | 28.3 (1.4) | 23.6 (1.4) | 31.3 (1.3)   |
| ≥2 | 436 | 17.9 (1.1) | 17.6 (1.4) | 18.0 (1.3)   |
| 1 | 965 | 37.3 (1.0) | 39.6 (1.7) | 35.9 (1.4)   |
| 0 | 1,060 | 40.2 (1.1) | 40.1 (1.8) | 40.3 (1.3)   |
| **NCEP ATP III risk categories** | | | | |
| High* | 131 | 4.8 (0.5) | 3.0 (0.5) | 6.0 (0.7)    |
| Intermediate† | 300 | 13.1 (0.9) | 17.7 (1.5) | 10.1 (0.9)   |
| Low‡ | 2,156 | 82.1 (1.1) | 79.3 (1.6) | 83.9 (1.1)   |
| Currently taking lipid-lowering medications | 36 | 1.7 (0.3) | NA§ | 2.3 (0.5) |

CHAMPS = Civilian Health and Medical Program of the Uniformed Services; CHD = coronary heart disease; NA = not available; NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; NHANES = National Health and Nutrition Examination Survey; SE = standard error.

| Note | |
|------|---|
| † Calculated as total family income/poverty threshold index adjusted for family size, composition, and location at year of interview: low (<1: family income less than or equal to poverty threshold index); medium (2-3: family income 2 to 3 times as high as poverty threshold index); and high (≥3: family income >3 times as high as poverty threshold index). |
| ‡ Having private insurance, Medicaid, or CHAMPS/Veterans Affairs insurance. |
| †† Assessed by responses to the question, “During the past 12 months, how many times have you seen a doctor or other health care professional about your health at a doctor’s office, a clinic, hospital emergency room, at home or some other place?” |
| § Self-reported coronary heart disease, angina, myocardial infarction, stroke, or diabetes (self-reported or fasting blood glucose ≥126 mg/dL). |
| ‡‡ Systolic blood pressure >140 mm Hg, diastolic blood pressure >90 mm Hg, or reporting a prescription medication for hypertension. |
| §§ Body mass index ≥30 kg/m² (weight in kilograms divided by the square of height in meters). |
| * CHD or CHD equivalent or ≥2 major CHD risk factors and a 10-year Framingham risk >20%. |
| † Two or more major CHD risk factors and a 10-year Framingham risk ≤20%. |
| ‡ One or no major CHD risk factor. |

Relative SE ≥30%, estimate is unreliable.
or a CHD equivalent was higher among women than among men (49%-53% vs 30%-38%, respectively), no significant difference in screening for cholesterol was observed among persons with 1 or 2 or more risk factors for CHD compared with persons with no risk factors in both sexes. The rate of screening for high cholesterol levels among persons with CHD or a CHD equivalent was less than 70% but was significantly higher than the screening rate for persons with no risk factors. Adjustment for sociodemographic characteristics in multivariate Cox regression models had only a small effect on screening rates by number of CHD risk factors regardless of sex.

Table 4 shows the prevalence of high LDL-C levels. Prevalence increased with the number of the CHD risk factors; 6.7% of persons with no risk factors had high LDL-C levels compared with 25.9% of those with 2 or more risk factors. The highest prevalence of high LDL-C levels (65.1%) was found among persons with CHD or a CHD equivalent. The prevalence of high LDL-C levels among young adults without CHD risk factors was 10.1% and 4.6% for men and women, respectively. Similar to the cholesterol screening, adjustment for sociodemographic characteristics in multivariate Cox regression models had only a small effect on prevalence of high LDL-C levels by number of CHD risk factors regardless of sex.

### DISCUSSION

According to 1999-2006 NHANES data, approximately 65% of young adults with CHD or a CHD equivalent, 26% of young adults with 2 or more risk factors, 12% of young adults with 1 risk factor, and 7% with no CHD risk factors had a high LDL-C level. Screening, however, for high blood cholesterol levels in young adults, except for persons with CHD or a CHD equivalent, was low: about 50% for women and less than 40% for men. The age and sex disparities in the use of preventive services have been reported before. For example, the screening rate increases as a function of age at the population level, and younger men are significantly less likely than younger women to receive certain preventive services. In our study, no significant difference was found in screening rates

