## Trends in Apolipoprotein B, Non-high-density Lipoprotein Cholesterol, and Low-density Lipoprotein Cholesterol for Adults Aged 20 and Over, 2005–2016

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## Abstract

*Objectives*—Guidelines for lowering cholesterol have focused on total and low-density lipoprotein cholesterol (LDL–C). Although the emphasis remains on LDL–C, more attention is now being given to apolipoprotein B (apo B) and non-high-density lipoprotein cholesterol (non-HDL–C). This report presents trends in mean apo B, non-HDL–C, and LDL–C in adults aged 20 and over from 2005–2006 through 2015–2016.

*Methods*—Data from the 2005–2016 National Health and Nutrition Examination Surveys were used to conduct trend analyses. Means and standard errors of the mean for apo B ($n$ = 13,802), non-HDL–C ($n$ = 30,921), and LDL–C ($n$ = 13,559) are presented overall and by sex, stratified by age, race and Hispanic origin, and body mass index (BMI) category for each 2-year survey cycle. Trends over time were tested using orthogonal contrast matrices and piecewise and multiple linear regression.

*Results*—In men, apo B declined from 98 mg/dL in 2005–2006 to 93 mg/dL in 2011–2012, but did not change after 2011–2012. Declining trends were also seen for men in non-HDL–C (147 to 141 mg/dL) and LDL–C (116 to 114 mg/dL) from 2005–2006 to 2015–2016. For women, age-adjusted mean apo B declined from 94 mg/dL in 2005–2006 to 91 mg/dL in 2015–2016. Non-HDL–C and LDL–C in women did not change significantly from 2005–2006 to 2011–2012, but non-HDL–C declined from 141 mg/dL in 2011–2012 to 133 mg/dL in 2015–2016, and LDL–C declined from 117 mg/dL in 2011–2012 to 111 mg/dL in 2015–2016. With the exception of LDL–C in men, these trends persisted after controlling for age, race and Hispanic origin, BMI, and lipid-lowering medication use.

*Conclusions*—From 2005–2006 to 2015–2016, significant but different declining trends in apo B, non-HDL–C, and LDL–C were seen in men and women. In general, differences in age, race and Hispanic origin, BMI category, and lipid-lowering medication use did not explain the trends.

**Keywords:** lipids • atherosclerotic cardiovascular disease (ASCVD) • body mass index • lipid-lowering medications • National Health and Nutrition Examination Survey (NHANES)

## Introduction

Total cholesterol (TC) and low-density lipoprotein cholesterol (LDL–C) are known to be related to atherosclerotic cardiovascular disease (ASCVD) (1). National Cholesterol Education Program guidelines for lowering cholesterol (Adult Treatment Panel I [ATP I], ATP II, and ATP III) (2–4) emphasized the measurement and reduction goals for lowering LDL–C, the dominant form of atherogenic cholesterol (1) (i.e., molecules that carry cholesterol to the bloodstream having a tendency to accumulate in blood vessels and block circulation, causing ASCVD). Although the American College of Cardiology and American Heart Association, in their 2018 report, "Guideline on the Management of Blood Cholesterol" (1), have continued to focus on the measurement and reduction of LDL–C, considerable discussion on the value of other lipid and lipoprotein measures is ongoing. In particular, apolipoprotein B (apo B), the main lipoprotein embedded in LDL–C, and non-high-density lipoprotein cholesterol (non-HDL–C), which is more atherogenic than LDL–C, have been proposed as better measures of the atherosclerotic burden of lipids as well as risk prediction (5–12).

Because of this increasing interest in the measurement and control of other lipids and lipoproteins, secular trends in apo B, non-HDL–C, and LDL–C are analyzed for adults aged 20 and over using data from the National Health and Nutrition Examination Surveys (NHANES) for 2005–2006, 2007–2008, 2009–2010, 2011–2012, 2013–2014, and 2015–2016. The starting point of 2005–2006 was chosen because it is the first NHANES cycle to measure apo B.

## Methods

NHANES, conducted by the National Center for Health Statistics (NCHS), comprises cross-sectional surveys representative of the U.S. civilian noninstitutionalized population. Beginning in 1999, NHANES became a continuous survey, and data have been released in 2-year cycles (13).

Results presented in this report are based on data from NHANES 2005–2006, 2007–2008, 2009–2010, 2011–2012, 2013–2014, and 2015–2016. The sample design for each 2-year cycle constitutes a highly stratified, multistage, area probability sample (14–16). The survey was approved by the NCHS Research Ethics Review Board, and written informed consent was obtained from adult participants.

NHANES includes a home interview and a health examination at a mobile examination center (MEC). Participants in the examination component were randomly assigned to a morning session (and asked to fast at least 9 hours prior to examination) or an afternoon or evening session. Each examined participant was eligible for TC and high-density lipoprotein cholesterol (HDL–C) tests; only participants examined in the morning were eligible for apo B and triglyceride tests. Examination response rates for adults aged 20 and over were 71.0% in 2005–2006, 70.6% in 2007–2008, 72.2% in 2009–2010, 64.5% in 2011–2012, 63.7% in 2013–2014, and 58.1% in 2015–2016.

### Laboratory methods

At the MECs, venous blood samples were collected from NHANES study participants and processed using a standardized protocol. After processing, serum samples were stored frozen at −30°C until they were shipped on dry ice to the contracted laboratory for analysis (17). Across survey periods, several changes have occurred in laboratories, methods, and analyzers used to measure lipid and lipoprotein concentrations. Apo B was measured using a nephelometric immunoassay on the Dade Behring BN100 Nephelometer in 2005–2006 (18), and on the Siemens BN ProSpec Nephelometer for 2007–2014 (Siemens acquired Dade Behring in 2007) (19). A comparison study revealed apo B values using the BN100 analyzer were 8% higher on average compared with the Siemens BN ProSpec analyzer. Apo B values for 2005–2006 were matched to 2007–2014 apo B values using a forward Deming regression correction (20). In 2015–2016, a new analyzer, the Roche Cobas 6000 Chemistry Analyzer (21), was used to measure apo B by turbidimetric assay. A comparison study revealed apo B values from the Roche Cobas 6000 analyzer were 3.7% higher than values from the Siemens BN ProSpec nephelometer. Apo B values from 2005–2014 were matched to 2015–2016 apo B values using a forward Deming regression correction (22).

For 2005–2016, TC and triglyceride were measured using coupled enzymatic reactions, and HDL–C was measured using a two-step colorimetric endpoint reaction method (23). The methods and analyzers used during the 2005–2016 survey cycles of NHANES are described in the laboratory method files available from the NHANES website (24). HDL–C values in 2005–2006, in contrast with values for 2007–2016, were on average 3% higher, most likely due to changes in instrumentation (25). LDL–C was calculated by the Friedewald equation (LDL–C = TC – HDL–C – triglyceride / 5, valid only for adult participants with triglyceride results at or below 400 mg/dL examined in the morning session and having fasted 8½ to less than 24 hours prior to venipuncture) (26). Non-HDL–C was calculated by subtracting HDL–C from TC (non-HDL–C = TC – HDL–C). The 2005–2006 cycle (3% higher on average than HDL–C values in the 2007–2016 survey cycles) resulted in estimates for non-HDL–C and LDL–C approximately 1–2 mg/dL lower for 2005–2006 only, thus having a negligible effect on overall trends. Despite changes in laboratory methods during several survey years, standardization of serum lipid measurements, following the Centers for Disease Control and Prevention's (CDC) lipid standardization program criteria (27), ensured accuracy and comparability of measurements across studies. Intralaboratory quality control and proficiency testing performed by the laboratories met the CDC program's acceptable performance of allowable bias and imprecision.

