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**Original article**

# Education differentials by race and ethnicity in the diagnosis and management of hypercholesterolemia: a national sample of U.S. adults (NHANES 1999–2002)

**Sharon Stein Merkin[1], Arun Karlamangla[1], Eileen Crimmins[2], Susan L. Charette[1], Mark Hayward[3], Jung Ki Kim[2], Brandon Koretz[1], Teresa Seeman[1]**

[1] *Division of Geriatrics, UCLA Geffen School of Medicine, Los Angeles, CA*
[2] *Andrus Gerontology Center, University of Southern California, Los Angeles, CA*
[3] *Population Research Center, University of Texas, Austin, TX*

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**Abstract**

**Objectives:** To examine education differentials in screening, awareness, treatment and control of hypercholesterolemia overall and in 3 race/ethnic groups.

**Methods:** We analyzed data for a nationally representative sample of 8,429 men and women ages 20 to 85 years, self-reported as white, black, Mexican American, or other race/ethnicity, who participated in the National Health and Nutrition Examination Survey from 1999–2002.

**Results:** Participants with <high school education were 2.5 times less likely than participants with ≥high school education to have been screened for hypercholesterolemia, after adjusting for age and gender (odds ratio: 0.4, 95 % confidence interval: 0.3–0.5, and similar across race/ethnic group). Multivariable models for awareness, treatment and control showed no significant trends associated with education after adjusting for age, gender, race and comorbidities.

**Conclusions:** Higher education significantly increased the odds of being screened for hypercholesterolemia overall and within each race/ethnic group. Education differentials were strongest for hypercholesterolemia screening, and weak or no longer apparent for subsequent steps of awareness, treatment and control. Focusing public health policy on increasing screening for individuals with low education might greatly improve their chances of preventing or mitigating morbidity related to hypercholesterolemia and subsequent cardiovascular disease.

**Keywords:** Cholesterol – Hypercholesterolemia – Education – Socioeconomic status – Race – Ethnicity.

## Introduction

High cholesterol is an established risk factor for coronary heart disease (CHD).[1] Proper detection and management of hypercholesterolemia is an important element in the prevention and mitigation of heart disease. While numerous studies have established associations between CHD and various indicators of low socioeconomic status (SES),[2] education has proven to be the strongest SES measure associated with cardiovascular disease risk factors.[3] One recent paper even suggested including education as a formal CHD risk factor in the National Cholesterol Education Program's (NCEP) guidelines.[4] Few studies, however have examined the pathway linking low education to CHD.

Poor detection and management of high cholesterol in people with low education may explain some of the association between education and CHD. Education can influence knowledge about disease risk factors[3,5] and the health care system, as well as the ability to utilize it effectively,[6,7] thus affecting the rate of screening for, and awareness of, hypercholesterolemia. This lack of knowledge and health care under-utilization might also influence treatment decisions and treatment compliance.

Accordingly, the objectives of this study were to examine associations between education and each of four sequential steps in the process of diagnosis and management of high cholesterol: screening, awareness, pharmaceutical treatment and control, in order to identify the education differentials at each stage. Furthermore, we examined the associations between education and these outcomes after adjusting for possible confounding factors.

