VITAL and HEALTH STATISTICS

DATA FROM THE NATIONAL HEALTH SURVEY

Series 11-Number 206

NCHS NATIONAL CENTER FOR HEALTH STATISTICS

Total Serum Cholesterol Levels of Adults 18-74 Years

United States, 1971-1974

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Office of Health Research, Statistics, and Technology
National Center for Health Statistics

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Serum cholesterol values of adults 18-74 years of age in the United States, 1971-74, are presented and discussed by age, sex, and race and are also compared with serum cholesterol values of adults of similar ages in the United States, 1960-62.

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Hyattsville, Md. April 1978

NATIONAL CENTER FOR HEALTH STATISTICS

DIVISION OF HEALTH EXAMINATION STATISTICS

COOPERATION OF THE U.S. BUREAU OF THE CENSUS

In accordance with specifications established by the National Health Survey, the Bureau of the Census, under a contractual agreement, participated in the design and selection of the sample, and carried out the first stage of the field interviewing and certain parts of the statistical processing for the Health Examination Survey.

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CONTENTS

LIST OF FIGURES

SYMBOLS

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TOTAL SERUM CHOLESTEROL LEVELS OF ADULTS 18-74 YEARS

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INTRODUCTION

This report contains data on serum cholesterol obtained as part of the examination used in assessing the nutritional and related health status of the U.S. population aged 1 through 74 years. It is one of several reports of findings on health status obtained in the first Health and Nutrition Examination Survey. The findings here are limited to serum cholesterol levels of adults aged 18-74 years.

The Health Examination Survey, in which these data were obtained, is one of the major programs of the National Center for Health Statistics authorized under the National Health Survey Act of 1956 by the 84th Congress as a continuing Public Health Service activity to determine the health status of the population.

As in previous Health Examination Survey programs, the U.S. Bureau of the Census cooperated in the sample design and in the initial visits and interviewing at selected eligible households in the 65 primary sampling units (PSU's) throughout the United States.

Field data collection operations for the first Health and Nutrition Examination Survey were started in April 1971 and completed in June 1974. Of the 28,043 persons selected in the national probability sample to represent the 194 million persons aged 1-74 years in the civilian noninstitutionalized population, 74 percent or 20,749 were examined. When adjustments were made for the differential sampling ratios used for the effect of oversampling among the poor, preschool children, women of childbearing age, and the elderly, this corresponded to an effective response rate of 75 percent. Among persons 18-74 years of age at time of interview for whom serum cholesterol determinations were made, 13,671 were examined out of the probability sample of 19,572 selected to represent the 128 million persons of those ages in the population. This is an unadjusted response rate of 70 percent and an effective adjusted response rate of 70 percent.

The purpose of the Health and Nutrition Examination Survey (HANES) was to measure the nutritional status of the U.S. population as well as to ascertain certain aspects of general health status and medical needs in the civilian noninstitutionalized population of the continental United States aged 1-74 years. The HANES nutrition examination included a general medical examination by a physician which consisted of screening for nutritional deficiencies, a skin examination by a dermatologist, and a dental examination by a dentist. Body measurements were made by a trained technician; a dietary interview was administered that consisted of a 24-hour recall and a food frequency questionnaire; numerous laboratory tests were performed on whole blood, serum, plasma, and urine. A description of the sampling process and HANES operation has been published.[1]

In this report, data on serum cholesterol levels of the U.S. adult population are analyzed and discussed by age, sex, and race. The HANES findings are also compared with those in the Health Examination Survey (HES) 1960-62 report of the distribution of serum cholesterol levels.[2] The Health Examination Survey and the HANES I program provide the first such data that are representative of the general U.S. population.

The analysis of serum cholesterol levels with variables other than age, sex, and race (i.e., region, urbanization, income, weight status, and the relationship of diet to serum cholesterol levels) will be presented in future reports. The distribution of serum cholesterol levels of children and youths is also the subject of separate reports.[3,4]

SERUM CHOLESTEROL

Collection and Storage—HES and HANES

A blood specimen was collected from each nonfasting HES examinee in a 15-cm^3 Sheppard-Keidel tube. The tube was kept at room temperature for a minimum of 1 hour following venipuncture and then refrigerated for a minimum of 6 hours to assure a good clot. The blood clot was freed gently from the tube and the tube was then centrifuged for 20 minutes. An aliquot of 1 cm^3 of serum was transferred to a prenumbered serum vial and frozen. Twice a week the accumulated vials were placed in styrofoam containers, packed with dry ice, and shipped to the Lipid Standardization Laboratory of what was then the Communicable Disease Center (CDC), Public Health Service, Altanta, Ga.

A blood specimen was collected from each nonfasting HANES examinee and stored in three 15-cm^3 vacutainers. The tubes were kept at room temperature for clotting for 20-30 minutes following venipuncture. A blood clot was gently rimmed from each tube and the tubes were then centrifuged for 10 minutes at 2,400 r/min. The serum from the three vials was pooled, mixed thoroughly, and distributed in 3-cm^3 aliquots to prenumbered vials. Within 1 hour of venipuncture, these serum vials were placed in the freezer. Daily accumulations of vials were packed with ample carbon dioxide, put in styrofoam shippers, and sent to the CDC Atlanta laboratory; no thawing occurred in transit. The vials were stored in freezers at -20° C until ready for analysis. Multiple assessments were performed on each 3-cm^3 vial of serum. The serum to be used eventually for the cholesterol assessment was thawed at CDC for iron, iron-binding capacity, and magnesium determinations. The remaining serum in each vial was refrigerated until it was packed in dry ice for shipment to the CDC Lipid Laboratory at Chamblee, Ga. The serum remained frozen at -20° C until analyzed for cholesterol content. Thawing and freezing the serum do not affect the determination of cholesterol content by competent extraction methods.[5]

