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Vital Signs: Prevalence, Treatment, and Control of Hypertension — United States, 1999–2002 and 2005–2008

ABSTRACT

Background: Hypertension is a modifiable risk factor for cardiovascular disease. It affects one in three adults in the United States and contributes to one out of every seven deaths and nearly half of all cardiovascular disease–related deaths in the United States.

Methods: CDC analyzed data from the National Health and Nutrition Examination Survey (NHANES) on the prevalence, treatment, and control of hypertension among U.S. adults aged ≥18 years. Hypertension was defined as an average blood pressure ≥140/90 mmHg or the current use of blood pressure–lowering medication. Control of hypertension was reported as an average treated systolic/diastolic blood pressure <140/90 mmHg. Multivariate analysis was performed to assess changes in prevalence of hypertension, use of pharmacologic treatment, and control of blood pressure between the 1999–2002 and 2005–2008 survey cycles.

Results: During 2005–2008, approximately 68 million (31%) U.S. adults aged ≥18 years had hypertension, and this prevalence has shown no improvement in the past decade. Of these adults, 48 million (70%) were receiving pharmacologic treatment and 31 million (46%) had their condition controlled. Although 86% of adults with uncontrolled blood pressure had medical insurance, the prevalence of blood pressure control among adults with hypertension was especially low among participants who did not have a usual source of medical care (12%), received medical care less than twice in the previous year (21%), or did not have health insurance (29%). Control prevalence also was low among young adults (31%) and Mexican Americans (37%). Although the prevalence of hypertension did not change from 1999–2002 to 2005–2008, significant increases were observed in the prevalence of treatment and control.

Conclusions: Hypertension affects millions of persons in the United States, and less than half of those with hypertension have their condition controlled. Prevalence of treatment and control are even lower among persons who do not have a usual source of medical care, those who are not receiving regular medical care, and those who do not have health insurance.

Implications for Public Health Practice: To improve blood pressure control in the United States, a comprehensive approach is needed that involves policy and system changes to improve health-care access, quality of preventive care, and patient adherence to treatment. Nearly 90% of persons with uncontrolled hypertension have health insurance, indicating a need for health-care system improvements. Health-care system improvements, including use of electronic health records with registry and clinical decision support functions, could facilitate better treatment and follow-up management, and improve patient-physician interaction. Allied health professionals (e.g., nurses, dietitians, health educators and pharmacists) could help increase patient adherence to medications. Patient adoption of healthy behaviors could improve their blood pressure control. Reducing dietary intake of salt would greatly support prevention and control of hypertension; a 32% decrease in average daily consumption, from 3,400 mg to 2,300 mg, could reduce hypertension by as many as 11 million cases. Further reductions in sodium intake to 1,500 mg/day could reduce hypertension by 16.4 million cases.

U.S. Department of Health and Human Services
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Introduction

Hypertension, a major risk factor for cardiovascular disease, affects approximately one in three adults in the United States. Every year, hypertension contributes to one out of every seven deaths in the United States and to nearly half of all cardiovascular disease–related deaths, including stroke (*1*). If all hypertensive patients were treated sufficiently to reach the goal specified in current clinical guidelines, 46,000 deaths might be averted each year (*2*). In addition to the cost in lives lost, hypertension is costly to the health-care system. The American Heart Association recently estimated that direct and indirect costs of hypertension are more than $93.5 billion per year, and that cardiovascular disease and stroke account for 17% of the total health expenditures in the United States annually (*3*).

This report uses data from the National Health and Nutrition Examination Survey (NHANES) to examine the prevalence, pharmacologic treatment, and control of hypertension among U.S. adults. The examination focuses on indicators of the use of medical care, as well as on demographic characteristics and socioeconomic factors.

Methods

NHANES is a complex, multistage probability sample of the noninstitutionalized population of the United States. Details of the NHANES methodology can be found elsewhere (*4*). Data from NHANES from 2005–2008, the most recent nationally representative data available on hypertension, were analyzed. During this time frame, 11,154 participants aged ≥18 years were interviewed and examined. Women who were pregnant or whose pregnancy status could not be determined (505) were excluded, as were participants who did not have at least one complete blood pressure measurement or information on current medication usage (617), or were missing covariates of interest (56), yielding an analytic sample of 10,037.

To examine changes over time, 1999–2002 NHANES data also were analyzed. From the 10,393 adult participants included in those data, 830 women who were pregnant or whose pregnancy status was unknown were excluded, as were 631 participants who were missing blood pressure information and 275 participants who were missing data on the covariates of interest, yielding a sample size of 8,851. Mobile examination center response rates for NHANES ranged from 75% to 80% during the study period.

This study used the average of up to three blood pressure measurements, obtained under standard conditions during a single physical examination at the mobile examination center (*4*). Approximately 95% of participants had two or three complete blood pressure measurements. For participants with only one blood pressure measurement, that single measurement was used in place of an average. Current use of blood pressure–lowering medication was determined based on participant self-report. Hypertension was defined as an average systolic blood pressure ≥140 mmHg, an average diastolic blood pressure ≥90 mmHg, or the current use of blood pressure–lowering medication. Treatment of blood pressure was defined as the self-reported current use of blood pressure–lowering medication, and its prevalence was calculated among all those defined as having hypertension. Blood pressure control was defined as a treated blood pressure <140 mmHg systolic and <90 mmHg diastolic, and its prevalence was calculated among all those with hypertension, as defined above (Figure 1).