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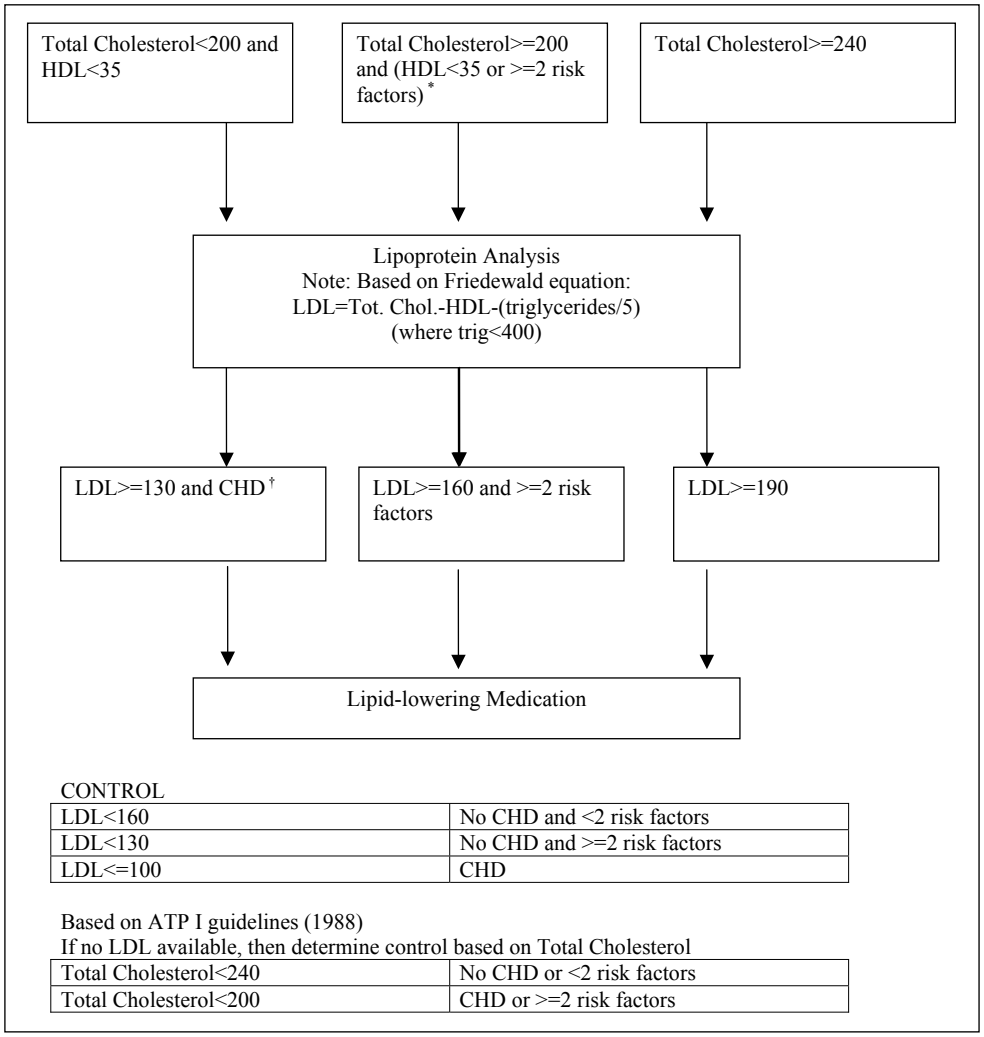


CONTROL

| | |
|---|---|
| LDL<160 | No CHD and <2 risk factors |
| LDL<130 | No CHD and >=2 risk factors |
| LDL<=100 | CHD |

Based on ATP I guidelines (1988)
If no LDL available, then determine control based on Total Cholesterol

| | |
|---|---|
| Total Cholesterol<240 | No CHD or <2 risk factors |
| Total Cholesterol<200 | CHD or >=2 risk factors |

**Figure 1.** NCEP Adult Treatment Panel II Guidelines (1994).

Research suggests that race and SES interact in their effects on health.[8] Many studies have been unable to examine the interaction between SES and race due to limited sample sizes for minority race/ethnic groups. Using NHANES data, a large, ethnically diverse nationally representative sample, we had the opportunity to investigate education differentials within race/ethnic groups. These associations were examined first in the entire sample, and then within race/ethnic groups.

## Methods

The study population included men and women ages 20 and older who participated in the National Health and Nutrition Examination Survey (NHANES), conducted between 1999 and 2002.

*Selection Criteria*

Age was determined at the time of the NHANES interview. Of the initial 21,004 participants, we excluded those under the age of 20, and those with missing data for any of the following variables: total serum cholesterol level, education, self-report of high cholesterol, or use of cholesterol medication (if missing both medication bottle review and self-report). The total study sample size was 8,429.