## Definition of covariates

Covariates known or demonstrated to be associated with apo B, non-HDL–C, and LDL–C included age group, race and Hispanic origin, body mass index (BMI), and use of lipid-lowering medications (28). Age reported during the NHANES screener was grouped into three categories: 20–39, 40–59, and 60 and over. Participants self-reported their race and Hispanic origin after being shown a list including an open-ended response. Race and Hispanic origin was categorized as non-Hispanic white, non-Hispanic black, Mexican American, all Hispanic (beginning in 2007–2008), and non-Hispanic Asian (beginning in 2011–2012) (29). Persons who were categorized as other Hispanic prior to 2007–2008, non-Hispanic Asian prior to 2011–2012, or other race (which included multiracial) were included in the analysis of the entire population but are not shown separately.

Use of lipid-lowering medications was assessed during the in-home interview using the question, "Are you currently taking medication to lower your blood cholesterol?" (28). Although specific medication information is collected in NHANES, this analysis used the self-reported question on use of lipid-lowering medications only.

Height and weight were measured using a standardized protocol (30) at the MEC. BMI was calculated as measured weight in kilograms divided by measured height in meters squared rounded to the nearest tenth. BMI categories were defined as normal (BMI of at least 18.5

but less than 25.0), overweight (BMI of at least 25.0 but less than 30.0), and obesity (BMI of at least 30.0) (31).

## Statistical methods

Mean apo B, non-HDL–C, and LDL–C are presented across the NHANES 2-year survey cycles for the period from 2005 through 2016 for all adults aged 20 and over and by sex overall (Figures 1–3), and stratified by age, race and Hispanic origin, and BMI subgroups (Tables 1–3). Normality was assessed by plotting the distribution of each variable against that of a normally distributed random variable and comparing their skewness and kurtosis. No substantial departures from normality were seen. All estimated means are accompanied by standard errors. Means for adults aged 20 and over (including by race and Hispanic origin and BMI category) were age adjusted to the projected U.S. Census 2000 population by the direct method using age groups 20–39, 40–59, and 60 and over (32).

Because of the small number of adults aged 20–39 and 40–59 who were on lipid-lowering medications, and the disproportionate number of adults aged 60 and over on lipid-lowering medications, means of the three lipid analytes are not presented by sex stratified by use of lipid-lowering medications. Mean apo B, non-HDL–C, and LDL–C for adults aged 60 and over from 2005–2006 to 2013–2014, by sex and use of lipid-lowering medications, are presented elsewhere (33).

Linear and quadratic trends in mean apo B, non-HDL–C, and LDL–C were tested overall and for each sex, age, race and Hispanic origin, and BMI subgroup using orthogonal contrast matrices (34). A significant quadratic trend implied the existence of a survey period where a change in direction or magnitude of the slope occurred (i.e., inflection point), located through the JoinPoint software package (35). For survey periods with an identified inflection point, hypotheses of nonzero slopes from 2005–2006 to the inflection point, a nonzero slope after the inflection point to 2015–2016, and the difference between the two slopes were tested through piecewise linear regression (36). Sex-specific models were constructed by adjusting for the possible confounding effects of lipid-lowering medications in addition to age group, race and Hispanic origin, and BMI categories. Adjusted trends were tested using multiple linear regression, treating the survey cycle as a continuous variable.

Statistical hypotheses were tested at the $\alpha = 0.05$ level using a two-sided $t$ statistic for univariate linear and quadratic trends, and the Satterthwaite adjusted $F$ statistic (37) for piecewise and multiple linear regression.

Sample weights accounting for unequal selection probabilities, adjusting for nonresponse, and calibrating to U.S. Census Bureau population totals were used to estimate all statistics.

Examination sample weights were used for non-HDL–C, while morning fasting sample weights were used for apo B and LDL–C. Stratification and clustering, in addition to weighting, were incorporated in estimating standard errors through Taylor series linearization (38) and in testing statistical hypotheses.

All statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, N.C.) and SUDAAN version 11 (RTI International, Research Triangle Park, N.C.).

## Sample sizes

Of the 49,653 adults aged 20 and over in the NHANES 2005–2016 sample, 34,180 (68.8%) were interviewed, and 32,920 (66.3%) were interviewed and examined. Of those 32,920 adults, 30,921 (93.9%) had calculated values for non-HDL–C. Of these 30,921 adults, 387 (1.2%) had missing values for BMI, and 623 (2.0%) had missing data for use of lipid-lowering medications.

Of the 32,920 interviewed and examined adults aged 20 and over, 14,301 were assigned to the morning session and fasted at least 8½ hours but less than 24 hours prior to venipuncture; of the 14,301 adults in the fasting sample, 13,802 (96.5%) had measured apo B, and 13,559 (94.8%) had calculated LDL–C. Of the adults with measured apo B, 160 (1.2%) had missing values for BMI, and 255 (1.8%) had missing data for use of lipid-lowering medications. Of the 13,559 adults aged 20 and over with calculated values for LDL–C, 158 (1.2%) had missing BMI, and 251 (1.9%) had missing values for use of lipid-lowering medications.

The unweighted sample sizes for apo B, non-HDL–C, and LDL–C are presented in Tables I–III by sex, stratified by age group, race and Hispanic origin, and BMI category for adults aged 20 and over.

## Results

### Apo B

Means and standard errors of the mean apo B for adults aged 20 and over are presented in Table 1. In 2015–2016,



NOTES: Mean apolipoprotein B (apo B) is age adjusted by the direct method to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over. Error bars are equal to plus or minus one standard error.
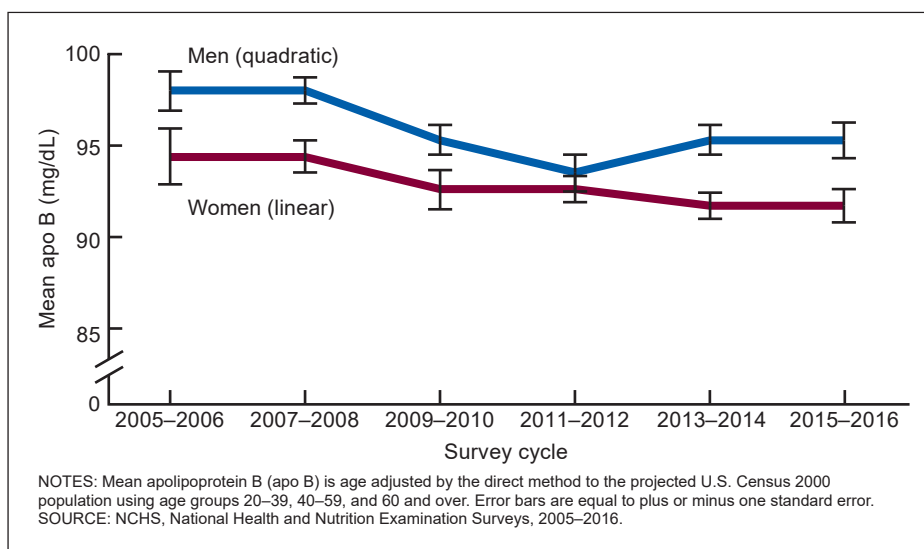SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Figure 1. Mean apolipoprotein B among men and women aged 20 and over, by survey cycle: United States, 2005–2016**

the age-adjusted mean apo B for adults aged 20 and over was 93 mg/dL overall, down from 96 mg/dL in 2005–2006.

For men, the age-adjusted mean apo B declined from 98 mg/dL in 2005–2006 to 93 mg/dL in 2011–2012, and then did not change significantly (Figure 1). Similar trends were seen in mean apo B for men aged 20–39 and in the age-adjusted mean apo B for men in the overweight category. The mean apo B declined from 2005–2006 to 2009–2010 for men aged 60 and over and then remained level between 2009–2010 and 2015–2016. The age-adjusted mean apo B declined from 2005–2006 to 2015–2016 for non-Hispanic black men and men in the normal weight category. The observed declining trend in apo B seen in non-Hispanic white men did not reach statistical significance. No significant trends were seen for Hispanic, Mexican-American, or non-Hispanic Asian men, for men aged 40–59, or for men with obesity.