Cholesterol Determinations—HES and HANES

Serum cholesterol determinations were made for HES examinees at the Lipid Standardization Laboratory of what was then the Communicable Disease Center (CDC), Public Health Service, Atlanta, Ga., using a modified ferric-chloride technique. A comparative study of methods for determining cholesterol levels, which was conducted by CDC during the course of the Health Examination Survey, showed that when compared with the reference method of Abell, Levy, Brodie, and Kendall,[2] the ferric-sulfuric method in use overestimated the cholesterol concentration. Therefore the data in the HES report presented here are the original ferric-chloride values reduced by a factor of 7.6 percent to approximate the determinations of Abell et al.[6]

All serum cholesterol determinations for HANES examinees were made in the Lipid Standardization Laboratory of what is now the Center for Disease Control (CDC), Public Health Service, Atlanta, Ga. The analytical method was based on that of Abell et al.,[6] but it was modified for a semiautomated production line. The method, described in detail by Eavenson et al.,[7] was made possible by the development of a relatively stable Liebermann color reagent and was designed for automatic pipetting units.

The Lipid Laboratory at the Center for Disease Control compared the results obtained from the semiautomated method with those obtained from the reference method of Abell et al.[6] For examining the bias of the semiautomated method, data were obtained from pools of sera analyzed by the reference method and by the semiautomated method. For pools ranging from 134 to 343 mg/100 ml, there was in 1972 an average positive bias of 4.07 percent for the semiautomated method as compared with the standard method; for 1973-74 the corresponding figure was a positive bias of 4.9

percent. The weighted average bias was 4.5 percent. In this report, when the HANES 1971-74 data are presented alone, they are presented without correction for bias so that they provide population reference standards for determinations made by the semiautomated methodology now in use (tables 1-6). However, when comparisons are made between HANES data and HES data (tables 8-11), the HANES serum cholesterol data are presented with a reduction of 4.5 percent to approximate determinations by Abell and others and to make them comparable to HES data presented in this report.

FINDINGS—HANES

Age Differences

Mean serum cholesterol levels for adults aged 18-74 years in the United States increased considerably with age from 189.4 mg/100 ml for young adults 18-24 years of age to 250.7 mg/100 ml for older adults 65-74 years of age, an increase of 61.3 mg/100 ml or 32 percent (table 1).

The mean serum cholesterol levels increased less rapidly for persons in their midsixties and midseventies, with the level attaining a peak for those aged 65-74 years. A similar pattern of increments with age is shown in table 1, with minimum exceptions, by selected percentiles in the distributions of serum cholesterol. Table 1 also shows that the standard deviations for serum cholesterol levels increased with age from 39.0 mg/100 ml for young adults 18-24 years of age to 54.2 mg/100 ml for older adults 65-74 years of age. However, the coefficient of variation (standard deviation/mean) showed no consistent pattern with age and varied between 20.2 and 21.6 percent over the 18-74-year age span. The standard deviation is thus about one-fifth as large as the mean value at every age group.

Sex and Age

The lowest mean serum cholesterol level for men was for the youngest age group, 18-24 years; it increased steadily with age until age group 35-44 and it then increased by a small increment to a maximum level at age group 55-64 years before declining slightly for the oldest age group measured, 65-74 years (table 1 and figure 1).

For women, the mean serum cholesterol levels did not parallel those of men in the same age groups. Mean levels for women are slightly higher than those for men in the youngest age group, 18-24 years. For each older age group, there was a slight but consistently higher mean serum cholesterol level for men than for women until age group 45-54 years. Thereafter, the means for men showed a plateau effect and a slight decrease, and those for women continued upward from ages 55-64 years to a maximum value at age group 65-74 years (table 1 and figure 1).

The standard deviations of age and sex are shown in table 1, and the percent distributions of specific age-sex groups are shown in figure 2 in the form of histograms. The variability within each age and sex group increased with age as indicated by the standard deviations. Though the differences were small, men showed greater variations around their mean at most age groups than women did. The distributions for men were sharply peaked and skewed to the right at ages under 35 years, and they became more symmetrical in older ages. The distributions for

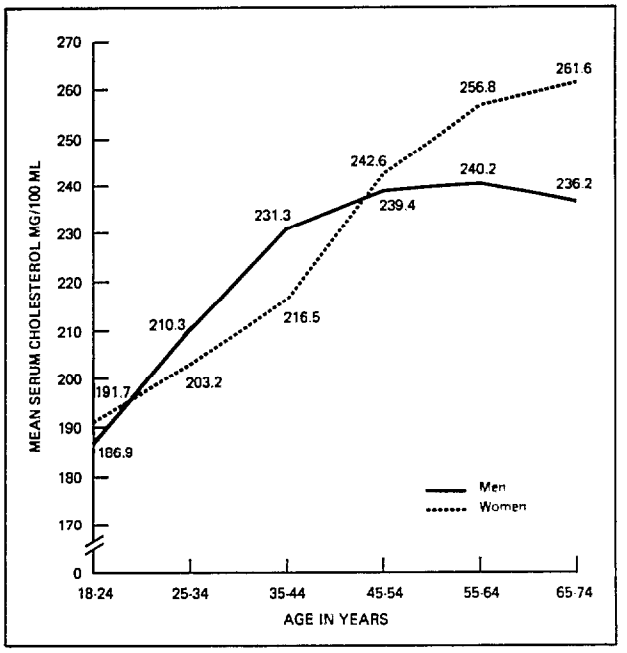

Figure 1. Mean serum cholesterol levels of adults aged 18-74 years, by sex and age: United States, 1971-74