*Outcome Definitions*

The four primary outcome measures related to the diagnosis and management of hypercholesterolemia were screening, awareness, lipid-lowering medication use, and adequate control. Due to skip patterns in NHANES, these outcomes were sequential in nature, since only those who were screened were asked about awareness, and only those aware were asked about treatment. Previously published studies likewise examined these outcomes sequentially.[9–13]

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**Table 1.** Sequence of steps in diagnosis and management of hypercholesterolemia and corresponding definitions for study outcomes.

| Diagnosis steps | Study outcomes |
|---|---|
| **Screening** | $\text{Level of Screening} = \frac{\text{Number screened}}{\text{Number in population}}$<br>Screening was defined by a positive answer to the question: "Have you ever had your blood cholesterol checked?" |
| **Awareness** | Hypercholesterolemia (HC) was defined as measured serum cholesterol ≥ 240 mg/dL, or cholesterol < 240 mg/dL and HDL < 35 mg/dL, or total cholesterol ≥ 200 mg/dL plus 2 or more risk factors, or taking lipid-lowering medication. See Figure 1 for listing of CHD risk factors.<br>$\text{Level of awareness} = \frac{\text{Number aware}}{\text{Number screened who have hypercholesterolemia}}$<br>Awareness was assessed only in those who had been screened and had HC. In these individuals, it was defined as a positive response to the question: "Have you every been told by a doctor that you had high blood cholesterol?" |
| **Management steps** | |
| **Lipid lowering medication** | Criteria for lipid lowering medication use based on NCEP ATP II guidelines (Figure 1) and measured cholesterol fractions. People on medication also identified as meeting criteria.<br>$\text{Level of medication use} = \frac{\text{Number screened, aware of their HC, meet criteria for medication and are on medication}}{\text{Number screened, aware of their HC and meet criteria for medication use}}$<br>Use of lipid-lowering medication was determined from medical bottle review or self-report. In supplementary analyses, level of medication use was alternatively defined as:<br>$\frac{\text{Number on medication}}{\text{Number who meet criteria for medication use}}$ |
| **Control** | $\text{Level of adequate control} = \frac{\text{Number screened, aware of their HC, are on medication and HC is adequately controlled}}{\text{Number screened, aware of their HC and are on medication}}$<br>Adequate control definition based on NCEP criteria for control (Figure 1). In supplementary analyses, level of adequate control was alternatively defined as:<br>$\frac{\text{Number who are on medication and HC is adequately controlled}}{\text{Number who are on medication}}$ |

Level of screening was estimated as the proportion of the population that responded positively to the interview question: "Have you ever had your blood cholesterol checked?"

Awareness was defined, among those screened and with hypercholesterolemia, as a positive response to the interview question: "Have you ever been told by a doctor or other health professional that your blood cholesterol level was high?" The definition of hypercholesterolemia used in this study was determined based on the clinical guidelines for hypercholesterolemia that were current at the initiation of the NHANES 1999–2002 survey, i.e., NCEP Adult Treatment Panel (ATP) II guidelines published in 1994 (Figure 1).[1] Accordingly, hypercholesterolemia was said to be present if one of the following 4 conditions were met:1) total serum cholesterol ≥ 240 mg/dL, 2) taking lipid-lowering medication, 3) total serum cholesterol < 240 mg/dL and high-density lipoprotein (HDL) cholesterol < 35 mg/dL, or 4) total serum cholesterol ≥ 200 mg/dL and at least 2 coronary heart disease (CHD) risk factors: older age (men ages ≥ 45, women ages ≥ 55), family history of CHD (defined as relative with myocardial infarction < age 50), smoking, hypertension (blood pressure ≥ 140/90 mmHg or hypertension medication), or diabetes (defined by self-report or fasting blood glucose > 126). In addition, HDL ≥ 60 mg/dL was considered beneficial to the patient and therefore a "negative" risk factor for CHD (one risk factor point was subtracted if HDL ≥ 60). Use of lipid-lowering medication was also indicative of hypercholesterolemia.