Multivariate regression analysis was used to examine changes in prevalence of high blood pressure, blood pressure medication use, and pharmacologic control of high blood pressure from 1999–2002 to 2005–2008. All analyses were conducted using statistical software to account for sampling weights and adjust variances for the multistage, clustered sample designs. Population counts were calculated using the Current Population Surveys.*

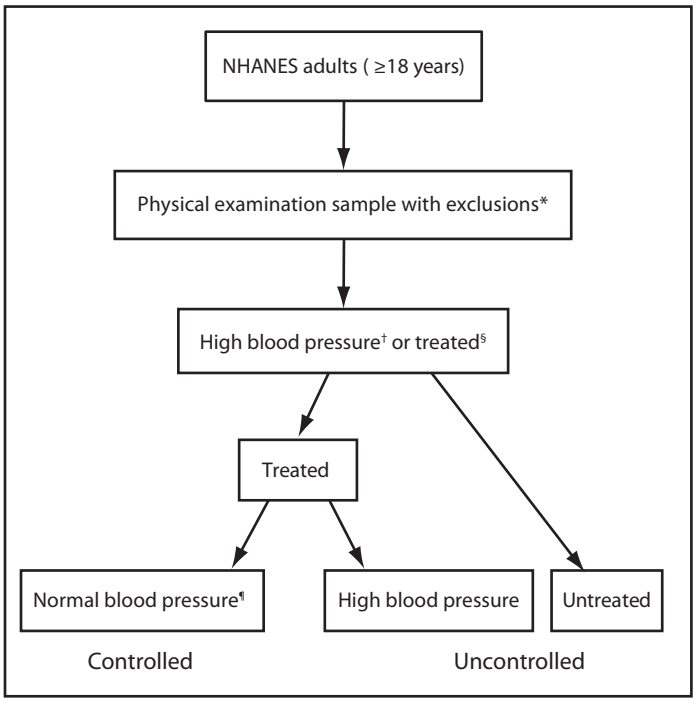
Results

The overall U.S. prevalence of hypertension among adults aged ≥18 years in 2005–2008 was 30.9% and was highest among persons aged ≥65 years (69.7%), non-Hispanic blacks (38.6%), and those participants with Medicare coverage (68.1%) (Table). Among persons with hypertension, the prevalence of pharmacologic treatment in 2005–2008 was 69.9%. The prevalence of treatment was lowest among persons aged 18–39 years (37.4%), Mexican Americans (56.1%), those without a usual source of medical care (19.8%), those who reported receiving medical care less than twice during the previous year (33.8%), and those without health insurance (43.5%). The overall prevalence of control among participants with hypertension was 45.8% during 2005–2008. The prevalence of control was lowest among persons aged 18–39 years (31.4%), Mexican Americans (36.9%), those without a usual source of medical care (12.1%), those who received medical care less than twice in the previous year (21.1%), and those without health insurance (29.0%) (Table). However, additional analysis using the same 2005–2008 NHANES data showed that 86.1% of adults with uncontrolled hypertension had either public or private medical insurance.

The prevalence of hypertension did not change significantly from 1999–2002 (28.1%) to 2005–2008 (30.9%) (Figure 2), after adjustment for sex, age, race/ethnicity, and poverty-income

*Additional information is available at http://www.cdc.gov/nchs/tutorials/nhanes/faqs.htm.

FIGURE 1. Study definitions for adults with hypertension whose blood pressure was treated or controlled for hypertension — National Health and Nutrition Examination Survey (NHANES), United States, 1999-2002 and 2005-2008



* Excludes pregnant women and participants with missing data needed for determining hypertension status.
† Average systolic pressure ≥140 mmHg or average diastolic pressure ≥90 mmHg.
§ Self-reported currently taking blood pressure–lowering medication.
¶ Average systolic pressure <140 mmHg and average diastolic pressure <90 mmHg.

ratio (p=0.24). The prevalence of pharmacologic treatment among those with hypertension increased from 60.3% to 69.9% during this period, and the adjusted increase was significant (p<0.01). The prevalence of control also changed significantly during this time, increasing from 33.2% in 1999–2002 to 45.8% in 2005–2008 (p<0.01).

Conclusions and Comments

The results of this analysis show that the prevalence of hypertension in U.S. adults during 2005–2008 was approximately 30%; another NHANES report has shown that this prevalence has remained unchanged during the past 10 years (*5*). Significant increases in the prevalence of pharmacologic treatment and control of blood pressure among persons with hypertension have been observed in the past decade.

In spite of these gains, 30% of patients with hypertension are not being treated pharmacologically, and only 46% of persons with hypertension have their blood pressure under control. The greatest need for improvement in control is among those persons who do not have a usual source of medical care, those who reported receiving care less than twice in the previous year, and those without health insurance.

The findings of this study are consistent with the findings of other studies illustrating that inadequate control of hypertension often is related to gaps in availability of, access to, use of, or continuity of health care (*6,7*). The Affordable Care Act (ACA) is intended to extend insurance coverage to 94% of the non-elderly U.S. population by 2019 (*8,9*). By reducing patient out-of-pocket expenses for medical visits, ACA provisions extending insurance coverage for preventive services with no cost sharing are designed to enhance patient access to those preventive services and are anticipated to improve patient use of those services (*8,9*). Among those with uncontrolled hypertension, approximately 86% reported having some form of health insurance, indicating that for most patients, insurance is necessary but not sufficient to achieve blood pressure control. Several programmatic initiatives promoted by ACA, including patient-centered medical homes, accountable care organizations, and the federally qualified health center program (*9*), can contribute to improved health-care access and quality.

Poor adherence to medication regimens is another barrier to blood pressure control and might explain, in part, the low prevalence of blood pressure control observed even among patients with health insurance. Medication costs, complicated regimens, adverse effects, and insufficient physician-patient communication are among major factors cited as associated with decreased patient adherence to medication regimens (*10*).

The American Heart Association; the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; and the U.S. Preventive Services Task Force also recommend the adoption of nonpharmacologic therapies associated with reductions in blood pressure. These recommendations include 1) achieving and maintaining a healthy body weight; 2) participating in regular leisure-time physical activity; 3) adoption of a healthy diet, including reduced salt intake and increased potassium intake; 4) smoking cessation; and 5) stress management.

Numerous clinical trials and longitudinal studies demonstrate that even small reductions in salt intake lower blood pressure and might prevent development of hypertension or improve blood pressure control among adults with hypertension (*11*). If average sodium intake in the United States was reduced from the current level of >3,400 mg/day to no more than 2,300 mg/day, an estimated 11 million fewer adults would be hypertensive. A reduction of 16.4 million cases of hypertension could be observed if intake were decreased to the recommended adequate intake of 1,500 mg/day (*12*). However, 90% of U.S. adults consume more salt than is recommended currently, nearly 80% of which comes from packaged, processed, and restaurant foods (*13*).