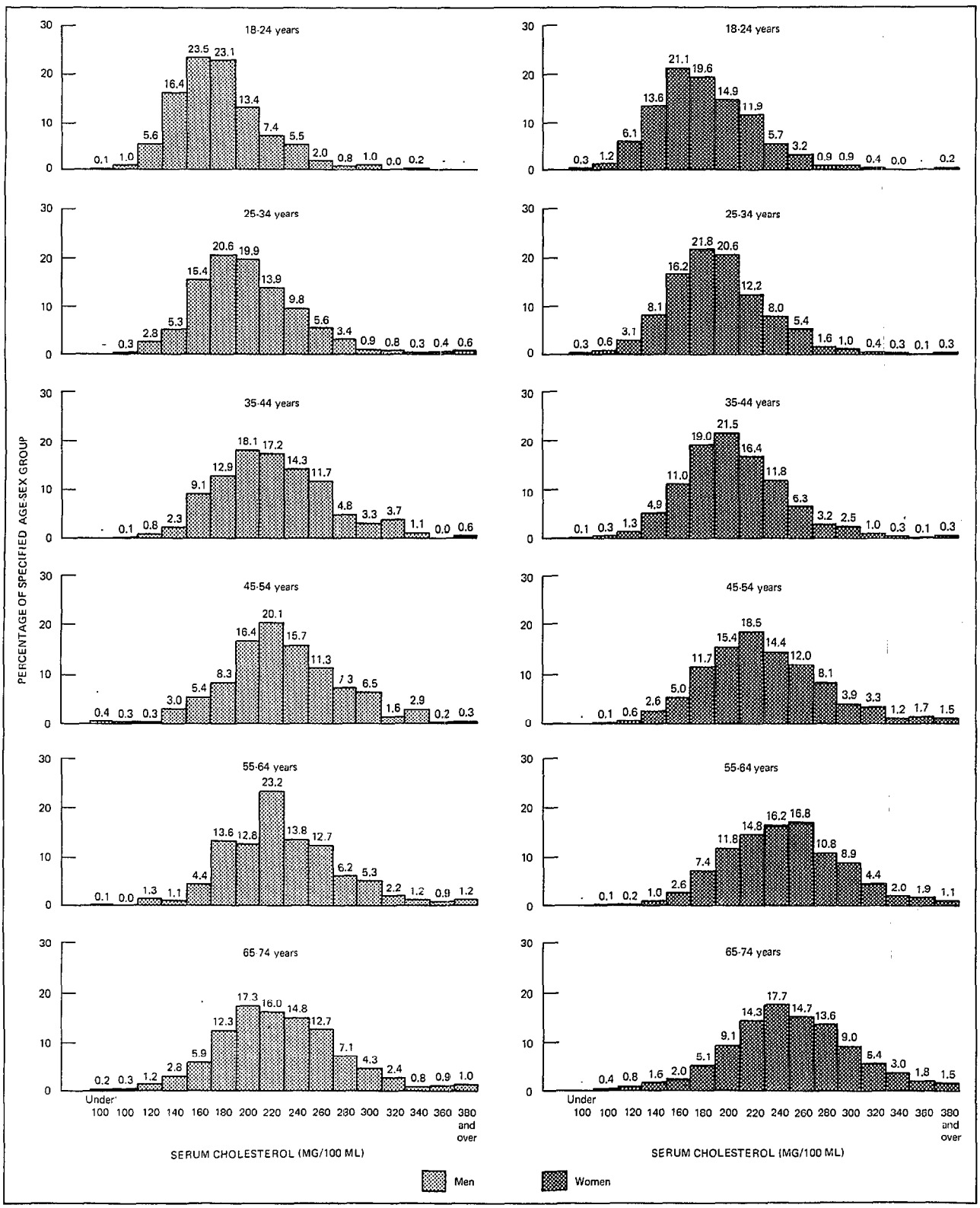

Figure 2. Distribution of serum cholesterol levels of adults aged 18-74 years, by sex and age: United States, 1971-74

women were quite similar in shape to those for men for each successive age group. Detailed data on the distributions in the various age and sex groups are given in tables 2 and 3.

Selected percentiles of the serum cholesterol distribution are shown by age for men and women (table 1 and figure 3). The age patterns described previously for the mean were also apparent when percentiles at the upper (90th percentile), middle (50th percentile), and lower (10th percentile) points of the distribution were examined. A slight exception occurred in the lower percentile for age group 18-24 years, where the mean value for men exceeded that for women.