In 2015–2016, the age-adjusted mean apo B for women aged 20 and over was 91 mg/dL, down from 94 mg/dL in 2005–2006 (Figure 1). Similar trends were seen in mean apo B for women aged 20–39 and 60 and over, and in age-adjusted mean apo B for women with normal weight, for those with obesity, and for Mexican-American women. The age-adjusted mean apo B also declined among Hispanic women during 2007–2016. The observed declines among non-Hispanic white women and overweight women did not reach statistical significance. No significant trends in apo B were seen for women aged 40–59 or non-Hispanic black women during 2005–2016, or for non-Hispanic Asian women during 2011–2016.

## Non-HDL–C

Means and standard errors of mean non-HDL–C for adults aged 20 and over are presented in Table 2. The age-adjusted mean non-HDL–C for adults aged 20 and over was 137 mg/dL during 2015–2016, down from 144 mg/dL during 2005–2006.

For men aged 20 and over, the age-adjusted mean non-HDL–C declined over this 12-year period to 141 mg/dL in

2015–2016, down from 147 mg/dL in 2005–2006 (Figure 2). Similar declining trends were seen for men in all age, race and Hispanic-origin, and BMI subgroups, except for non-Hispanic Asian men.

For women aged 20 and over, age-adjusted mean non-HDL–C declined after 2011–2012 to 133 mg/dL in 2015–2016, following no significant change from 2005–2006 to 2011–2012 (Figure 2). Similar trends were seen among women aged 40–59, non-Hispanic white and non-Hispanic black women, and women in the normal and overweight categories. For women aged 60 and over, mean non-HDL–C remained level from 2005–2006 to 2009–2010, then declined after 2009–2010 to 2015–2016. Declining trends over the entire 12-year period were seen in mean non-HDL–C for women aged 20–39, and in the age-adjusted mean for Mexican-American women and women with obesity. Similarly, a decline was seen among Hispanic women during 2007–2016. The observed declining trend in non-HDL–C seen in non-Hispanic Asian women during 2011–2016 did not reach statistical significance.

## LDL–C

Means and standard errors of the mean LDL–C for adults aged 20 and over are presented in Table 3. During 2015–2016, the age-adjusted mean LDL–C for adults aged 20 and over was 113 mg/dL overall, down from 115 mg/dL in 2005–2006. Among men

aged 20 and over, LDL–C declined from 116 mg/dL in 2005–2006 to 114 mg/dL in 2015–2016 (Figure 3). Declining trends were also seen in the mean LDL–C for men aged 60 and over, and in the age-adjusted mean LDL–C for men in both the normal weight and overweight categories. No significant trends were seen in the mean LDL–C for men aged 20–39 or 40–59, or in the age-adjusted mean LDL–C for men with obesity. The observed declines among Hispanic men during 2007–2018, and among Mexican-American and non-Hispanic black men during 2005–2018, did not reach statistical significance. No significant changes occurred among any other race or Hispanic-origin group.

The age-adjusted mean LDL–C for women aged 20 and over declined after 2011–2012 to 111 mg/dL in 2015–2016, following an observed increasing trend that did not reach statistical significance (Figure 3). A similar trend was seen in non-Hispanic black women—a declining trend after 2011–2012 to 2015–2016, following an observed increasing trend that was not statistically significant. The observed declining trend from 2005–2006 to 2015–2016 in the age-adjusted mean LDL–C seen in Mexican-American women did not reach statistical significance. However, the age-adjusted mean LDL–C declined significantly from 2007–2008 to 2015–2016 for Hispanic women. The mean LDL–C declined over the 12-year survey period in women aged 20–39. For women aged 60 and



NOTES: Mean non-high-density lipoprotein cholesterol (non-HDL–C) is age adjusted by the direct method to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over. Error bars are equal to plus or minus one standard error.
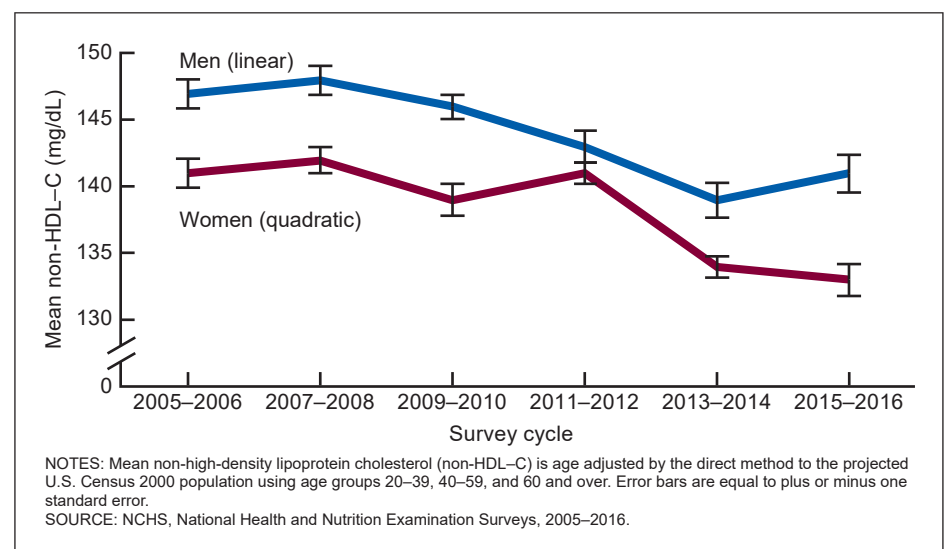SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Figure 2. Mean non-high-density lipoprotein cholesterol among men and women aged 20 and over, by survey cycle: United States, 2005–2016**

NOTES: Mean low-density lipoprotein cholesterol (LDL–C) is age adjusted by the direct method to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over. Error bars are equal to plus or minus one standard error.
SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.
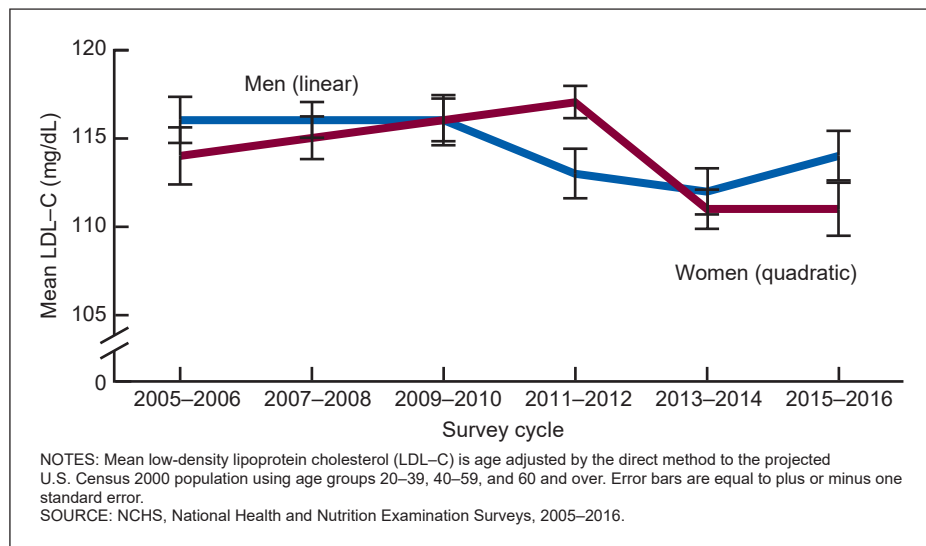
**Figure 3. Mean low-density lipoprotein cholesterol among men and women aged 20 and over, by survey cycle: United States, 2005–2016**

over, an increasing trend was seen during 2005–2010 that did not reach statistical significance, followed by a decline after 2009–2010 to 2015–2016. Declines were observed in women with either normal weight or obesity. For women in the overweight category, the age-adjusted mean increased from 2005–2006 to 2011–2012, then decreased after 2011–2012 to 2015–2016.