TABLE. Prevalence of hypertension among adults aged ≥18 years, and the prevalence of treatment and control among adults with hypertension — National Health and Nutrition Examination Survey, United States, 2005–2008

	Hypertension* (n = 10,037)¶		Treatment† (n = 3,569)		Control§ (n = 3,569)	
Characteristic	%**	(95% CI)	%	(95% CI)	%	(95% CI)
Total	**30.9**	**(29.4–32.4)**	**69.9**	**(67.4–72.2)**	**45.8**	**(43.7–48.0)**
Sex						
Male	30.0	(28.3–31.8)	63.8	(60.1–67.4)	43.8	(40.5–47.2)
Female	31.7	(29.9–33.5)	75.3	(73.2–77.4)	47.7	(45.8–49.6)
Age group (yrs)						
18–39	7.4	(6.2–8.7)	37.4	(30.1–45.2)	31.4	(24.6–39.1)
40–64	35.6	(33.6–37.7)	68.9	(66.1–71.6)	48.4	(45.7–51.2)
≥65	69.7	(67.0–72.4)	78.7	(76.5–80.6)	45.7	(43.0–48.4)
Race/ethnicity††						
White, non-Hispanic	32.3	(30.4–34.2)	71.2	(68.3–73.9)	47.7	(45.3–50.0)
Black, non-Hispanic	38.6	(35.6–41.6)	71.7	(67.7–75.4)	42.7	(39.7–45.8)
Mexican-American	17.3	(14.6–20.3)	56.1	(49.9–62.2)	36.9	(33.6–40.3)
Poverty-income ratio§§						
<100%	25.9	(23.2–28.9)	70.7	(64.9–75.9)	42.0	(35.0–49.4)
100–199%	35.1	(33.0–37.2)	69.9	(66.7–73.0)	42.3	(38.8–45.9)
200–499%	28.8	(26.6–31.2)	69.5	(64.8–73.8)	48.0	(43.8–52.2)
≥500%	29.2	(26.9–31.5)	70.5	(64.8–75.7)	51.8	(47.3–56.2)
Education (age ≥25 yrs)						
Less than high school	42.1	(39.0–45.3)	69.0	(65.1–72.6)	40.0	(36.1–43.9)
High school graduate	39.3	(36.4–42.2)	71.3	(68.2–74.3)	46.0	(42.9–49.1)
Some college	32.1	(30.1–34.2)	70.7	(65.8–75.2)	46.8	(42.7–50.9)
College graduate	28.5	(25.6–31.6)	71.8	(65.6–77.2)	52.9	(48.1–57.7)
Usual source of care¶¶						
Yes	33.8	(32.2–35.5)	73.4	(70.9–75.8)	48.3	(46.1–50.5)
No	14.0	(12.0–16.2)	19.8	(14.8–26.0)	12.1	(7.6–18.6)
Times received care in past year***						
0–1	17.6	(16.0–19.3)	33.8	(28.1–40.1)	21.1	(16.3–27.0)
2–3	36.8	(34.5–39.1)	78.6	(76.2–80.8)	52.1	(49.6–54.6)
≥4	43.5	(40.5–46.7)	80.2	(76.1–83.7)	52.0	(47.2–56.7)
Health insurance†††						
Medicare	68.1	(65.2–70.9)	79.3	(77.1–81.2)	47.2	(44.5–49.8)
Private	23.0	(21.2–24.9)	67.0	(63.2–70.5)	47.8	(44.6–51.1)
Public	30.9	(26.7–35.5)	71.6	(61.4–80.0)	51.5	(42.7–60.2)
Uninsured	17.2	(15.9–18.7)	43.5	(36.6–50.6)	29.0	(23.3–35.5)

Abbreviation: CI = confidence interval.

* Average blood pressure ≥140/90 mmHg or reported current use of blood pressure-lowering medication.

† An answer of "yes" to the question, "Are you currently taking medication to lower your blood pressure?" Among those with hypertension (average systolic blood pressure ≥140 mmHg, average diastolic pressure ≥90 mmHg, or current medication use).

§ Average treated blood pressure <140/90 mmHg on examination among all persons with hypertension.

¶ Unweighted sample size.

** Weighted estimates.

†† Participants of other racial/ethnic groups included in analysis.

§§ Participants missing poverty-income ratio included in analysis.

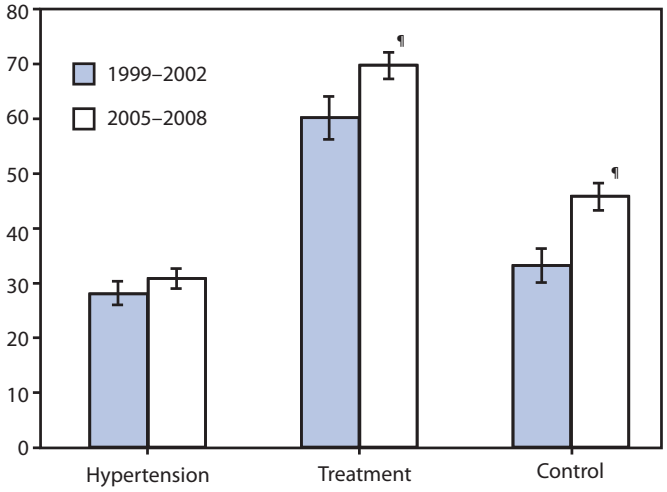
¶¶ Participants were asked "Is there a place that you usually go when you are sick or need advice about your health?" Yes responses include those who answered "yes" or "there is more than one place".

*** Participants were asked "During the last 12 months how many times have you seen a doctor or other health professional about your health at a doctor's office, a clinic, hospital emergency room, at home or some other place? Do not include times you were hospitalized overnight."

††† Public insurance includes all public non-Medicare coverage, with the exception of Indian Health Service. Uninsured includes participants with Indian Health Services or single service plan only.