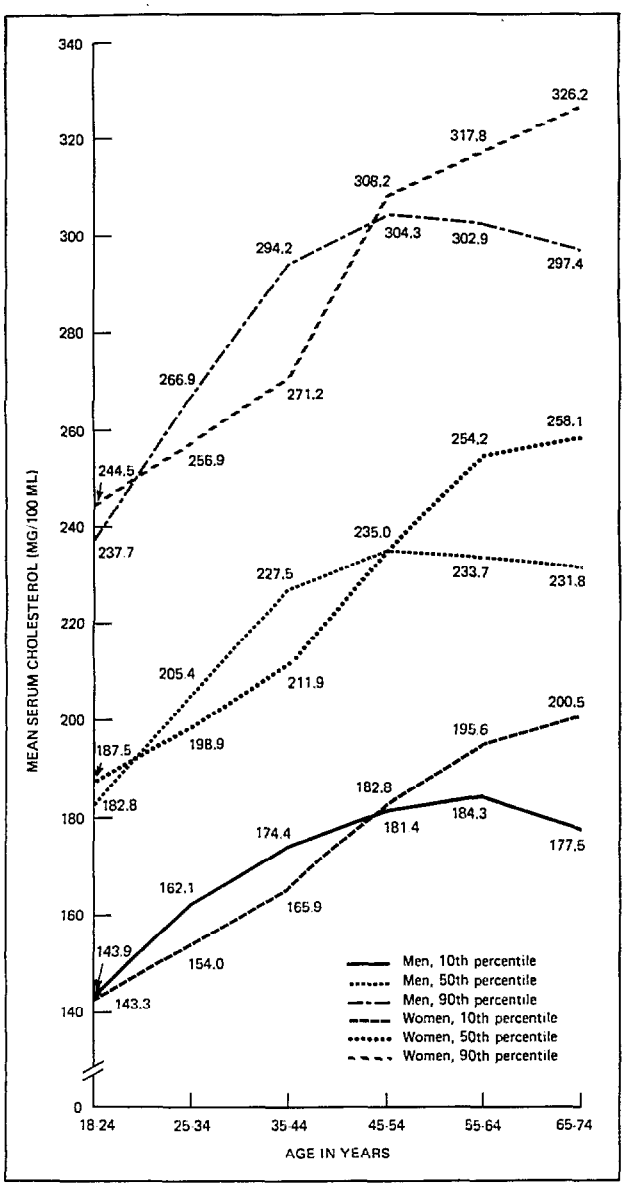

Figure 3. Selected estimated percentiles of the serum cholesterol distribution in adults aged 18-74 years, by sex and age: United States, 1971-74

Race, Sex, and Age

The mean levels for white and black men in the youngest age group were slightly lower than the mean levels for the women of both races (figure 4). A crossover occurred in the levels for men in their midthirties and midforties after which the mean levels for men were consistently higher than those for women. After age 45, the mean levels for women increased more rapidly than the levels for men and exceeded those for men, particularly after age 55.

Mean serum cholesterol levels for white men were consistently higher than those for black men in age groups 18-24, 35-44, and 45-54 years. The differences in mean levels ranged from 2.3 to 6.8 mg/100 ml. The same direction was not evident at ages 25-34 and 55 years and over, when black men had higher mean serum cholesterol levels than white men had. The differences in mean levels were still small and ranged from 1.0 to 4.3 mg/100 ml (table 4 and figure 5).

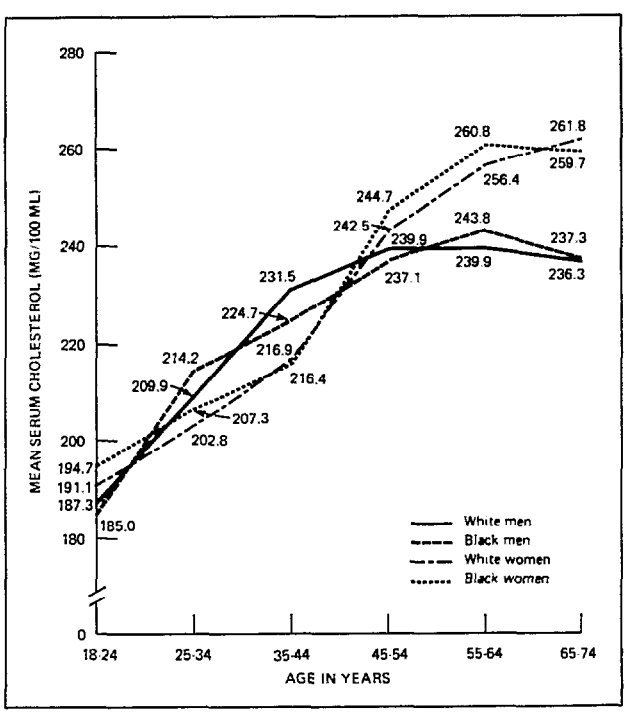

Figure 4. Mean serum cholesterol levels of adults aged 18-74 years, by age and race: United States, 1971-74

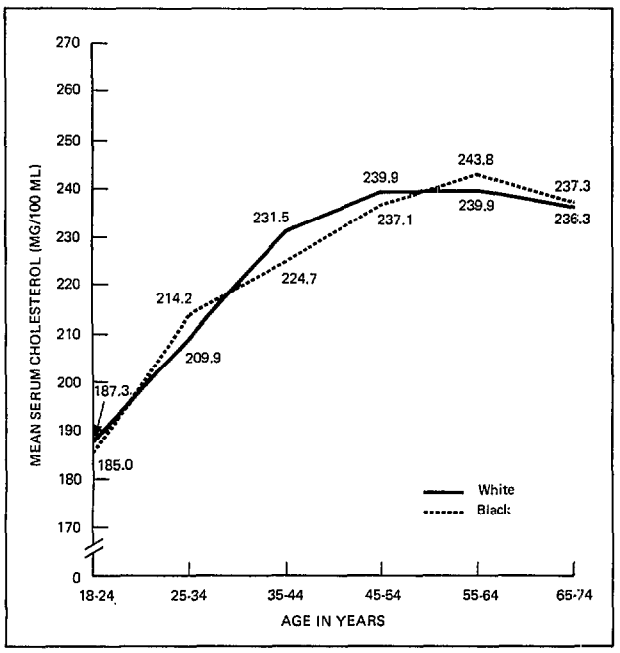

Figure 5. Mean serum cholesterol levels of men aged 18-74 years, by age and race: United States, 1971-74