Treatment of high cholesterol was determined from medication use (self report and medication bottle review), among those who met criteria for medication use. Criteria for pharmacological treatment were based on the NCEP ATP II guidelines[1] (Figure 1). In addition, everyone on lipid-lowering medications was considered to meet criteria for treatment, regardless of their measured cholesterol level. In keeping with the sequential nature of the process of diagnosis and management of hypercholesterolemia, lipid-lowering medication use was examined only in those who were screened, had hypercholesterolemia, and were aware of the diagnosis. Since screening and awareness were determined by self-report,

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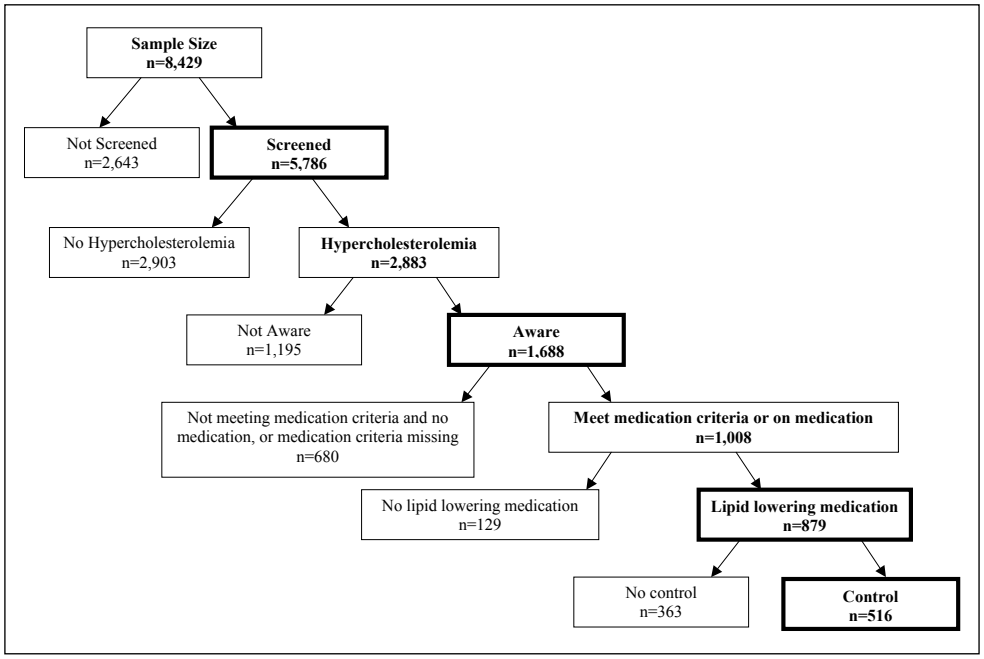


**Figure 2.** Sequential outcomes for diagnosis and management of hypercholesterolemia for the study sample.

which may be differentially prone to error based on level of education, in supplementary analyses, we also examined the level of treatment among those who met criteria for medication use without regard to screening and awareness status.

Among those taking lipid-lowering medication, adequate control was defined as measured cholesterol levels meeting NCEP ATP II definitions of adequate control[1] (Figure 1). If LDL (only based on those who fasted ≥9 hours) was not available (n=516), we used total cholesterol to determine control as described in the ATP I guidelines[14] (Figure 1). As with treatment, in supplementary analyses, we also examined the level of adequate control among those who were on lipid lowering medication without regard to screening and awareness status.

Table 1 provides a summary of all 4 primary and 2 supplementary outcome definitions and Figure 2 shows a flow chart describing the sample sizes in each sequential step.

*Outcome Measurements*

Data relevant to these outcomes were collected from individuals at a household interview, followed by an examination at the mobile examination center (MEC) or at home (for those unable to attend MEC exam). Variables for this study were obtained from NHANES Demographic, Questionnaire, Examination and Laboratory Files.[15,16] LDL cholesterol was calculated using the Friedewald equation: LDL cholesterol = Total cholesterol-HDL cholesterol-(triglycerides/5), for those who had fasted 9 or more hours, and had triglyceride values <400 mg/dL. In order to determine criteria for medication use, we used the same algorithm to estimate LDL for non-fasters, since this estimation approach (based on non-fasting triglycerides) underestimates LDL values. Thus if underestimated LDL nonetheless met NCEP criteria for medication use, those individuals were considered having met the criteria.

*Main Independent Variables*

Educational attainment was reported in NHANES as less than high school, high school diploma (including GED), and more than high school. Race/ethnicity consisted of the following self-reported categories: non-Hispanic white, non-Hispanic black, Mexican American and other (including other reported race groups, multiracial responses and missing on race/ethnicity). Analyses stratified by race/ethnicity excluded the "other" category.