Reducing sodium intake to recommended levels will require changes in the manufacture and production of packaged, processed, and restaurant food, as well as changes by persons in their food consumption. Some manufacturers have committed to substantial sodium reduction, as has been done in other countries (*14*). On January 20, 2011, for example, Walmart announced plans to reduce sodium content of their corporate label foods by 25% by 2015 (*15*). Persons can lower their sodium intake by consuming more fresh fruits and vegetables and selecting food products and menu items labeled as "low sodium" or "no sodium added." This is particularly important for those in population groups that have a high risk for cardiovascular disease, including those with hypertension, older adults, African Americans, and those with diabetes or chronic kidney disease

FIGURE. 2 Prevalence of hypertension,* prevalence of treatment† and control§ of blood pressure among persons with hypertension — National Health and Nutrition Examination Survey, United States 1999–2002 and 2005–2008.



* Average systolic blood pressure ≥140 mm Hg, average diastolic pressure ≥90 mmHg, or current blood pressure–lowering medication use.
† An answer of "yes" to the question, "Are you currently taking medication to lower your blood pressure?" Among those with hypertension (average systolic blood pressure ≥140 mmHg, average diastolic pressure ≥90 mmHg, or current medication use). Unadjusted prevalence.
§ Average treated blood pressure <140/90 mmHg on examination among all persons with hypertension. Unadjusted prevalence.
¶ Test for difference in prevalence statistically significant (p<0.01) after adjustment for sex, age group, race/ethnicity, and poverty-income ratio.

(*16*). Food manufacturers and restaurants have an opportunity to positively affect the health of the nation by voluntarily and gradually reducing the amount of sodium used in processed, packaged, and restaurant foods.

Lifestyle and environmental strategies to reduce blood pressure also might benefit persons who have blood pressure that is below 140/90 mmHg, but not necessarily optimal. Blood pressure reductions below the threshold for clinical hypertension (i.e., down to 115/75 mmHg) can have additional health benefits over time. For example, in a meta-analysis of 61 prospective observational studies of blood pressure and mortality, each 20 mmHg increase in usual systolic blood pressure (or, approximately equivalently, 10 mmHg increase in usual diastolic blood pressure) above 115/75 mmHg was associated with more than a twofold increase in stroke mortality, and with a twofold increase in death from coronary heart disease and other vascular causes of death at ages 40–69 years (*17*).

Progress in hypertension control cannot be achieved without improvements in health-care quality. Efforts to improve measurement of successes and shortfalls, such as the Physician Quality Reporting Initiative,† are designed to improve provider performance. System improvements, including adoption of electronic health records with registry and clinical decision support functions, will facilitate better patient management and the generation of patient and physician reminders to improve patient-physician interaction and patient follow-up (*18*). Other promising system improvements include nurse- or pharmacist-led care, which can improve preventive care delivery and reduce time pressures on physicians. Improved access and quality improvement efforts might need to be particularly focused on groups for whom the prevalence of control is especially low, such as young adults and Mexican Americans.

The findings in this report are subject to at least three limitations. First, the prevalence of hypertension in the U.S. population might be underestimated because older persons residing in nursing homes and other institutions, who have a higher prevalence of age-related hypertension, are not included in the NHANES. Second, although data collection is standardized, NHANES self-reported data on the use of blood pressure medications from interviews and questionnaires might be subject to

† Available at https://www.cms.gov/PQRI.

Key Points

- In 2005–2008, 31% of U.S. adults had hypertension (blood pressure ≥140/90 mmHg or reported current use of blood pressure lowering medication).
- No significant decline in the national prevalence of hypertension occurred in the past decade, despite more people with hypertension being treated (70%) and controlled (46%).
- Among hypertensive persons, the groups with the lowest prevalence of blood pressure control are adults aged 18–39 years (31%), Mexican Americans (37%), those without health insurance (29%), those without a usual source of medical care (12%), and those who received medical care less than twice in the previous year (21%).
- Approximately 86% of persons with uncontrolled hypertension reported having some form of health insurance, indicating that for most patients, having insurance is not sufficient to achieve blood pressure control.
- To control hypertension in the U.S. population, a comprehensive approach is needed that involves not only improved access to health care, but also improved medical care delivery systems, patient adherence to prescribed treatment, and increased access to healthful foods and physical activity.
- Additional information is available at http://www.cdc.gov/vitalsigns.

misunderstanding and/or recall bias. Finally, this report focuses exclusively on pharmacologic treatment of hypertension. It does not take into account patients who might have reduced their blood pressure through lifestyle or dietary changes. Some of the participants in this study whose blood pressure levels were measured as normal might have been treated and successfully controlled with life-style modifications; thus, they would not have been classified as having hypertension.

Hypertension affects an estimated 68 million U.S. adults, yet only 70% receive treatment and fewer than half of these conditions are controlled. Better control of blood pressure is needed, not only through improved access to and use of health care, but also through improvements in medical care delivery systems and patients' adherence to treatment, increased access to healthful foods, and physical activity. The development of targeted programs for special groups (e.g., persons who are uninsured) is warranted. Success in improving blood pressure control requires comprehensive strategies with participation from federal, state, and local governments; health-care providers; employers; nonprofit organizations; and food, restaurant, and pharmaceutical industries.

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Vital Signs: Prevalence, Treatment, and Control of High Levels of Low-Density Lipoprotein Cholesterol — United States, 1999–2002 and 2005–2008

ABSTRACT

Background: High levels of low-density lipoprotein cholesterol (LDL-C), a major risk factor for coronary heart disease (CHD), can be treated effectively.

Methods: CDC analyzed data from 1999–2002 and 2005–2008 to examine the prevalence, treatment, and control of high LDL-C among U.S. adults aged ≥20 years. Values were determined from blood specimens obtained from persons participating in the National Health and Nutrition Examination Survey (NHANES), a nationally representative cross-sectional, stratified, multistage probability sample survey of the U.S. civilian, noninstitutionalized population. The National Cholesterol Education Program Adult Treatment Panel-III guidelines set LDL-C goal levels of <100 mg/dL, <130 mg/dL, and <160 mg/dL for persons with high, intermediate, and low risk for developing CHD during the next 10 years, respectively. A person with high LDL-C was defined as either a person whose LDL-C levels were above the LDL-C goal levels or a person who reported currently taking cholesterol-lowering medication. Control of high LDL-C was defined as having a treated LDL-C value below the goal levels.