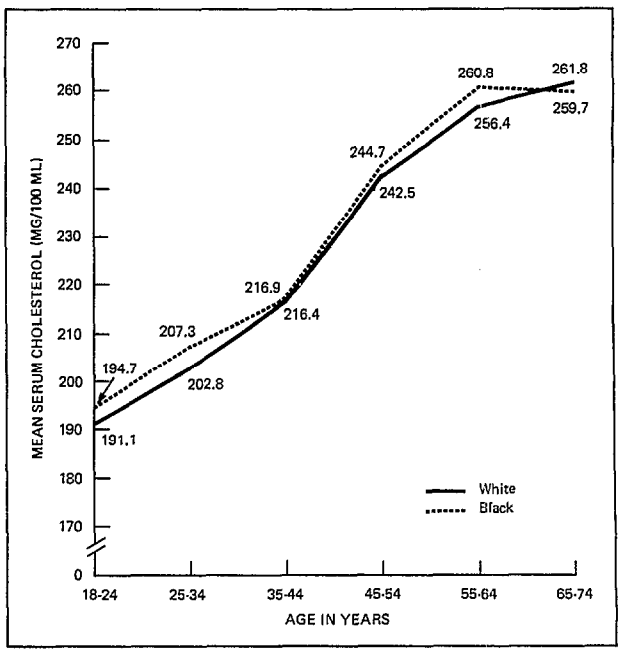

Figure 6. Mean serum cholesterol levels of women aged 18-74 years, by age and race: United States, 1971-74

Mean serum cholesterol levels for white and black men generally increased with age. Mean levels for white men increased rapidly to age group 35-44 and then continued upward at a slower rate of increase, reaching a peak of 239.9 mg/100 ml at ages 45-64, thereafter they declined slightly. Mean levels for black men also increased with age but at a slower rate; they were slightly higher at the older ages and peaked at a later age (55-64) than those for white men did. A slight decline in mean level occurred for ages 65-74 years.

Table 5 and figure 6 show that the mean levels for black women were consistently higher than the levels for white women in the age groups under 65 years. In the oldest age group, 65-74 years, the mean levels for white women were slightly higher than those for black women, a difference of 2.1 mg/100 ml.

The mean levels for both female racial groups increased with age to age group 55-64 years. Then the mean level for black women declined slightly whereas that for white women continued to rise less rapidly and slightly exceeded the level for black women.

In general, interracial differences for women were greater at the upper end (90th percentile) of the serum cholesterol distribution than at the lower end (10th percentile) (table 5 and figure 7). Such findings were not consistent for men (table 4 and figure 7).

Elevated Serum Cholesterol Level

Estimates were made of the prevalence of elevated serum cholesterol levels. The distributions of serum cholesterol levels were used to note the proportion of persons in any race-sex-age group whose levels exceeded 260 mg/100 ml. Within the study population group, the risk of developing coronary heart disease has been shown to increase with higher serum cholesterol levels. This has been documented in several epidemiologic studies.[8-10] The risk of attack appears to increase progressively in relation to increase in cholesterol concentration, although there is no statistical information regarding the actual level of serum cholesterol that separates high-risk from low-risk individuals. The level of 260 mg/100 ml has been cited in studies to distinguish high risk from less high or low.

Age and sex.—Table 6 shows the proportion of persons in each age group whose serum cholesterol was found to be 260 mg/100 ml and