## Adjusted trends

Table 4 presents results of the sex-specific multiple linear regressions for apo B, non-HDL–C, and LDL–C by survey cycle in adults aged 20 and over, adjusting for the possible confounding effects of use of lipid-lowering medications, age group, race and Hispanic origin, and BMI categories. The declining trends in apo B seen in women, and in non-HDL–C seen in men, from 2005–2006 to 2015–2016 persisted after controlling for these possible confounders. Based on these adjusted models, the estimated decline in apo B in women was nearly 4 mg/dL (equal to 5 x 0.81 mg/dL), and the estimated decline in non-HDL–C in men was more than 8 mg/dL (equal to 5 x 1.68 mg/dL).

The declining trend in apo B in men seen in the early period from 2005–2006 to 2011–2012, as well as the declining trends in non-HDL–C and in LDL–C seen in women in the later period from 2011–2012 to 2015–2016, also persisted after controlling for these

covariates. Based on these adjusted models, estimated declines were found of approximately 5 mg/dL (equal to 3 x 1.71 mg/dL) in apo B for men over the early survey period, and approximately 9 mg/dL (equal to 2 x 4.54 mg/dL) in non-HDL–C and nearly 7 mg/dL (equal to 2 x 3.30 mg/dL) in LDL–C for women over the later survey period.

The estimated decline based on the adjusted model of nearly 3 mg/dL (equal to 5 x 0.56) seen in LDL–C for men was not statistically significant ($p = 0.087$).

## Discussion

From 2005–2006 to 2015–2016, significant but different patterns of declining trends in the three lipid analytes were seen in men and women aged 20 and over. Age-adjusted mean non-HDL–C and LDL–C declined for men over this 12-year survey period, whereas declines in age-adjusted mean non-HDL–C and LDL–C occurred in the later part of the period among women. The age-adjusted mean apo B declined over the entire time period among women aged 20 and over. In contrast, mean apo B for men declined from 2005–2006 to 2011–2012 and then leveled off after 2011–2012 to 2015–2016. With the exception of LDL–C for men, these trends persisted after controlling for the possible confounding effects of age group, race and Hispanic origin, BMI category, and the use of lipid-lowering

medications. Declining trends in apo B, non-HDL–C, and LDL–C were seen in men with normal weight, in women aged 20–39 and women with obesity during 2005–2016, and in Hispanic women during 2007–2016. For non-Hispanic black men and Mexican-American women, significant declining trends were seen in apo B and non-HDL–C, whereas observed declining trends in LDL–C did not reach statistical significance.

Observed declining trends that did not reach statistical significance were also seen in apo B for non-Hispanic white men, non-Hispanic white women, and overweight women, as well as in LDL–C for Mexican-American and Hispanic men for 2007–2016. The sample sizes for apo B and LDL–C for these subgroups may be too small to detect a trend when a trend does, indeed, exist.

Ford, Li, and Sniderman examined changes in lipids, including apo B in U.S. adults with diagnosed diabetes, undiagnosed diabetes, prediabetes, and normoglycemia, from 1988–1991 to 2005–2008 (39). Bachorik et al. presented distributions of apo B for children and adults in the United States during 1988–1991 (40), and Carroll et al. assessed trends in apo B, non-HDL–C, and LDL–C in adults aged 60 and over during 2005–2014 by sex and use of lipid-lowering medications (33). Perak et al. presented trends in lipids of children and youth aged 6–19 years during 1999–2016 (41). Vega and Grundy present trends in non-HDL–C and LDL–C for adults with atherosclerotic cardiovascular disease (42). To the authors' knowledge, this report is the first to present data on trends in apo B in the U.S. population aged 20 and over in more recent years.

The declines in apo B, non-HDL–C, and LDL–C seen in women, and the declines in apo B and non-HDL–C seen in men, cannot be explained by the use of lipid-lowering medications, age, race and Hispanic origin, or BMI. The decreasing trends in TC from 2005–2006 to 2015–2016 most likely contributed to the declining trends in non-HDL–C. Other factors that affect lipids include diet such as trans-fatty acid consumption (43,44), physical activity, and weight loss. In 2006, the U.S. Food and Drug Administration required that trans-fatty

acid content be declared on the nutrition label of foods and dietary supplements. Consequently, trans-fatty acids were banned in a number of places, such as California in 2008 and New York City in 2006. By 2010, studies showed that many manufacturers reduced or removed trans-fatty acids (45,46), which may explain the declines in apo B, non-HDL–C, and LDL–C seen in adults aged 20 and over of both sexes. Individual behavior changes related to physical activity are unlikely to have contributed substantially to these declining trends. In 2017, 41.8% of men met the Healthy People 2020 physical activity recommendation (to engage in aerobic physical activity of at least moderate intensity for more than 300 minutes per week, or of vigorous intensity for more than 150 minutes per week, or an equivalent combination), up from 38.7% in 2012. Among women, 32.5% met the recommendations in 2017 compared with 30.2% in 2012 (47). In addition, the prevalence of obesity in adults continued to increase, from 34.5% in 2005–2006 to 39.6% in 2015–2016 (48). The percentage of adults on lipid-lowering medications increased from 2005–2006 to 2015–2016 in both men and women aged 60 and over, but no changes were observed in adults aged 20–39 or 40–59 among either sex (49).

Strengths of this analysis include the use of standardized lipid measurements for adults in six national samples representative of the U.S. civilian noninstitutionalized population. However, observed trends in mean apo B and LDL–C for many subgroups based on small sample sizes (particularly for race and Hispanic origin and BMI categories) did not reach statistical significance due to lack of power (i.e., the ability to detect a trend when a trend exists). Another limitation is that the use of lipid-lowering medications is based on the report of any type, rather than on specific types, of lipid-lowering medications, and no information on the duration of use of lipid-lowering medications is available. Furthermore, the trends presented in this report are based on only six survey cycles spanning a relatively short period of time, and only three data points are available for non-Hispanic Asian adults. The calculation of LDL–C by the Friedewald equation rather than by

direct measurement may be an additional limitation. LDL calculated by the Friedewald equation has been shown to be unreliable for levels less than 70 mg/dL (1).

Declining trends from 2005–2006 to 2015–2016 were seen in apo B for women and in non-HDL–C for men after controlling for the use of lipid-lowering medications in addition to age, race and Hispanic origin, and BMI categories. Declining trends from 2005–2006 to 2011–2012 were seen in apo B for men, and declining trends from 2011–2012 to 2015–2016 were seen in non-HDL–C and LDL–C for women. These trends may continue to be monitored with future NHANES surveys.