Results: Based on data from the 2005–2008 NHANES, an estimated 71 million (33.5%) U.S. adults aged ≥20 years had high LDL-C, but only 34 million (48.1%) were treated and 23 million (33.2%) had their LDL-C controlled. Among persons with uncontrolled LDL-C, 82.8% reported having some form of health insurance. The proportion of adults with high LDL-C who were treated increased from 28.4% to 48.1% between the 1999–2002 and 2005–2008 study periods. Among adults with high LDL-C, the prevalence of LDL-C control increased from 14.6% to 33.2% between the periods. The prevalence of LDL-C control was lowest among persons who reported receiving medical care less than twice in the previous year (11.7%), being uninsured (13.5%), being Mexican American (20.3%), or having income below the poverty level (21.9%).

Conclusions: The prevalence of control of high LDL-C in the United States, although improving, remains low, especially among low-income adults and those with limited access to health care. Strengthening the use of preventive services through improvement in health-care access and quality of care is expected to help achieve better control of high LDL-C in the United States.

Implications for Public Health Practice: To improve LDL-C control levels, a comprehensive approach that involves improved clinical care, as well as improved health-care access, sustainability, and affordability, is needed. A standardized system of patient care incorporating electronic health records, registries, and automated reminders for practitioners, focusing on achieving regular patient follow-up, has the potential to improve control of high LDL-C. Lower out-of-pocket costs and simplification of the drug regimen, as well as involvement of nurses, dietitians, health educators, pharmacists and other allied health-care professionals in direct patient care also could be used to improve patient adherence to prescribed regimens.

Introduction

Having a high level of low-density lipoprotein cholesterol (LDL-C) is a major risk factor for coronary heart disease (CHD), a major cause of death in the United States (*1*). Control of high LDL-C can reduce cardiovascular morbidity and mortality substantially (*2*), yet high LDL-C remains underdiagnosed and undertreated in the United States. Predictive modeling in one study suggested that every 10% increase in the prevalence of treatment among adults with high LDL-C could prevent approximately 8,000 deaths per year in those aged <80 years (*3*). Another study estimated that full adherence to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) primary prevention guidelines* among adults aged 35–85 years could prevent 20,000 myocardial infarctions and 10,000 deaths from CHD and save $2.8 billion in CHD-related health care costs per year (*4*). Previous studies demonstrated that many U.S. adults with high LDL-C

* Additional information is available at http://www.nhlbi.nih.gov/guidelines/cholesterol/index.htm.

are not treated adequately (*5*). To assess the current status and recent trends in the prevalence, treatment, and control of high LDL-C among U.S. adults aged ≥20 years, data from the 1999–2002 and 2005–2008 National Health and Nutrition Examination Survey (NHANES) were analyzed.

Methods

NHANES is a continuous nationally representative cross-sectional survey of the health and nutritional status of the U.S. civilian, noninstitutionalized population. The survey has a complex, multistage probability design, which is intended to represent the U.S. population.[†] NHANES data are released in 2-year cycles. All NHANES cycles include a household interview and a detailed physical examination that includes anthropometric measurements. A subsample of NHANES is selected randomly and participants are instructed to fast before the physical examination. Participants are included in the fasting subsample if they have fasted at least 8 hours before blood specimens are taken for laboratory testing. As with other subsamples in the study, the data from the fasting subsample are weighted to account for the probability of selection and nonresponse.

To estimate trends in the prevalence of high LDL-C reliably in multiple strata of the population, data were analyzed from four survey periods; data from 1999–2000 and 2001–2002 were aggregated and compared with aggregated results from 2005–2006 and 2007–2008. The overall survey response rates for adults aged ≥20 years during 1999–2002 and 2005–2008 were 78.1% and 76.4%, respectively. During 1999–2002, a total of 9,471 adults aged ≥20 years took part in the home interviews and were examined at NHANES mobile examination centers; 10,480 participated in 2005–2008. Among those participants, 4,059 (1999–2002) and 4,341 (2005–2008) provided fasting blood samples for lipid profile testing. The final analytic samples were 3,550 (1999–2002) and 3,996 (2005–2008) after further exclusions were made for pregnant women (280 and 189) and participants missing data needed for determining high LDL-C status (229 and 156).

Current guidelines by NCEP ATP III recommend LDL-C goals based on level of risk for developing coronary heart disease (CHD) in the next 10 years. The guidelines set LDL-C goal levels of <100 mg/dL, <130 mg/dL, and <160 mg/dL for high, intermediate, and low risk groups, respectively. Participants with a self-reported history of CHD, angina, myocardial infarction, stroke, and/or diabetes, or participants with a fasting blood glucose level of ≥126 mg/dL or fasting hemoglobin A1c ≥6.5 were placed in the high NCEP ATP III risk category. After participants with high risk were identified, the remaining participants were assessed according to the number of major CHD risk factors they had. These risk factors included cigarette smoking (self-reported smoking every day or some days), hypertension (an average of up to three blood pressure measurements ≥140/90 mm Hg, determined by NHANES physical examination; or self-reported current use of antihypertensive medication), high-density lipoprotein cholesterol (HDL-C) <40 mg/dL, and age (men ≥45 years and women ≥55 years). In accord with the NCEP ATP III guidelines, if a person had an HDL-C ≥60 mg/dL, one risk factor was subtracted from the person's total number of risk factors. Participants with no more than one major CHD risk factor were placed in the low NCEP ATP III risk category. For participants with two or more risk factors, a 10-year CHD risk score was calculated using the Framingham risk equation, an assessment tool used in the NCEP ATP III. Those participants with a 10-year CHD risk greater than 20% were placed in the high NCEP ATP III risk category, and those with 20% or lower risk were placed in the intermediate category. Further details on classifications of the study participants into each of the NCEP ATP III risk categories are published elsewhere (*5*).