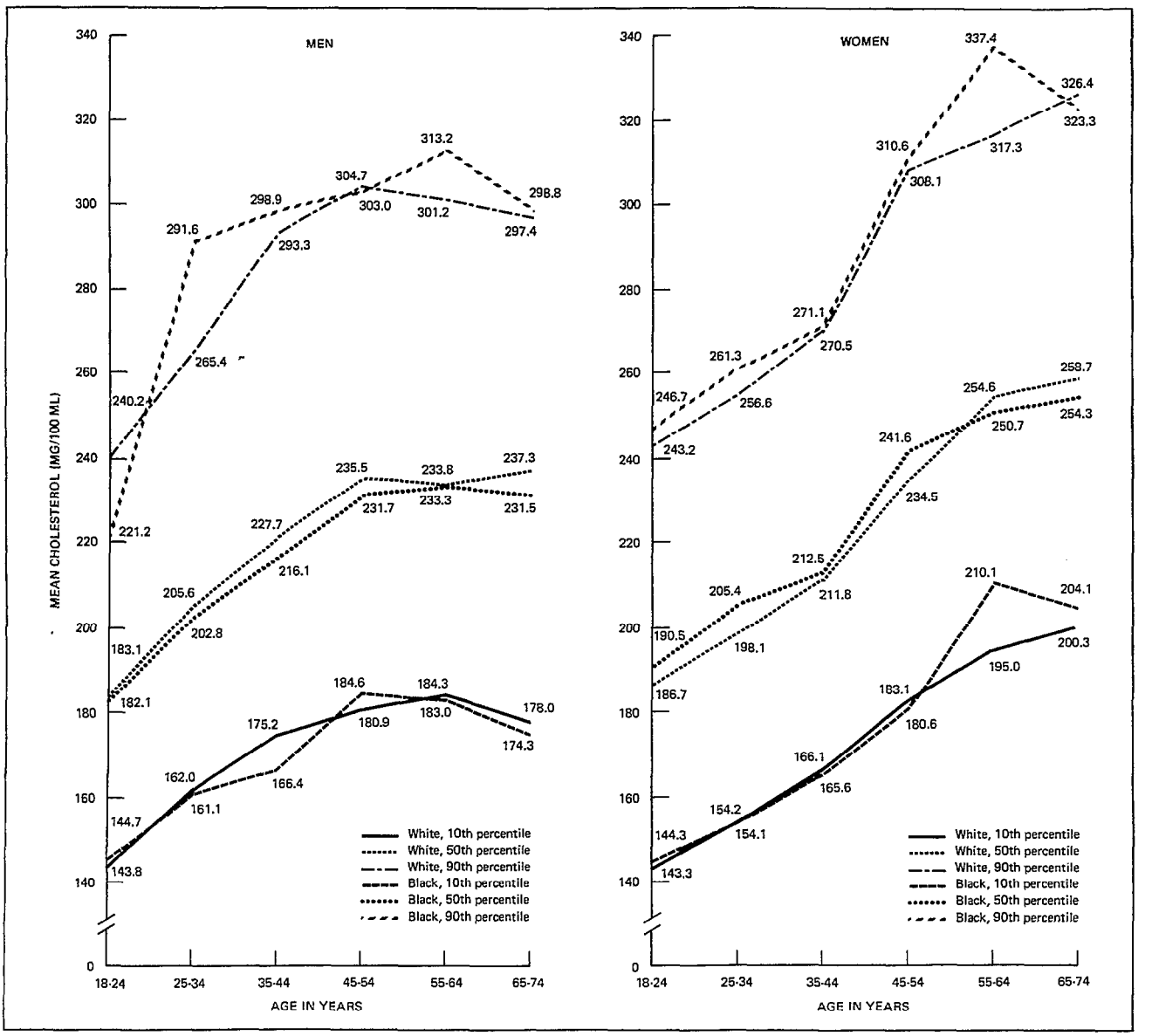

Figure 7. Selected estimated percentiles of the serum cholesterol distribution in adults aged 18-74 years, by age, sex, and race: United States, 1971-74

over. Among men proportions varied from a low of 4.0 percent for the age group 18-24 years to a high of 30.1 percent for the age group 45-54 years, and then declined to about 29 percent for the older ages, 55 years and over.

Among women, the lowest proportions were in the youngest age group, with the proportion increasing steadily with age until it reached a maximum of 49.2 percent at age group 65-74 years.

Table 6 shows that at the youngest ages, 18-24 years, and at the older ages, 45 years and over, there were higher proportions of women than of men with serum cholesterol levels of 260 mg/100 ml and over. This pattern was not evident for age groups 25-34 and 35-44 years, where the proportions were higher for men than for women. In age groups 18-24 and 45-54 years, the differences in proportions between the sexes were small, slightly more than 1.5

percent. These differences were much larger for those ages 55 years and over. Elevated serum cholesterol levels increased with age for women but showed a slight decrease for men at age 55 years and over.

Rates for men and women with elevated serum cholesterol levels (defined at 260 mg/100 ml and over followed the same pattern that was observed when sex-age trends of mean cholesterol levels for men and women were compared (tables 4-6). The highest mean levels of and rates for elevated cholesterol were found for women 55 years and over. At ages 18-24 years, mean levels of and rates for elevated serum cholesterol were slightly higher for women than for men. Thereafter, both corresponding rates and means were higher for men than for women until age 45, after which the reverse was true.

Race, sex, and age.—There were higher proportions of white and black women than of men at the youngest and oldest ages (18-24 years and 45 years and over, respectively) with serum cholesterol levels of 260 mg/100 ml and over (table 6 and figure 8). This pattern was reversed for ages 25-34 and 35-44, when the proportions were higher for men than for women of both races. At ages 45-54 years, the differences in proportions between white men and women were small (0.6 percent), but those between black men and women were much larger (11.8 percent). At ages 55-64 and 65-74 years, the differences were also larger, particularly for white men as compared with white women—16.8 and 20.5 percent, respectively.

The proportions of white men and women aged 18-24 with serum cholesterol levels of 260 mg/100 ml and over were consistently higher than those presented for their black counterparts (table 6, figure 9). The pattern was reversed for ages 25-44 years, where the proportions of black men and women were slightly higher than those of white adults. Findings were not consistent in the older age groups. In age group 45-54 years, white men and black women showed a higher proportion with elevated serum cholesterol levels than black men and white women did. In contrast, in age groups 55-64 and 65-74 years,