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**Table 1. Mean apolipoprotein B among men and women aged 20 and over, by survey cycle, age group, race and Hispanic origin, and body mass index category: United States, 2005–2016**

| Sex, age, race and Hispanic origin, and BMI | Survey cycle | | | | | | | | | | | | p value for linear trend |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 2005–2006 | | 2007–2008 | | 2009–2010 | | 2011–2012 | | 2013–2014 | | 2015–2016 | | |
| | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | |
| Total, both sexes[1–3] . . . . . . . . . . | 96 | 1.3 | 96 | 0.7 | 94 | 1.0 | 93 | 0.8 | 93 | 0.7 | 93 | 0.7 | 0.004 |
| **Men** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . . | 98 | 1.2 | 98 | 0.8 | 95 | 0.9 | 93 | 1.1 | 95 | 0.9 | 95 | 1.1 | † |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 　20–39 . . . . . . . . . . . . . . . . . . | 94 | 1.9 | 93 | 1.2 | 92 | 1.7 | 88 | 1.3 | 91 | 1.5 | 92 | 1.4 | † |
| 　40–59 . . . . . . . . . . . . . . . . . . | 103 | 1.3 | 105 | 1.5 | 100 | 1.4 | 101 | 2.5 | 102 | 1.6 | 102 | 1.8 | 0.406 |
| 　60 and over . . . . . . . . . . . . . . | 98 | 1.6 | 93 | 1.9 | 91 | 1.2 | 89 | 1.5 | 90 | 1.7 | 89 | 2.5 | ‡ |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| 　Non-Hispanic: | | | | | | | | | | | | | |
| 　　White . . . . . . . . . . . . . . . . . | 97 | 1.2 | 97 | 1.0 | 93 | 1.3 | 93 | 1.6 | 94 | 1.1 | 95 | 1.5 | 0.061 |
| 　　Black . . . . . . . . . . . . . . . . . | 96 | 1.9 | 93 | 2.6 | 95 | 1.5 | 88 | 1.2 | 90 | 1.2 | 91 | 2.3 | 0.011 |
| 　　Asian . . . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 92 | 2.2 | 96 | 1.8 | 97 | 2.6 | 0.150 |
| 　Hispanic[4] . . . . . . . . . . . . . . . | --- | --- | 102 | 1.3 | 101 | 0.9 | 100 | 1.1 | 101 | 2.4 | 100 | 1.2 | 0.289 |
| 　　Mexican American . . . . . . . . | 104 | 1.9 | 103 | 1.7 | 102 | 1.7 | 100 | 1.4 | 103 | 3.1 | 100 | 1.6 | 0.168 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| 　Normal weight . . . . . . . . . . . . | 92 | 1.2 | 93 | 1.2 | 89 | 1.8 | 89 | 1.4 | 85 | 1.6 | 88 | 2.4 | 0.005 |
| 　Overweight . . . . . . . . . . . . . . | 103 | 1.5 | 98 | 1.1 | 98 | 1.2 | 94 | 1.5 | 95 | 1.5 | 97 | 1.9 | † |
| 　Obese . . . . . . . . . . . . . . . . . . | 100 | 1.7 | 103 | 2.2 | 99 | 1.6 | 96 | 1.5 | 101 | 2.0 | 99 | 1.4 | 0.256 |
| **Women** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . . | 94 | 1.7 | 94 | 1.0 | 92 | 1.2 | 92 | 0.8 | 91 | 0.8 | 91 | 1.0 | 0.030 |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 　20–39 . . . . . . . . . . . . . . . . . . | 89 | 2.4 | 87 | 1.1 | 85 | 1.3 | 84 | 1.0 | 84 | 1.6 | 82 | 1.5 | 0.004 |
| 　40–59 . . . . . . . . . . . . . . . . . . | 97 | 2.3 | 100 | 2.3 | 96 | 1.7 | 98 | 1.1 | 97 | 1.8 | 99 | 1.4 | 0.828 |
| 　60 and over . . . . . . . . . . . . . . | 98 | 1.5 | 98 | 1.2 | 99 | 1.8 | 97 | 1.2 | 94 | 1.4 | 95 | 1.3 | 0.017 |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| 　Non-Hispanic: | | | | | | | | | | | | | |
| 　　White . . . . . . . . . . . . . . . . . | 95 | 2.1 | 94 | 1.0 | 92 | 1.6 | 92 | 0.9 | 92 | 1.1 | 92 | 1.5 | 0.068 |
| 　　Black . . . . . . . . . . . . . . . . . | 89 | 1.5 | 93 | 1.9 | 93 | 1.4 | 91 | 1.9 | 85 | 2.4 | 90 | 1.6 | 0.132 |
| 　　Asian . . . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 88 | 2.2 | 88 | 2.3 | 89 | 1.5 | 0.600 |
| 　Hispanic[4] . . . . . . . . . . . . . . . | --- | --- | 96 | 1.4 | 94 | 1.5 | 93 | 2.0 | 93 | 1.5 | 91 | 1.1 | 0.008 |
| 　　Mexican American . . . . . . . . | 95 | 2.0 | 97 | 1.3 | 95 | 1.9 | 92 | 2.1 | 92 | 2.2 | 91 | 1.5 | 0.011 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| 　Normal weight . . . . . . . . . . . . | 87 | 1.8 | 89 | 0.8 | 85 | 1.2 | 85 | 1.4 | 83 | 1.3 | 85 | 2.2 | 0.045 |
| 　Overweight . . . . . . . . . . . . . . | 97 | 1.6 | 96 | 2.0 | 97 | 2.0 | 96 | 1.2 | 94 | 1.3 | 94 | 2.0 | 0.069 |
| 　Obese . . . . . . . . . . . . . . . . . . | 99 | 2.2 | 99 | 1.7 | 96 | 1.7 | 97 | 1.3 | 95 | 1.1 | 94 | 0.9 | 0.015 |

† Significant quadratic trend for 2005–2016. Mean apo B declined from 2005–2006 to 2011–2012 ($p < 0.05$) and remained level after 2011–2012 ($p > 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

‡ Significant quadratic trend for 2005–2016. Mean apo B declined from 2005–2006 to 2009–2010 ($p < 0.05$) and remained level after 2009–2010 ($p > 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

--- Data not available.

[1] Age adjusted to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over.

[2] Includes other races not shown separately.

[3] Includes underweight adults not shown separately.

[4] Includes Mexican-American adults.

NOTES: Apolipoprotein B (apo B) is measured in mg/dL. BMI is body mass index; underweight is BMI less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Table 2. Mean non-high-density lipoprotein cholesterol among men and women aged 20 and over, by survey cycle, age group, race and Hispanic origin, and body mass index category: United States, 2005–2016**