Persons who had levels at or above the LDL-C goal for their risk group or self-reported currently taking cholesterol-lowering medication were defined as having high LDL-C. A person who reported currently taking cholesterol-lowering medication was defined to be treated for high LDL-C. A person's cholesterol level was considered to be under control if their LDL-C level was below the risk-specific goal (Figure 1). Results are described as weighted prevalence, calculated using the survey statistical weight that was designated for the subgroup with LDL-C levels measured in the morning after fasting, to account for the additional probability of selection and nonresponse, with 95% confidence limits. Population counts were calculated using the Current Population Surveys.[§]

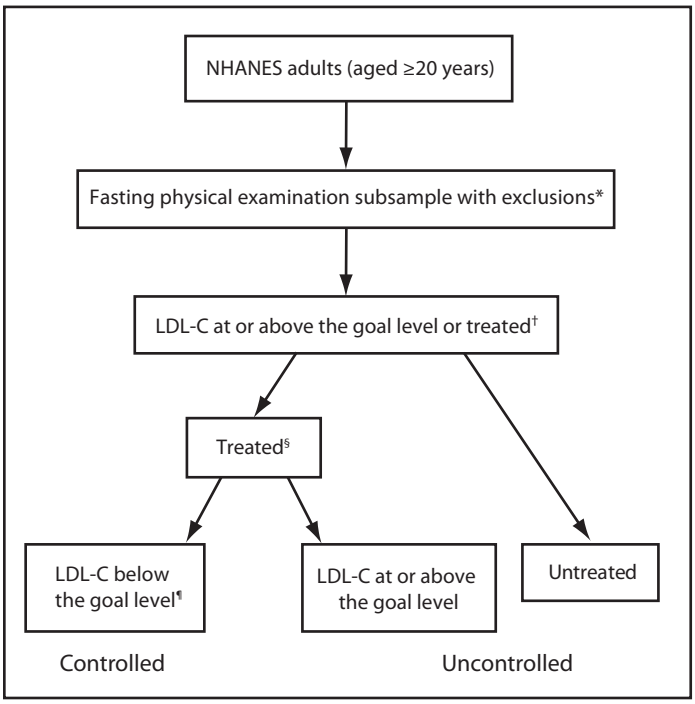
Results

Differences in prevalence, treatment, and control of high LDL-C in 2005–2008 were observed among demographic groups (Table). The prevalence of high LDL-C increased with age: 11.7%, 41.2%, and 58.2% for the age groups 20–39, 40–64, and ≥65 years, respectively. The lowest treatment prevalences occurred among persons aged 20–39 years (10.6%), those without a usual source of care (17.7%), those receiving medical care less than twice during the past year (17.7%), and those without health insurance (22.6%). However, in this study, 82.8% of persons with uncontrolled LDL-C reported having some form of health insurance. The highest treatment

[†] Additional information is available at http://www.cdc.gov/nchs/nhanes.htm.

[§] Additional information is available at http://www.cdc.gov/nchs/tutorials/nhanes/faqs.htm.

FIGURE 1. Study definitions for high levels of low-density lipoprotein cholesterol (LDL-C) and treatment and control of high LDL-C — National Health and Nutrition Examination Survey (NHANES), United States, 1999–2002 and 2005–2008.



* Pregnant women and participants with missing data needed for determining high LDL-C status were excluded.
† LDL-C levels ≥100 mg/dL for high risk group, ≥130 mg/dL for intermediate risk group, or ≥160 mg/dL for low risk group; or self-reported currently taking cholesterol-lowering medication.
§ Self-reported currently taking cholesterol-lowering medication.
¶ LDL-C levels <100 mg/dL for high risk group, <130 mg/dL for intermediate risk group, or <160 mg/dL for low risk group.

prevalences during the study period were observed among persons aged ≥65 years (64.4%), those insured under Medicare (63.4%), and those who received medical care at least four times during the previous year (61.4%). Factors associated with the highest and lowest levels of control of high LDL-C were similar to those observed for treatment.

The overall population prevalence of high LDL-C did not change significantly from 1999–2002 (34.5%) to 2005–2008 (33.5%) (Figure 2). However, treatment of high LDL-C increased significantly, from 28.4% in 1999–2002 to 48.1% in 2005–2008. In addition, the prevalence of those under control more than doubled during the study period, from 14.6% to 33.2%.

Conclusions and Comment

High LDL-C can be managed and controlled successfully with lifestyle changes, medications, or a combination of these approaches. Implementing lifestyle modifications, such as a low-fat and high-fiber diet, increased physical activity, and weight control, might decrease LDL-C levels by up to 20%–30%. Results from a meta-analysis of 14 clinical trials showed that therapy with statins, the most common type of drug prescribed to lower cholesterol, can safely reduce the 5-year incidence of major coronary events, coronary revascularization, and stroke by about 20% for each mmol/L (about 39 mg/dL) reduction in LDL-C (*6*). Although this study documented that striking improvements in the prevalence of treatment and control of high LDL-C have occurred, an estimated 71 million (33.5%) U.S. adults aged ≥20 years have high LDL-C, and only one third of conditions are controlled.

These results demonstrate that the lowest prevalence of control of high LDL-C existed among participants who did not have health insurance and those who had received medical care less than twice in the previous year. In addition, the especially low prevalence of control among Mexican Americans warrants specific attention. This study and others illustrate that gaps in cholesterol control often are related to gaps in availability of, access to, or continuity of health care (*7–9*). The Affordable Care Act (ACA) is intended to reduce some of these gaps (*10*) by increasing insurance coverage among the nonelderly population from 82.5% in the first quarter of 2010 to 94% by 2019 and by providing coverage for cholesterol screening with no cost-sharing (*11*).

Access to care alone will not solve problems with cholesterol control completely. In this study, approximately 83% of persons with uncontrolled LDL-C reported having some form of health insurance. However, even among participants with private health insurance coverage, prevalence of control of high LDL-C was <35% in this study. These results are not surprising; up to half of patients discontinue lipid-lowering medication within 1 year of treatment initiation, and adherence rates generally decrease over time (*12*). Lower out-of-pocket costs (*13*) and simplification of the drug regimen (*14*) generally are associated with better adherence.