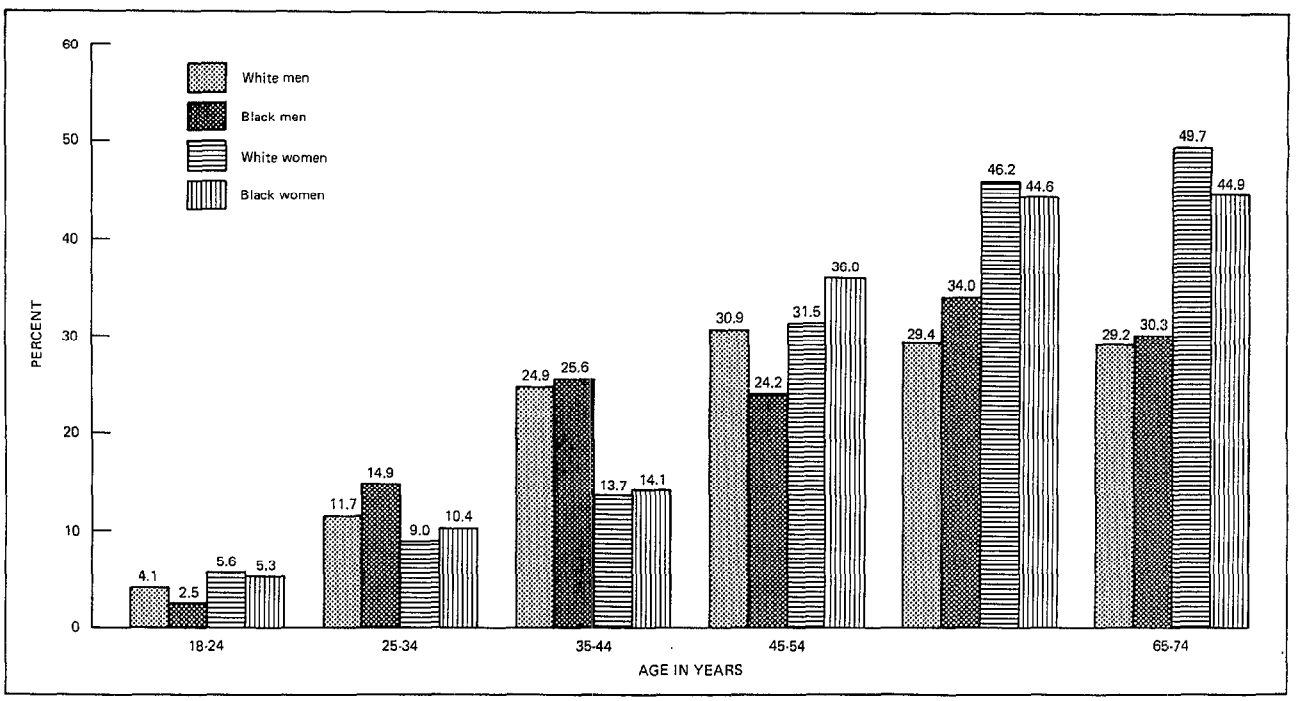

Figure 8. Percent of adults aged 18-74 years with serum cholesterol levels of 260 mg/100 ml and over, by age and race: United States, 1971-74

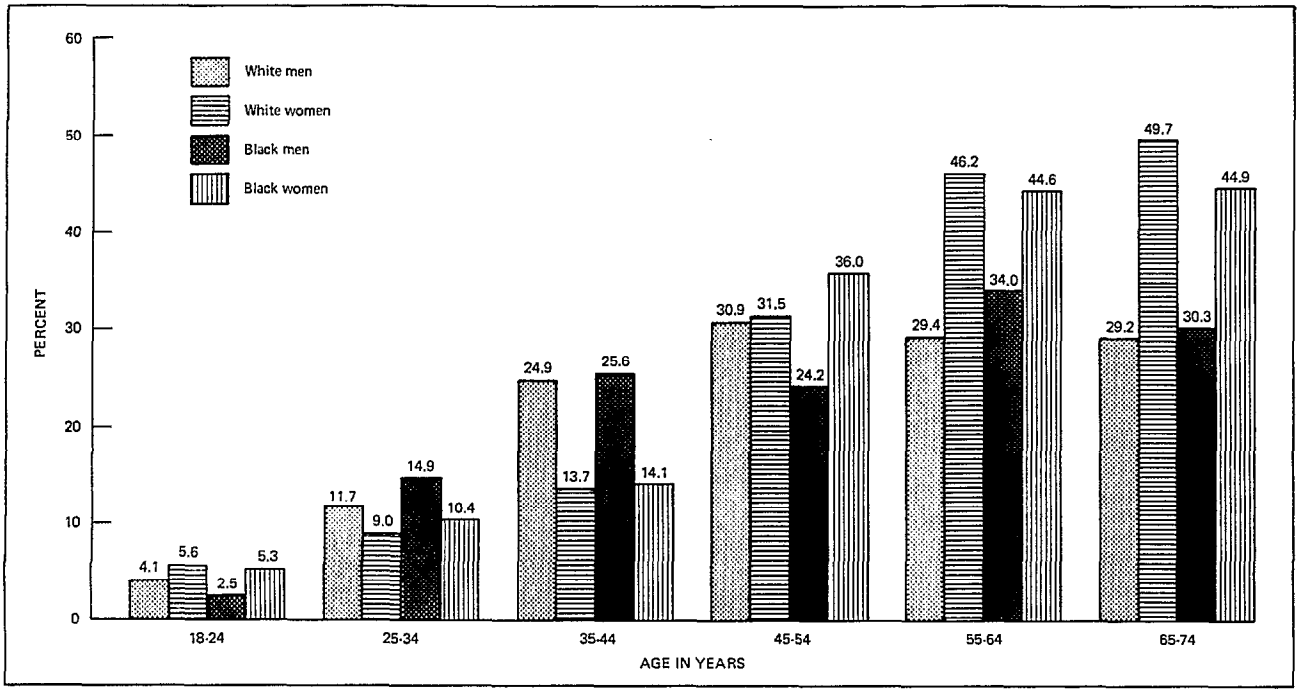

Figure 9. Percent of black and white adults aged 18-74 years with serum cholesterol levels of 260 mg/100 ml and over, by age and sex: United States, 1971-74

relatively more black men and white women than white men and black women had elevated serum cholesterol levels.

The age patterns in prevalence rates for elevated serum cholesterol levels (260 mg/100 ml and over) and mean levels found for men and women in the United States as a whole were also found for white men and women, and Negro men and women separately. White and black men showed lower values for both prevalence rates and mean levels at the younger ages than women did. After this age group, both values were higher for men than for women until age group 45-54 years when the values for women increased more rapidly and exceeded those for men (tables 4-6 and figures 8 and 9).

In general, the age patterns described for the prevalence rates for elevated serum cholesterol levels for white and black men were similar when mean cholesterol levels were examined (tables 4 and 6). This observation was also evident for white and black women (tables 5 and 6).

COMPARISON WITH HANES AND PREVIOUS HES FINDINGS

Serum cholesterol levels for adults aged 18-74 years in the U.S. civilian noninstitutionalized population had been determined previously by means of the Health Examination Survey 1960-62.[2] This was prompted by epidemiological studies associating levels of serum cholesterol with the risk of developing coronary heart disease. Since the initial report, there is evidence that the level of cholesterol in the plasma can be lowered by dietary modification.[11-14]

Nongovernmental agencies such as the American Heart Association, the Inter-Society Commission for Heart Disease Resources, and the American Health Foundation in its *Position Statement on Diet and Coronary Heart Disease* have publicized the dietary risk factors and have recommended necessary changes in dietary control aimed at lowering serum lipid concentrations.[15-18] A task force established by the

National Heart and Lung Institute issued similar suggestions on diet in June 1971.[19] Practical and palatable diets have been developed to reduce serum cholesterols. It is now possible to buy a variety of foods that are of special help to persons with specific dietary needs. A number of food industries have provided some public education through advertising regarding the fat contents of their products. The downward trend of mortality from diseases of the heart, particularly ischemic heart disease, is also of interest[20]—death rate peaked in 1963 and has declined since then. Therefore, it was considered time to reexamine the serum cholesterol levels in the population. Table 7 shows the number of examined persons with serum cholesterol measurements by sex and age, 1960-62 and 1971-74.