| | Survey cycle | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 2005–2006 | | 2007–2008 | | 2009–2010 | | 2011–2012 | | 2013–2014 | | 2015–2016 | | |
| Sex, age, race and Hispanic origin, and BMI | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | p value for linear trend |
| Total, both sexes[1–3] . . . . . . . . . | 144 | 0.9 | 145 | 0.7 | 143 | 0.8 | 142 | 0.9 | 136 | 0.7 | 137 | 1.1 | Less than 0.001 |
| **Men** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . | 147 | 1.1 | 148 | 1.1 | 146 | 0.9 | 143 | 1.2 | 139 | 1.3 | 141 | 1.4 | Less than 0.001 |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . | 143 | 1.9 | 145 | 1.7 | 142 | 1.2 | 137 | 1.9 | 136 | 2.2 | 136 | 1.8 | Less than 0.001 |
| 40–59 . . . . . . . . . . . . . . . . . | 156 | 1.6 | 159 | 1.8 | 157 | 2.1 | 156 | 1.6 | 148 | 1.7 | 153 | 2.7 | 0.010 |
| 60 and over . . . . . . . . . . . . . | 139 | 1.4 | 134 | 1.6 | 136 | 1.9 | 132 | 1.5 | 128 | 2.4 | 128 | 2.8 | Less than 0.001 |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| Non-Hispanic: | | | | | | | | | | | | | |
| White . . . . . . . . . . . . . . . | 147 | 1.3 | 147 | 1.4 | 145 | 1.1 | 143 | 1.5 | 138 | 1.6 | 140 | 1.8 | Less than 0.001 |
| Black . . . . . . . . . . . . . . . | 136 | 1.8 | 139 | 2.0 | 137 | 2.1 | 133 | 2.2 | 130 | 1.8 | 130 | 2.6 | 0.001 |
| Asian . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 141 | 2.5 | 142 | 2.8 | 141 | 2.8 | 0.988 |
| Hispanic[4] . . . . . . . . . . . . . | --- | --- | 155 | 1.7 | 153 | 1.2 | 149 | 2.2 | 147 | 2.5 | 147 | 1.8 | Less than 0.001 |
| Mexican American . . . . . . . | 157 | 2.2 | 157 | 2.6 | 153 | 2.0 | 151 | 2.9 | 146 | 3.1 | 149 | 2.6 | 0.001 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| Normal weight . . . . . . . . . . . | 133 | 1.6 | 139 | 1.8 | 132 | 1.8 | 134 | 1.6 | 124 | 1.6 | 126 | 2.2 | Less than 0.001 |
| Overweight . . . . . . . . . . . . . | 153 | 1.6 | 149 | 1.5 | 152 | 1.6 | 145 | 1.5 | 141 | 1.8 | 146 | 2.7 | Less than 0.001 |
| Obese . . . . . . . . . . . . . . . . | 153 | 1.4 | 157 | 2.5 | 152 | 1.2 | 150 | 2.1 | 147 | 2.5 | 146 | 1.8 | Less than 0.001 |
| **Women** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . | 141 | 1.1 | 142 | 1.0 | 139 | 1.2 | 141 | 0.8 | 134 | 0.8 | 133 | 1.2 | † |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . | 132 | 2.2 | 130 | 1.9 | 127 | 1.5 | 128 | 1.1 | 124 | 2.1 | 120 | 1.8 | Less than 0.001 |
| 40–59 . . . . . . . . . . . . . . . . . | 147 | 1.9 | 150 | 2.2 | 147 | 1.9 | 151 | 1.4 | 142 | 1.5 | 143 | 1.5 | † |
| 60 and over . . . . . . . . . . . . . | 148 | 1.7 | 149 | 1.6 | 148 | 1.7 | 148 | 1.8 | 138 | 1.2 | 138 | 2.0 | ‡ |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| Non-Hispanic: | | | | | | | | | | | | | |
| White . . . . . . . . . . . . . . . | 142 | 1.4 | 143 | 1.1 | 140 | 1.4 | 142 | 1.0 | 134 | 0.9 | 133 | 1.3 | † |
| Black . . . . . . . . . . . . . . . | 131 | 1.7 | 133 | 2.5 | 133 | 2.2 | 136 | 1.1 | 126 | 2.1 | 125 | 2.2 | † |
| Asian . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 135 | 1.8 | 132 | 2.1 | 131 | 2.1 | 0.194 |
| Hispanic[4] . . . . . . . . . . . . . | --- | --- | 144 | 1.7 | 141 | 1.5 | 142 | 1.9 | 139 | 1.3 | 135 | 1.2 | Less than 0.001 |
| Mexican American . . . . . . . | 144 | 2.1 | 144 | 2.1 | 142 | 1.5 | 139 | 2.2 | 137 | 2.3 | 135 | 1.6 | Less than 0.001 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| Normal weight . . . . . . . . . . . | 131 | 1.3 | 131 | 1.5 | 131 | 1.4 | 133 | 2.3 | 121 | 1.4 | 121 | 1.7 | † |
| Overweight . . . . . . . . . . . . . | 146 | 1.9 | 147 | 1.3 | 144 | 2.0 | 146 | 1.8 | 137 | 1.3 | 136 | 1.4 | † |
| Obese . . . . . . . . . . . . . . . . | 150 | 2.1 | 149 | 1.9 | 146 | 2.0 | 146 | 1.1 | 142 | 1.3 | 140 | 1.9 | Less than 0.001 |

--- Data not available.

† Significant quadratic trend for 2005–2016. Mean non-HDL–C remained level from 2005–2006 to 2011–2012 ($p > 0.05$) but declined after 2011–2012 ($p < 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

‡ Significant quadratic trend for 2005–2016. Mean non-HDL–C remained level from 2005–2006 to 2009–2010 ($p > 0.05$) but declined after 2009–2010 ($p < 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

[1] Age adjusted to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over.

[2] Includes other races not shown separately.

[3] Includes underweight adults not shown separately.

[4] Includes Mexican-American adults.

NOTES: Non-high-density lipoprotein cholesterol (non-HDL–C) is calculated as total cholesterol (TC) – HDL–C, where both TC and HDL–C are measured in mg/dL. BMI is body mass index; underweight is BMI Less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Table 3. Mean low-density lipoprotein cholesterol among men and women aged 20 years and over by survey cycle, age group, race and Hispanic origin, and BMI category: United States, 2005–2016**

| Sex, age, race and Hispanic origin, and BMI | Survey cycle | | | | | | | | | | | | p value for linear trend |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005–2006 | | 2007–2008 | | 2009–2010 | | 2011–2012 | | 2013–2014 | | 2015–2016 | | |
| | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | Mean | Standard error | |
| Total, both sexes[1–3] . . . . . . . . . . | 115 | 1.2 | 116 | 0.9 | 116 | 1.1 | 115 | 0.9 | 111 | 0.9 | 113 | 1.1 | 0.011 |
| **Men** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . . | 116 | 1.3 | 116 | 1.0 | 116 | 1.2 | 113 | 1.4 | 112 | 1.3 | 114 | 1.4 | 0.028 |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . | 111 | 2.3 | 114 | 1.9 | 114 | 1.9 | 112 | 1.9 | 110 | 2.1 | 113 | 1.7 | 0.864 |
| 40–59 . . . . . . . . . . . . . . . . . | 123 | 1.8 | 126 | 1.9 | 124 | 2.4 | 120 | 2.6 | 121 | 1.7 | 122 | 2.3 | 0.153 |
| 60 and over . . . . . . . . . . . . . . | 113 | 1.9 | 103 | 2.6 | 107 | 2.1 | 105 | 2.6 | 102 | 2.7 | 102 | 3.6 | 0.015 |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| Non-Hispanic: | | | | | | | | | | | | | |
| White . . . . . . . . . . . . . . . . | 114 | 1.3 | 115 | 1.3 | 115 | 1.8 | 113 | 2.0 | 111 | 1.7 | 113 | 2.1 | 0.214 |
| Black . . . . . . . . . . . . . . . . | 115 | 2.8 | 114 | 3.1 | 117 | 2.1 | 109 | 2.4 | 112 | 1.8 | 110 | 3.4 | 0.103 |
| Asian . . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 114 | 4.2 | 111 | 2.9 | 116 | 4.0 | 0.705 |
| Hispanic[4] . . . . . . . . . . . . . . | --- | --- | 120 | 2.0 | 120 | 1.3 | 120 | 1.6 | 119 | 4.3 | 117 | 1.7 | 0.161 |
| Mexican American . . . . . . . . | 123 | 2.6 | 120 | 2.7 | 120 | 2.4 | 119 | 2.1 | 118 | 5.1 | 116 | 2.0 | 0.090 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| Normal weight . . . . . . . . . . . | 112 | 2.0 | 113 | 2.1 | 110 | 2.4 | 111 | 2.1 | 105 | 2.4 | 107 | 3.5 | 0.018 |
| Overweight . . . . . . . . . . . . . | 123 | 2.6 | 118 | 1.8 | 120 | 1.8 | 118 | 1.9 | 113 | 2.1 | 117 | 2.3 | 0.014 |
| Obese . . . . . . . . . . . . . . . . | 113 | 2.0 | 120 | 3.0 | 120 | 1.6 | 112 | 1.9 | 116 | 2.4 | 116 | 1.8 | 0.888 |
| **Women** | | | | | | | | | | | | | |
| Aged 20 and over[1–3] . . . . . . . . . | 114 | 1.6 | 115 | 1.2 | 116 | 1.4 | 117 | 0.9 | 111 | 1.1 | 111 | 1.5 | † |
| Age group (years)[2,3]: | | | | | | | | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . | 109 | 2.9 | 106 | 1.6 | 107 | 2.0 | 107 | 0.9 | 102 | 2.1 | 100 | 1.9 | 0.006 |
| 40–59 . . . . . . . . . . . . . . . . . | 119 | 2.8 | 123 | 2.5 | 122 | 1.6 | 126 | 2.1 | 118 | 2.7 | 122 | 2.7 | 0.703 |
| 60 and over . . . . . . . . . . . . . . | 116 | 2.0 | 117 | 2.0 | 121 | 2.5 | 120 | 1.6 | 113 | 2.1 | 113 | 1.9 | ‡ |
| Race and Hispanic origin[1,3]: | | | | | | | | | | | | | |
| Non-Hispanic: | | | | | | | | | | | | | |
| White . . . . . . . . . . . . . . . . | 116 | 2.1 | 116 | 1.1 | 116 | 1.9 | 118 | 1.3 | 112 | 1.5 | 113 | 2.0 | 0.117 |
| Black . . . . . . . . . . . . . . . . | 110 | 2.8 | 113 | 2.8 | 115 | 1.8 | 116 | 2.0 | 107 | 4.0 | 109 | 2.6 | † |
| Asian . . . . . . . . . . . . . . . . | --- | --- | --- | --- | --- | --- | 114 | 3.8 | 106 | 3.1 | 110 | 2.4 | 0.312 |
| Hispanic[4] . . . . . . . . . . . . . . | --- | --- | 115 | 1.8 | 114 | 2.3 | 115 | 2.3 | 110 | 2.3 | 108 | 1.7 | 0.003 |
| Mexican American . . . . . . . . | 110 | 3.0 | 117 | 2.4 | 113 | 2.3 | 111 | 3.3 | 107 | 3.1 | 108 | 2.3 | 0.078 |
| BMI category[1,2]: | | | | | | | | | | | | | |
| Normal weight . . . . . . . . . . . | 109 | 2.3 | 111 | 1.3 | 110 | 2.2 | 112 | 2.4 | 103 | 1.9 | 105 | 3.1 | 0.037 |
| Overweight . . . . . . . . . . . . . | 117 | 2.6 | 117 | 2.3 | 123 | 2.8 | 123 | 2.1 | 115 | 1.7 | 115 | 2.9 | § |
| Obese . . . . . . . . . . . . . . . . | 118 | 2.0 | 118 | 2.2 | 116 | 1.7 | 119 | 1.6 | 114 | 1.4 | 114 | 1.4 | 0.043 |