*Analysis*

Population-level values for all analyses were estimated from the study sample by the use of the NHANES 1999–2002 weight variable for interviewed and MEC-examined participants (WTMEC4YR) to take into account selection probability and non-response. We examined the age-adjusted levels of screening, awareness, medication treatment and control by levels of education, overall and stratified by race/ethnic groups. Age adjustment consisted of standardizing age distributions separately within comparison groups to the overall US 2000 Census population. Analyses were run using Stata version 9,[17] accounting for the NHANES' complex study design.

Multivariate logistic regression models were fit for each outcome separately. Odds ratios by education levels were determined in the overall population, and then stratified by

**Table 2.** Distribution of select characteristics of study sample and excluded NHANES 1999–2002 population*.

| | Study Sample n = 8,429 | Excluded Sample n = 12,575 |
|---|---|---|
| **Age** mean (median) | 46.1 (44.0) | 16.4 (12.0) |
| **Gender** % Male | 48.1 | 49.9 |
| **Race** % | | |
| White | 72.3 | 60.7 |
| Black | 10.1 | 15.3 |
| Mexican American | 7.0 | 11.4 |
| Other | 10.5 | 12.6 |
| **Education** % | | |
| <High School | 21.3 | 76.5 |
| Complete High School | 25.4 | 10.7 |
| >High School | 53.3 | 12.8 |
| **Diagnosis** | | |
| **Screening** %‡ (n for denominator) | 70.5 (8,429) | 67.9 (1,462) |
| **Awareness** %‡ (n for denominator) | 59.7 (2,883) | † |
| **Medication** | | |
| **Treatment** %‡ (n for denominator) | 86.4 (1,008) | † |
| **Control** %‡ (n for denominator) | 58.1 (879) | † |

* All distributions are weighted by NHANES exam weight. All p-values for differences between study and excluded sample values were <0.0001.
† Sample sizes for excluded sample were too small for examining awareness, treatment and control (n = 31, 1 and 0, respectively).
‡ Awareness is based on those with reported screening and had high cholesterol (based on NCEP criteria or medication use). Treatment is based on those who reported screening, had high cholesterol, were aware of their condition. and who meet the NCEP treatment guidelines (including medication use). Control is based on those who were screened, had high cholesterol, aware and were taking cholesterol-lowering medication.

race/ethnic groups. Each model was adjusted for age (using group-specific weights for age-standardization), and gender. Considering that screening, awareness, treatment and control might be confounded by existing comorbid conditions, those models were additionally adjusted for comorbidity in supplemental analyses. Comorbidity was defined using two measures: the sum of the number of prevalent non-cardiovascular (CVD) conditions (asthma, arthritis, chronic bronchitis, emphysema, liver disease and cancer), and CVD conditions (diabetes, hypertension, CHD, myocardial infarction, stroke and angina).

## Results

*Descriptive Analyses*

The population distributions for variables of interest are listed in Table 2. Almost three quarters of the population was white; 10 % and 7 % were black and Mexican American, respectively. Over half had completed more than high school education. The results showed that 70.5 % of the population was screened for high cholesterol and 59.7 % of those who were screened and had high cholesterol (based on NCEP criteria listed at top row of Figure 1, or medication use) were aware of their condition. Of those individuals, 86.4 % of the participants who also met NCEP treatment criteria, were treated for hypercholesterolemia; of those treated, 58.1 % had their hypercholesterolemia adequately controlled. Compared to the excluded NHANES participants, this study sample had a higher percentage of older, white, and more educated individuals; a slightly lower percentage was male.