In addition to access to care and patient adherence, quality of care must be addressed. The continued development and widespread use of electronic health records will facilitate efforts to better control cholesterol; such efforts include patient registries, panel management (an innovative approach that incorporates provider and patient reminders for proactive follow-up appointments and additional treatment), and use of these systems in real-time to direct patient care. Another promising system improvement includes team-led care, which can improve preventive and chronic care delivery (*15*). Several programmatic initiatives promoted by ACA will contribute to health-care access and quality (*15*). Those include comprehensive, family-centered, coordinated primary care (patient-centered medical homes), health care provided by types of managed-care organizations that are accountable to patients

TABLE. Prevalence of high levels of low-density lipoprotein cholesterol (LDL-C)* and treatment† and control§ of high levels of LDL-C by selected characteristics, adults¶ aged ≥20 years — National Health and Nutrition Examination Survey, United States, 2005–2008**

	High LDL-C (n = 3,996)		Treatment (n = 1,482)		Control (n = 1,486)	
Characteristic	**%††**	**(95% CI)**	**%**	**(95% CI)**	**%**	**(95% CI)**
Total	33.5	(30.9–36.2)	48.1	(44.3–52.0)	33.2	(29.7–36.9)
Sex						
Male	36.2	(32.7–39.8)	45.6	(41.2–50.1)	31.1	(27.2–35.4)
Female	31.0	(27.8–34.4)	50.8	(44.9–56.8)	35.5	(30.1–41.3)
Age group (yrs)						
20–39	11.7	(9.6–14.4)	10.6	(6.0–17.9)	—§§§	
40–64	41.2	(37.6–45.0)	47.7	(42.2–53.2)	33.8	(28.6–39.4)
≥65	58.2	(54.7–61.6)	64.4	(61.0–67.8)	44.7	(39.5–50.1)
Race/Ethnicity						
White, non-Hispanic	34.5	(31.3–37.8)	50.3	(46.0–54.5)	35.4	(31.9–39.0)
Black, non-Hispanic	30.4	(26.5–34.6)	44.5	(37.3–51.8)	26.2	(19.8–33.7)
Mexican-American	27.7	(24.2–31.6)	34.1	(27.9–40.8)	20.3	(15.5–26.2)
Poverty status (%)§§						
<100	35.6	(30.8–40.8)	41.0	(32.7–49.9)	21.9	(17.0–27.7)
100–199	36.1	(32.6–39.9)	48.1	(41.4–54.9)	26.4	(21.8–31.6)
200–399	32.8	(29.1–36.8)	49.9	(43.8–56.0)	35.2	(29.2–41.7)
400–499	29.8	(23.9–36.5)	42.2	(29.5–56.0)	29.2	(17.6–44.3)
≥500	32.8	(28.1–37.8)	49.3	(41.1–57.5)	39.8	(31.8–48.3)
Education (aged ≥25 yrs)						
Less than high school	41.0	(36.7–45.4)	46.4	(40.7–52.3)	27.8	(22.4–34.0)
High school	42.3	(38.2–46.5)	51.5	(45.6–57.2)	35.8	(30.8–41.2)
Some college	35.7	(32.2–39.4)	47.2	(39.4–55.3)	31.8	(24.7–39.8)
College graduate	28.7	(24.0–34.0)	48.6	(39.7–57.5)	38.5	(30.2–47.4)
Usual source of care¶¶						
Yes	35.7	(33.0–38.5)	50.7	(46.8–54.6)	35.7	(31.8–39.7)
No	20.0	(15.9–24.9)	17.7	(10.9–27.4)	—§§§	
Times received health-care during last 12 months* **						
0–1	21.7	(19.0–24.7)	17.7	(13.3–23.0)	11.7	(8.0–16.7)
2–3	34.3	(29.9–39.0)	48.4	(42.6–54.2)	34.6	(29.6–40.0)
≥4	43.9	(40.7–47.1)	61.4	(56.4–66.2)	42.6	(37.1–48.3)
Insurance status†††						
Medicare	58.9	(55.2–62.6)	63.4	(59.3–67.3)	41.8	(36.7–47.2)
Private	27.8	(25.0–30.8)	45.2	(38.3–52.3)	33.5	(27.9–39.6)
Public	38.6	(30.9–46.8)	47.5	(37.4–57.8)	30.6	(21.1–42.1)
Uninsured	25.0	(21.0–29.6)	22.6	(17.4–28.8)	13.5	(8.4–21.0)

Abbreviation: CI = confidence interval.

* LDL-C levels were examined; n = unweighted sample size using National Cholesterol Education Program's Adult Treatment Panel III risk categories based on the risk for developing coronary heart disease in the next 10 years. High LDL-C was defined as ≥100 mg/dL for the high risk group, ≥130 mg/dL for the intermediate risk group, and ≥160 mg/dL for the low risk group or a person currently taking cholesterol-lowering medication. Additional information available at http://www.nhlbi.nih.gov/guidelines/cholesterol/index.htm.

† Participants were asked "Are you now following this advice to take prescribed medicine?" if they responded "yes" to the following questions: "Have you ever had your blood cholesterol checked? Have you ever been told by a doctor or other health professional that your blood cholesterol level was high? To lower your blood cholesterol have you ever been told by a doctor or other health professional to take prescribed medicine?" Treatment was examined only among those with high LDL-C.

§ Defined as having a treated LDL-C value below the goal levels (<100 mg/dL for the high risk group, <130 mg/dL for the intermediate risk group, and <160 mg/dL for the low risk group). Control was examined only among those with high LDL-C.

¶ Pregnant women were excluded from analyses.

** 2005–2008 data are from the 2005–2006 and 2007–2008 survey cycles.

†† Weighted estimates, calculated using the morning fasting sample weight.

§§ Family income relative to family size and age of the members adjusted for inflation by using the poverty thresholds developed by the U.S. Bureau of the Census.