--- Data not available.

† Significant quadratic trend for 2005–2016. Mean LDL–C appeared to increase from 2005–2006 to 2011–2012 but did not reach statistical significance ($p > 0.05$) and declined after 2011–2012 ($p < 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

‡ Significant quadratic trend for 2005–2016. Mean LDL–C appeared to increase from 2005–2006 to 2009–2010 but did not reach statistical significance ($p > 0.05$) and declined after 2009–2010 ($p < 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

§ Significant quadratic trend for 2005–2016. Mean LDL–C increased from 2005–2006 to 2011–2012 ($p < 0.05$) and declined after 2011–2012 ($p < 0.05$). Slopes for line segments are significantly different ($p < 0.05$).

[1] Age adjusted to the projected U.S. Census 2000 population using age groups 20–39, 40–59, and 60 and over.

[2] Includes other races not shown separately.

[3] Includes underweight adults not shown separately.

[4] Includes Mexican-American adults.

NOTES: Low-density lipoprotein cholesterol (LDL–C) is calculated by the Friedewald equation (see reference 26 in this report) and is measured in mg/dL. BMI is body mass index; underweight is BMI less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Table 4. Adjusted trends in apolipoprotein B, non-high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol among men and women aged 20 and over: United States, 2005–2016**

| Sex and time period comparison | Apo B | | Non-HDL–C | | LDL–C | |
|---|---|---|---|---|---|---|
| | Slope (standard error) | *p* value | Slope (standard error) | *p* value | Slope (standard error) | *p* value |
| **Men** | | | | | | |
| 2005–2006 to 2015–2016 . . . . . . . . . . . . . | … | … | −1.68 (0.29) | Less than 0.001 | −0.56 (0.33) | 0.087 |
| 2005–2006 to 2011–2012 . . . . . . . . . . . . . | −1.71 (0.48) | Less than 0.001 | … | … | … | … |
| 2011–2012 to 2015–2016 . . . . . . . . . . . . . | 0.72 (0.70) | 0.304 | … | … | … | … |
| Difference in slopes . . . . . . . . . . . . . . . . . . | … | 0.021 | … | … | … | … |
| **Women** | | | | | | |
| 2005–2006 to 2015–2016 . . . . . . . . . . . . . | −0.81 (0.26) | 0.003 | … | … | … | … |
| 2005–2006 to 2011–2012 . . . . . . . . . . . . . | … | … | −0.62 (0.43) | 0.150 | 0.71 (0.53) | 0.184 |
| 2011–2012 to 2015–2016 . . . . . . . . . . . . . | … | … | −4.54 (0.62) | Less than 0.001 | −3.30 (0.83) | Less than 0.001 |
| Difference in slopes . . . . . . . . . . . . . . . . . . | … | … | … | Less than 0.001 | … | 0.001 |

… Category not applicable.

NOTES: Data are adjusted for age, race and Hispanic origin, body mass index (BMI) category, and use of lipid-lowering medications. Apo B is apolipoprotein B. Non-HDL–C is non-high-density lipoprotein cholesterol. LDL–C is low-density lipoprotein cholesterol. Underweight is BMI less than 18.5, normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

# Technical Notes

**Table I. Unweighted sample size for mean apolipoprotein B among men and women aged 20 and over, by survey cycle, age group, race and Hispanic origin, and body mass index category: National Health and Nutrition Examination Surveys, 2005–2016**

| Sex, age, race and Hispanic origin, and BMI | Survey cycle | | | | | |
|---|---|---|---|---|---|---|
| | 2005–2006 | 2007–2008 | 2009–2010 | 2011–2012 | 2013–2014 | 2015–2016 |
| Total, both sexes[1,2] . . . . . . . . . . . . . . . . . . . . . . . . | 1,959 | 2,345 | 2,595 | 2,286 | 2,364 | 2,253 |
| **Men** | | | | | | |
| Aged 20 and over[1,2] . . . . . . . . . . . . . . . . . . . . . . . | 956 | 1,141 | 1,211 | 1,135 | 1,129 | 1,087 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 319 | 367 | 367 | 409 | 362 | 345 |
| 40–59 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 306 | 366 | 444 | 369 | 395 | 355 |
| 60 and over . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 331 | 408 | 400 | 357 | 372 | 387 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 505 | 568 | 578 | 444 | 514 | 389 |
| Black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 202 | 205 | 203 | 230 | 207 | 203 |
| Asian . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | --- | --- | 172 | 139 | 133 |
| Hispanic[3] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | 322 | 365 | 258 | 243 | 317 |
| Mexican American . . . . . . . . . . . . . . . . . . . . . | 182 | 199 | 232 | 134 | 151 | 168 |
| BMI category[1]: | | | | | | |
| Normal weight . . . . . . . . . . . . . . . . . . . . . . . . . . | 258 | 294 | 291 | 320 | 321 | 273 |
| Overweight . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 361 | 463 | 456 | 413 | 435 | 398 |
| Obese . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 307 | 356 | 437 | 375 | 350 | 390 |
| **Women** | | | | | | |
| Aged 20 and over[1,2] . . . . . . . . . . . . . . . . . . . . . . . | 1,003 | 1,204 | 1,384 | 1,151 | 1,235 | 1,166 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 427 | 369 | 477 | 409 | 397 | 371 |
| 40–59 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 290 | 394 | 456 | 392 | 451 | 407 |
| 60 and over . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 286 | 441 | 451 | 350 | 387 | 388 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 480 | 560 | 647 | 441 | 542 | 380 |
| Black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 230 | 232 | 226 | 292 | 227 | 249 |
| Asian . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | --- | --- | 160 | 148 | 128 |
| Hispanic[3] . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | 369 | 435 | 229 | 288 | 375 |
| Mexican American . . . . . . . . . . . . . . . . . . . . . | 210 | 218 | 272 | 113 | 162 | 205 |
| BMI category[1]: | | | | | | |
| Normal weight . . . . . . . . . . . . . . . . . . . . . . . . . . | 284 | 335 | 383 | 340 | 363 | 295 |
| Overweight . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 275 | 350 | 426 | 316 | 319 | 335 |
| Obese . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 408 | 474 | 544 | 451 | 515 | 508 |

--- Data not available.