Age-adjusted percent distributions of the main outcomes overall and by education levels are presented in Table 3. Percentages of those screened for high cholesterol increased with each additional level of education (p-value for trend<0.0001). The proportion of those aware exhibited the opposite pattern, with awareness highest at the lowest education level (although the trend was not statistically significant). There was

**Table 3.** Age-adjusted* levels of high cholesterol screening, awareness, treatment and control in the U.S. population from 1999–2002, by education and race/ethnic groups.

| | Diagnosis | | Management | |
|---|---|---|---|---|
| | **Screened%** | **Awareness %** (of those screened and with high cholesterol) | **Medication treatment %** (of those screened, prevalent, aware, meeting NCEP guidelines) | **Control %** (of those screened, aware, prevalent, treated) |
| **Overall** | 70.5 | 52.4 | 77.2 | 60.9 |
| **n** | 8,429 | 2,883 | 1,008 | 879 |
| **Education** | | | | |
| <HS | 53.0 | 56.4 | 80.7 | 53.1 |
| Complete HS | 66.2 | 57.5 | 75.6 | 55.9 |
| >HS | 78.6 | 48.4 | 80.1 | 71.5 |
| P-value for Trend | <0.0001 | 0.07 | 0.95 | 0.05 |
| **White Education** | n = 4,190 | n = 1,706 | n = 616 | n = 538 |
| <HS | 59.7 | 60.1 | 80.3 | 47.1 |
| Complete HS | 66.6 | 57.5 | 85.3 | 59.1 |
| >HS | 79.6 | 48.1 | 78.2 | 71.2 |
| P-value for Trend | <0.0001 | 0.03 | 0.7 | 0.07 |
| **Black Education** | n = 1,539 | n = 449 | n = 164 | N = 137 |
| <HS | 50.4 | 50.8 | 80.5 | 60.3 |
| Complete HS | 60.7 | 41.6 | 75.5 | 33.7 |
| >HS | 75.5 | 47.1 | 86.7 | 71.3 |
| P-value for Trend | <0.0001 | 0.6 | 0.6 | 0.7 |
| **Mexican American Education** | n = 2,028 | n = 525 | n = 157 | N = 143 |
| <HS | 44.6 | 53.0 | 77.2 | 46.6 |
| Complete HS | 62.1 | 39.6 | 73.9 | 67.0 |
| >HS | 70.9 | 44.0 | 85.5 | 76.8 |
| P-value for Trend | <0.0001 | 0.2 | 0.5 | 0.02 |

* To adjust for age difference between comparison groups, each group was age-standardized so that the age distribution was the same in all the groups.

no apparent trend for medication treatment, however, levels of control among those on medication increased with higher education levels (p-value for trend = 0.05).

Education differentials were generally similar within each race/ethnic group, with some exceptions. The education gradient was strongest for screening rates in all 3 groups. There were no statistical associations between awareness and education except among whites (p = 0.03). Pharmacological treatment was not statistically associated with education. Results for hypercholesterolemia control showed generally higher percentages of control for those in the highest education level, although sample sizes were small. The association was statistically significant only for Mexican Americans (p = 0.02).

*Multivariable Analyses*

Multivariable regression models showed education to be directly associated with screening for hypercholesterolemia, after adjusting for age, gender and race/ethnicity; each additional level of education increased the odds of screening. Results in each of the 3 race/ethnic groups were similar to those for the overall sample (Table 4).

Results showed that individuals with less than a high school education had greater awareness of hypercholesterolemia compared to those with more than a high school education; this was statistically significant overall and among whites.

The odds of pharmacological treatment indicated no coherent trends with regard to education and the results were not statistically significant.

Models for control showed that persons with the least education were less likely to have their hypercholesterolemia under control, although these odds ratios were not statistically significant. Note however, that the sample sizes for treatment and control models, especially stratified by race/ethnicity, were substantially reduced.

Supplemental analyses conducted with additional adjustment for the number of comorbidities yielded similar re-

**Table 4.** Adjusted Odds Ratios (95 % confidence intervals) of screening, prevalence, awareness, treatment and control of high cholesterol*.