| Risk Factors* | High LDL-Cb | High LDL-Cch | Risk Ratio (95% CI) |
|--------------|-------------|-------------|-------------------|
| All          | CHD or CHD equivalentd | 65.1 (4.2) | 12.8 (8.8;18.5) |
| ≥2           | 25.9 (2.6) | 4.0 (2.7;5.9) |
| 1            | 12.5 (1.3) | 1.8 (1.3;2.6) |
| 0            | 6.7 (0.8) | Referent    |
| Men 20-35 y  | CHD or CHD equivalentd | 55.1 (10.1) | 5.6 (1.6;11.9) |
| ≥2           | 27.5 (3.8) | 2.8 (1.5;5.1) |
| 1            | 13.9 (1.9) | 1.2 (0.7-2.1) |
| 0            | 10.1 (1.7) | Referent    |
| Women 20-45 y| CHD or CHD equivalentd | 68 (4.9) | 21.1 (13.4;33.3) |
| ≥2           | 24.9 (3.1) | 5.7 (3.5;9.2) |
| 1            | 11.6 (1.8) | 2.6 (1.5;4.4) |
| 0            | 4.6 (0.8) | Referent    |

### Table 3. Screening by Number of Risk Factors Among Men Aged 20 to 35 Years and Women Aged 20 to 45 Years (N = 2,587), NHANES, 1999–2006

| Risk Factora | Screeningb % (SE) | Screeningc Risk Ratio (95% CI) |
|--------------|-------------------|-----------------------------|
| All          | 67.7 (5.7)        | 1.5 (1.1-2.2)               |
| CHD or CHD equivalentd | 47.4 (3.0) | 1.2 (1.0-1.4) |
| ≥2           | 45.1 (2.3)        | 1.2 (1.0-1.4)               |
| 1            | 41.8 (1.8)        | Referent                     |
| 0            | 30.0 (2.4)        | Referent                     |
| Men 20-35 y  | 63.6 (10.9)       | 2.40 (1.40-4.13)            |
| ≥2           | 37.9 (4.8)        | 1.30 (0.87-1.94)            |
| 1            | 35.9 (2.7)        | 1.36 (1.01-1.84)            |
| 0            | 30.0 (2.4)        | Referent                     |
| Women 20-45 y| 68.9 (6.6)        | 1.32 (0.89-1.96)            |
| ≥2           | 53.4 (3.9)        | 1.12 (0.90-1.39)            |
| 1            | 51.6 (2.8)        | 1.10 (0.90-1.34)            |
| 0            | 49.3 (2.2)        | Referent                     |

CHD = coronary heart disease; CI = confidence interval; NHANES = National Health and Nutrition Examination Survey; SE = standard error.

a Risk factors: high blood pressure, smoking, family history, and obesity.
b Self-reported cholesterol screening within the last 5 years.
c N = 2,402 due to missing data. Each model was adjusted for race/ethnicity, education, poverty status, medical insurance status, and health care access during last 12 months, and age (continuous).
d Self-reported coronary heart disease, angina, myocardial infarction, stroke, or diabetes (self-reported or fasting blood glucose ≥126 mg/dL).
between young adults with no risk factors and their counterparts with 1 or more risk factors even after adjustment for sociodemographic and health care factors. Because the severity of atherosclerosis in young adults increases with the number of risk factors, the low screening rates, particularly among young persons with 2 or more risk factors, are of concern. A tendency for more ambulatory care visits has been proposed as a factor explaining higher screening rates among young women than among young men. The efficiency as a factor explaining higher screening rates for more ambulatory care visits has been proposed with 2 or more risk factors, are of concern. A tendency for higher screening rates, particularly among young persons with 2 or more risk factors, are of concern. A tendency for more ambulatory care visits has been proposed as a factor explaining higher screening rates among young women than among young men. The efficiency as a factor explaining higher screening rates for more ambulatory care visits has been proposed with 2 or more risk factors, are of concern.

The findings in this study suggest approximately two-thirds of all young adults have 1 or more cardiovascular risk factors. Among young adults, we found that the prevalence of high cholesterol levels increased with the number of CHD risk factors, but the cholesterol screening rate was less than 50% regardless of risk status. Our results indicate that improvement of risk assessment and management for cardiovascular disease among young adults through evidence-based clinical and public health interventions is warranted. To develop and implement these interventions successfully, a comprehensive analysis of the currently available prevention strategies is needed.

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CHD RISK FACTORS AND CHOLESTEROL SCREENING

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