[1]Includes other races not shown separately.

[2]Includes underweight adults not shown separately.

[3]Includes Mexican-American adults.

NOTES: BMI is body mass index. Underweight is BMI less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Table II. Unweighted sample size for mean non-high-density lipoprotein cholesterol among men and women aged 20 and over, by survey cycle, age group, race and Hispanic origin, and BMI category: National Health and Nutrition Examination Surveys, 2005–2016**

| Sex, age, race and Hispanic origin, and BMI | Survey cycle | | | | | |
|---|---|---|---|---|---|---|
| | 2005–2006 | 2007–2008 | 2009–2010 | 2011–2012 | 2013–2014 | 2015–2016 |
| Total, both sexes[1,2] | 4,481 | 5,332 | 5,696 | 4,913 | 5,342 | 5,157 |
| **Men** | | | | | | |
| Aged 20 and over[1,2] | 2,155 | 2,616 | 2,760 | 2,434 | 2,547 | 2,478 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 | 742 | 830 | 885 | 877 | 875 | 830 |
| 40–59 | 680 | 843 | 948 | 778 | 862 | 800 |
| 60 and over | 733 | 943 | 927 | 779 | 810 | 848 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White | 1,114 | 1,295 | 1,368 | 929 | 1,111 | 865 |
| Black | 481 | 488 | 477 | 593 | 517 | 494 |
| Asian | --- | --- | --- | 340 | 288 | 304 |
| Hispanic[3] | --- | 714 | 764 | 495 | 554 | 717 |
| Mexican American | 428 | 448 | 503 | 259 | 352 | 419 |
| BMI category[1]: | | | | | | |
| Normal weight | 544 | 662 | 678 | 710 | 688 | 622 |
| Overweight | 866 | 1,019 | 1,051 | 876 | 961 | 912 |
| Obese | 680 | 866 | 968 | 784 | 840 | 881 |
| **Women** | | | | | | |
| Aged 20 and over[1,2] | 2,326 | 2,716 | 2,936 | 2,479 | 2,795 | 2,679 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 | 959 | 872 | 1,020 | 871 | 927 | 907 |
| 40–59 | 697 | 878 | 963 | 851 | 979 | 913 |
| 60 and over | 670 | 966 | 953 | 757 | 889 | 859 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White | 1,150 | 1,248 | 1,410 | 915 | 1,219 | 843 |
| Black | 515 | 531 | 493 | 655 | 538 | 562 |
| Asian | --- | --- | --- | 345 | 318 | 300 |
| Hispanic[3] | --- | 830 | 869 | 502 | 638 | 886 |
| Mexican American | 484 | 493 | 544 | 235 | 370 | 499 |
| BMI category[1]: | | | | | | |
| Normal weight | 709 | 766 | 804 | 724 | 815 | 684 |
| Overweight | 645 | 808 | 866 | 693 | 743 | 737 |
| Obese | 895 | 1,055 | 1,186 | 966 | 1,154 | 1,196 |

--- Data not available.

[1]Includes other races not shown separately.

[2]Includes underweight adults not shown separately.

[3]Includes Mexican-American adults.

NOTES: BMI is body mass index. Underweight is BMI less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

**Table III. Unweighted sample size for mean low-density lipoprotein cholesterol among men and women aged 20 and over, by survey cycle, age group, race and Hispanic origin, and BMI category: National Health and Nutrition Examination Surveys, 2005–2016**

| Sex, age, race and Hispanic origin, and BMI | Survey cycle | | | | | |
|---|---|---|---|---|---|---|
| | 2005–2006 | 2007–2008 | 2009–2010 | 2011–2012 | 2013–2014 | 2015–2016 |
| Total, both sexes[1,2] . . . . . . . . . . . . . . . . . . . . . . . | 1,907 | 2,296 | 2,550 | 2,244 | 2,332 | 2,230 |
| *Men* | | | | | | |
| Aged 20 and over[1,2] . . . . . . . . . . . . . . . . . . . . . | 921 | 1,106 | 1,181 | 1,105 | 1,105 | 1,070 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 308 | 357 | 356 | 402 | 352 | 341 |
| 40–59 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 290 | 350 | 430 | 354 | 384 | 347 |
| 60 and over . . . . . . . . . . . . . . . . . . . . . . . . . . | 323 | 399 | 395 | 349 | 369 | 382 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 488 | 553 | 561 | 428 | 500 | 385 |
| Black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 198 | 202 | 201 | 228 | 206 | 202 |
| Asian . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | --- | --- | 170 | 136 | 131 |
| Hispanic[3] . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | 307 | 355 | 248 | 238 | 310 |
| Mexican American . . . . . . . . . . . . . . . . . . . . | 172 | 189 | 227 | 127 | 147 | 164 |
| BMI category[1]: | | | | | | |
| Normal weight . . . . . . . . . . . . . . . . . . . . . . . . | 255 | 288 | 289 | 317 | 320 | 272 |
| Overweight . . . . . . . . . . . . . . . . . . . . . . . . . . | 340 | 447 | 440 | 401 | 426 | 391 |
| Obese . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 296 | 343 | 426 | 360 | 336 | 381 |
| *Women* | | | | | | |
| Aged 20 and over[1,2] . . . . . . . . . . . . . . . . . . . . . | 986 | 1,190 | 1,369 | 1,139 | 1,227 | 1,160 |
| Age group (years)[1,2]: | | | | | | |
| 20–39 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 423 | 366 | 474 | 407 | 395 | 371 |
| 40–59 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 282 | 386 | 449 | 387 | 446 | 402 |
| 60 and over . . . . . . . . . . . . . . . . . . . . . . . . . . | 281 | 438 | 446 | 345 | 386 | 387 |
| Race and Hispanic origin[2]: | | | | | | |
| Non-Hispanic: | | | | | | |
| White . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 470 | 554 | 637 | 435 | 537 | 379 |
| Black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 229 | 229 | 226 | 290 | 227 | 249 |
| Asian . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | --- | --- | 158 | 148 | 127 |
| Hispanic[3] . . . . . . . . . . . . . . . . . . . . . . . . . . . | --- | 365 | 430 | 227 | 285 | 371 |
| Mexican American . . . . . . . . . . . . . . . . . . . . | 206 | 215 | 267 | 112 | 160 | 203 |
| BMI category[1]: | | | | | | |
| Normal weight . . . . . . . . . . . . . . . . . . . . . . . . | 282 | 333 | 381 | 339 | 363 | 294 |
| Overweight . . . . . . . . . . . . . . . . . . . . . . . . . . | 271 | 347 | 424 | 309 | 319 | 331 |
| Obese . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 397 | 466 | 534 | 447 | 507 | 507 |

--- Data not available.
[1]Includes other races not shown separately.
[2]Includes underweight adults not shown separately.
[3]Includes Mexican-American adults.

NOTES: BMI is body mass index. Underweight is BMI less than 18.5 (not shown separately), normal weight is BMI at or above 18.5 and below 25.0, overweight is BMI at or above 25.0 and below 30.0, and obese is BMI at or above 30.0.

SOURCE: NCHS, National Health and Nutrition Examination Surveys, 2005–2016.

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