| | Diagnosis | | Management | |
|---|---|---|---|---|
| | **Screening %**<br>**n = 8,429** | **Awareness %**<br>(of those screened and with high cholesterol)<br>**n = 2,883** | **Medication treatment %**<br>(of those screened, prevalent, aware, meeting NCEP guidelines)<br>**n = 1,008** | **Control %**<br>(of those screened, aware, prevalent, treated)<br>**N = 879** |
| **Education (Overall)†** | | | | |
| <HS | 0.4 (0.3–0.5) | 1.5 (1.0–2.2) | 1.1 (0.5–2.4) | 0.4 (0.2–1.0) |
| Complete HS | 0.5 (0.5–0.6) | 1.4 (1.0–2.1) | 0.8 (0.4–1.8) | 0.5 (0.2–1.4) |
| >HS | Reference | Reference | Reference | Reference |
| P-value for Trend | <0.0001 | 0.04 | 0.9 | 0.05 |
| **WHITE Education** | | | | |
| < HS | 0.4 (0.3–0.5) | 1.6 (1.0–2.7) | 1.1 (0.4–3.1) | 0.4 (0.1–1.0) |
| Complete HS | 0.5 (0.4–0.6) | 1.4 (0.9–2.2) | 1.7 (0.7–4.0) | 0.6 (0.2–1.7) |
| >HS | Reference | Reference | Reference | Reference |
| P-value for Trend | <0.0001 | 0.03 | 0.7 | 0.06 |
| **BLACK Education** | | | | |
| < HS | 0.3 (0.2–0.5) | 1.2 (0.6–2.3) | 0.7 (0.2–2.5) | 0.6 (0.2–2.3) |
| Complete HS | 0.5 (0.4–0.7) | 0.8 (0.3–2.2) | 0.6 (0.1–2.7) | 0.3 (0.1–1.2) |
| >HS | Reference | Reference | Reference | Reference |
| P-value for Trend | <0.0001 | 0.6 | 0.6 | 0.6 |
| **MEXICAN AMERICAN** | | | | |
| Education | | | | |
| < HS | 0.3 (0.2–0.5) | 1.4 (0.7–2.8) | 0.4 (0.1–2.4) | 0.4 (0.1–1.2) |
| Complete HS | 0.7 (0.4–1.1) | 0.8 (0.4–1.7) | 0.5 (0.03–6.7) | 0.6 (0.1–3.0) |
| >HS | Reference | Reference | Reference | Reference |
| P-value for Trend | <0.0001 | 0.3 | 0.3 | 0.06 |

* Models were adjusted for age, gender. Age was adjusted for by including age-standardized weights (standardized to the US 2000 Census population and weighted using NHANES MEC/EXAM weight) in the model.
† Additionally adjusted for race.

sults, with slightly attenuated odds ratios for awareness (overall OR:1.4, 95 % CI:0.9–2.1 for <high school vs. >high school, p-value for trend=0.08; for whites: OR:1.5, 95 % CI:0.9–2.5, p-value for trend=0.06). The same was true for the treatment and control models, where results were similar to the main analyses (and not statistically significant). Only the screening models yielded statistically significant results (data not shown).

Additional sensitivity analyses considered the more global definitions of treatment (level of treatment among those who met criteria for medication use without regard to screening and awareness status) and control (level of adequate control among those who were on lipid lowering medication without regard to screening and awareness status). The odds ratios using these definitions were similar to the main analyses; no trends were apparent by education level.

Finally, our analyses confirmed that the education differentials with regard to screening remain after accounting for health care access. We examined this issue by adjusting the screening models for 2 factors: health insurance coverage, and whether a participant has a routine place available for health care (including clinics, doctor office, HMO, or outpatient hospital visits). After adjusting for these factors, the odds ratios were attenuated, but significant risk of no screening remained strongly associated with low education (overall, OR:2.1, 95 % CI:1.7–2.7 for <high school vs. >high school; for whites, OR:2.2, 95 % CI:1.5–3.1; for blacks OR:2.7, 95 % CI:2.0–3.7; for Mexican Americans, OR:2.0, 95 % CI:1.4–2.7; p-values for all education trends<0.0001).

## Discussion

This study suggests a strong association between education and greater screening for hypercholesterolemia. Odds of not being screened for high cholesterol were 2.5 times greater for

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those with the lowest education compared to the highest (inverse odds of screening, see Table 4). Our results indicate that these education differentials persist across race/ethnic communities, and thus present a widespread public health concern. Moreover, while these analyses examine the most recent NHANES data, we also examined NHANES III (1988–1994) data and found comparable education differentials for the previous 10-year period.