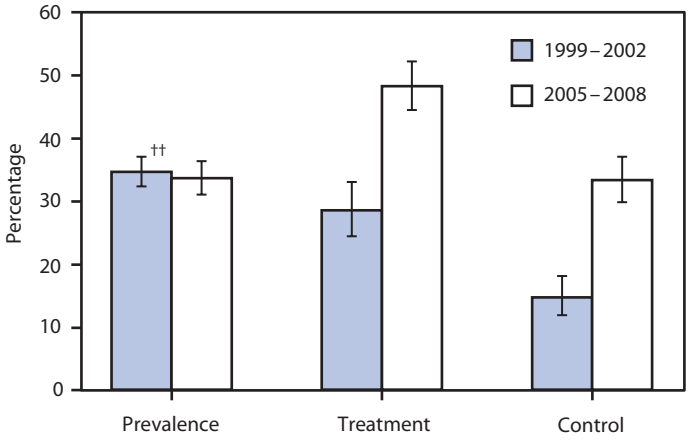
¶¶ Participants were asked "Is there a place that you usually go when you are sick or need advice about your health?" Yes responses include those who answered "yes" or "there is more than one place."

*** Participants were asked "During the last 12 months how many times have you seen a doctor or other health professional about your health at a doctor's office, a clinic, hospital emergency room, at home or some other place? Do not include times you were hospitalized overnight."

††† Medicare includes all participants who had Medicare coverage. Private does not include those participants with Medicare coverage. As a result of the survey design in the 1999–2000 and 2001–2002 survey cycles, public insurance includes participants who only reported Indian Health Service. Uninsured includes participants with single service plan only.

§§§ Estimate is not reportable because the relative standard error is >30%.

FIGURE 2. Prevalence of high levels of low-density lipoprotein cholesterol (LDL-C)* and treatment† and control§ of high levels of LDL-C in adults¶ aged ≥20 years — National Health and Nutrition Examination Survey, United States, 1999–2002 and 2005–2008**



* LDL-C levels were examined using National Cholesterol Education Program's Adult Treatment Panel III risk categories based on the risk for developing coronary heart disease in the next 10 years. High LDL-C was defined as ≥100 mg/dL for the high risk group, ≥130 mg/dL for the intermediate risk group, and ≥160 mg/dL for the low risk group or a person currently taking cholesterol-lowering medication. Additional information available at http://www.nhlbi.nih.gov/guidelines/cholesterol/index.htm.

† Participants were asked "Are you now following this advice to take prescribed medicine?" if they responded "yes" to the following questions: "Have you ever had your blood cholesterol checked? Have you ever been told by a doctor or other health professional that your blood cholesterol level was high? To lower your blood cholesterol have you ever been told by a doctor or other health professional to take prescribed medicine?" Treatment was examined only among those with high LDL-C.

§ Defined as having a treated LDL-C value below the goal levels (<100 mg/dL for the high risk group, <130 mg/dL for the intermediate risk group, and <160 mg/dL for the low risk group). Control was examined only among those with high LDL-C.

¶ Pregnant women were excluded from analyses.

** Data for 1999–2002 are from the 1999–2000 and 2001–2002 survey cycles; 2005–2008 from the 2005–2006 and 2007–2008 survey cycles.

†† Weighted estimates, calculated using the morning fasting sampling weight, and error bars representing 95% confidence intervals. Treatment and control estimates are significantly different (p<0.01).

and third-party payers for the overall care of beneficiaries (accountable care organizations), and health care targeted to underserved communities and vulnerable populations (the federally qualified health center program) (*15*).

The findings in this report are subject to at least four limitations. First, the prevalence of high LDL-C levels in the U.S. population might be underestimated because older persons residing in nursing homes and other institutions, who have a higher prevalence of age-related high LDL-C, are not included in the NHANES. Second, although data collection is standardized, the NHANES self-reported data from interviews and questionnaires might be subject to misunderstanding and/or recall bias. Third, the reported prevalence of high LDL-C treatment and control in this report might be underestimated for the following reasons. The Framingham risk score only assesses adults up to age 79 years, but the NHANES sample contained participants aged >79 years. Participants who were aged >79 years were assigned the same level of risk as those aged 70–79 years. Although family history of premature CHD is a risk factor, it could not be included in the assessment because it was not reported consistently through all study cycles. Finally, lifestyle modification factors were not examined in this report. Some of the participants in this study whose LDL-C levels were measured as normal might have been treated and successfully controlled with life-style modification measures; thus, they would not have been classified as having high LDL-C.

The prevalence of control of high LDL-C in the United States remains below 35% and is especially low (below 15%) among adults with limited access to health care. Although the development of targeted programs for low-income adults and those with limited access to health care is warranted, better control of high LDL-C cannot be achieved only with increased access to health care. Key elements for control also include improved clinical care and better patient adherence to treatment. The development of targeted programs for special groups (e.g., persons who are uninsured or whose income is below the

Key Points

- Control of high levels of low-density lipoprotein cholesterol (LDL-C), a major risk factor for coronary heart disease that is asymptomatic, can reduce cardiovascular morbidity and mortality substantially.
- An estimated 71 million U.S. adults aged ≥20 years, or 34% of the adult population, had high LDL-C during 2005–2008 (LDL-C levels above the recommended goal levels or reported current use of cholesterol-lowering medication).
- The proportion of those treated for high LDL-C increased from 28% during 1999–2002 to 48% (34 million adults) during 2005–2008. The proportion of those who achieved control more than doubled, to 33%, or 23 million adults.
- The prevalence of LDL-C control was lowest (<15%) among adults with limited access to health care. However, about 83% of persons with uncontrolled LDL-C reported having some form of health insurance.
- Better control of high LDL-C cannot be achieved only with increased access to health care. Key elements for control also include improved clinical care and better patient adherence to treatment.
- Additional information is available at http://www.cdc.gov/vitalsigns.

poverty level) is warranted. Given the multicomponent nature of high LDL-C control, implementation of comprehensive strategies by federal, state, and local governments; health-care providers; employers; nonprofit organizations; and food, restaurant, and pharmaceutical industries is needed.

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