These results parallel previous studies that have found associations between lower income and reduced screening for high cholesterol. Low income has been associated with less screening for hypercholesterolemia, as well as less preventive care for other conditions, among insured and uninsured individuals,[18,19] indicating that SES differentials are not solely due to differences in access to care.

After accounting for financial resources and access to care, low education remains an important barrier to preventive care. Sabates and Feinstein [7] maintain that "education is one of the most important distal factors in explaining uptake of screening" and suggest that education affects screening through awareness, health knowledge, as well as through psychosocial factors such as social inclusion, self-confidence and motivation. [7] Davis et al found that low education was significantly associated with less screening for high cholesterol, [5] after accounting for interaction with a physician in the past year, and suggest that lack of knowledge and health insurance hurdles regarding preventive care measures might be responsible. [5,20]

Among those who were screened and determined to have high cholesterol, there were some marginal associations of greater awareness among those with lower education. While this association was unexpected, it may have been due to greater prevalence of other diseases among those of lower SES and greater awareness of high cholesterol in relation to overall poor health, since the associations were somewhat attenuated after adjustment for comorbidities. We could not, however, fully explain this association after adjusting for comorbid conditions (although odds ratios were no longer statistically significant). This might indicate residual confounding, perhaps due to our limited measures of self-reported comorbid conditions. This issue should be examined further with a variety of clinically determined conditions that might indicate general illness and account for health-seeking behavior.

Patterns of pharmacological treatment did not differ significantly by education level, even after adjusting for age, race and gender (as well as comorbidities). Although the odds ratios were not statistically significant, control of hypercholesterolemia appeared to be higher among those with the highest education. Moreover, the p-values for education trends for the overall model, whites and Mexican Americans were marginally significant. It is possible that with increased sample sizes, these odds ratios would be significant. It is important that future research examine education differentials with regard to treatment and control to ascertain the significance of these results.

Overall, we found a strong socioeconomic association with high cholesterol screening, and weak or no education differentials with regard to awareness, treatment and control. While we were only able to consider crude measures of health care access, future research is warranted to assess how low socioeconomic status may prevent initial screening for a condition that might then be managed effectively.

There are some limitations to this study that may affect the generalization of these results. Foremost, is the concern of inadequate power to detect education effects on treatment and control because of small samples sizes for analyses of the study outcomes, especially in race-stratified analyses. However, supplemental analyses considering more global definitions of treatment and control (with larger sample sizes) showed the same weak associations.

Another limitation relates to the sequential determination of diagnosis and management of hypercholesterolemia. Due to skip patterns inherent in NHANES data, we were unable to adequately examine awareness, treatment and control for the total population, and were restricted to those who had been screened and were subsequently aware of their condition.

Our initial outcome of screening was also based solely on self-report. While many other studies rely on self-reported screening information, [5,7] it is possible that those of lower education might be more likely to be unaware of the nature of their medical tests, which may have overestimated our results. However, the association between low education and low awareness of screening (rather than actual low screening), may be just as harmful if no additional care is sought, and thus just as relevant from a public health perspective.

In addition, this study did not assess non-pharmacological means of hypercholesterolemia management, including diet and exercise, which are often the first steps in the management of this condition. While the focus of this paper was on lipid-lowering treatment, future studies might address the education differentials related to non-pharmacological treatment of hypercholesterolemia.

An additional limitation relates to the exposure variable. Our study focused on education differentials only. While education differentials might only be associated with initial diagnosis of this condition, it is possible that other socioeconomic barriers (such as income) might be associated with other stages of disease management.

Our results suggest that the most robust education-related barrier to hypercholesterolemia management is at the screening stage; this association exists in every race/ethnic group. Once

screening has occurred and preventive care initiated, education differentials are reduced with regard to subsequent disease management.

Future policy and research should focus on education initiatives to promote screening of hypercholesterolemia, especially among those with limited education.

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**Address for correspondence**

**Sharon Stein Merkin, MHS, PhD**
**Division of Geriatrics**
**Geffen School of Medicine at UCLA**
**10945 Le Conte Avenue, Suite 2339**
**Los Angeles, California 90095-1687**
**USA**
**Tel.: 310-825-8253**
**Fax: 310-794-2199**
**E-mail: smerkin@mednet.ucla.edu**