Findings by Sex—HANES and HES[a]

Men.—Table 8 and figure 10 show that in all age groups mean serum cholesterol levels for men as determined in 1960-62 were slightly higher (differences ranged from 1.9 to 5.9 mg/100 ml) than those for men as determined in 1971-74, except at age group 18-24 years, when HANES data were 0.4 mg/100 ml higher than HES data. None of the differences were statistically significant ($P > .05$). The mean levels for men in both data sets increased rapidly to age group 35-44 years and increased less rapidly to age groups 45-54 and 55-64 years. A slight decline occurred in the age group 65-74 years.

Women.—Table 8 and figure 11 show that the mean serum cholesterol levels for women in 1960-62 as determined in HES were higher than the levels for women in 1971-74 as determined in HANES for all age groups. In the age groups under 55 years, with the exception of ages 35-44 years, the differences were small—1.6 to 5.1 mg/100 ml—and were not statistically significant ($P > .05$). In the age group 35-44 and in the older age groups 55 years and over, the mean

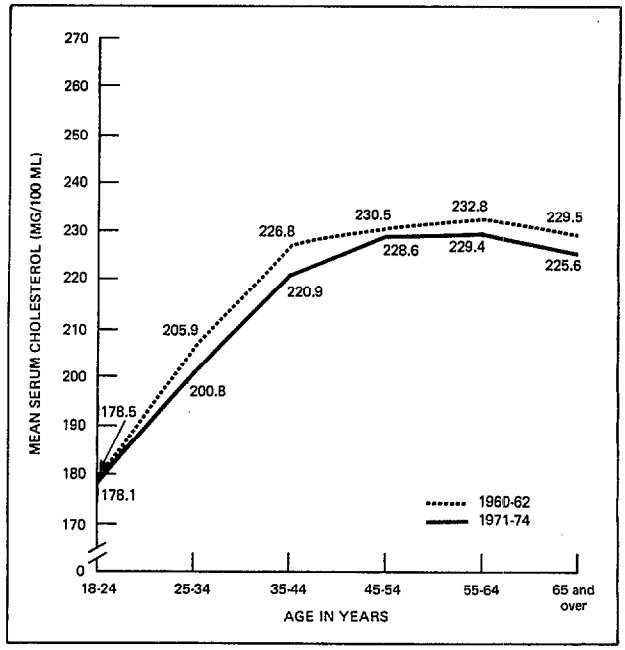

Figure 10. Mean serum cholesterol levels of men aged 18-74 years, by age: United States, 1960-62 and 1971-74

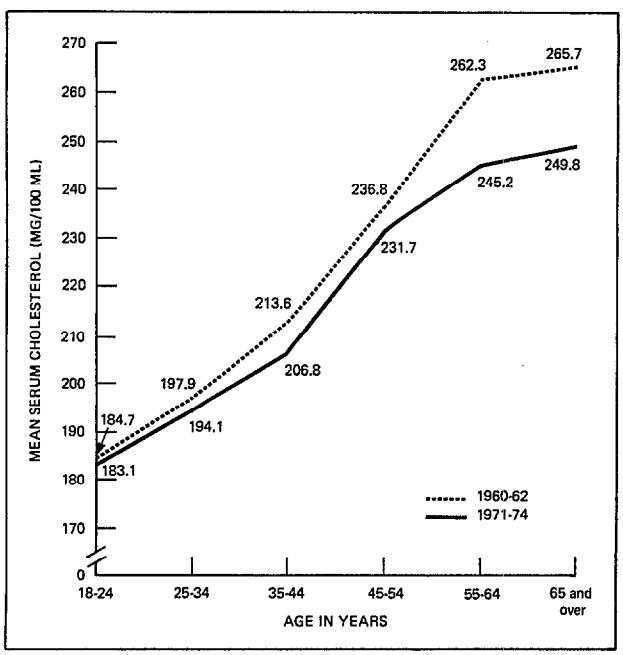

Figure 11. Mean serum cholesterol levels of women aged 18-74 years, by age: United States, 1960-62 and 1971-74

[a]In this section, all cholesterol values have been adjusted to approximate the values of Abell et al., the common reference method,[6] by reducing the 1960-62 data by 7.6 percent and the 1971-74 data by 4.5 percent.

levels in the HES sample were significantly ($P <$ .05) higher than those in the HANES sample. The differences in mean levels were 17.1 and 15.9 mg/100 ml, respectively, for age groups 55-64 and 65-74 years, and 6.8 mg/100 ml for age group 35-44 years.

The mean serum cholesterol levels for women from HES and HANES sets of data increased with age, but in a slightly different pattern. The mean levels for women in the HES sample increased to the age group 55-64 years, with the rate of increase more rapid for those in their midfifties and midsixties than for younger women. The rate of increase then diminished substantially; the mean levels attained a peak in the oldest age group 65-74 years. The rate of increase in mean levels in the HANES sample showed a similar pattern before age 55. The mean levels increased less rapidly for women in their midsixties and then flattened out, with the levels also attaining a peak in the age group 65-74 years.

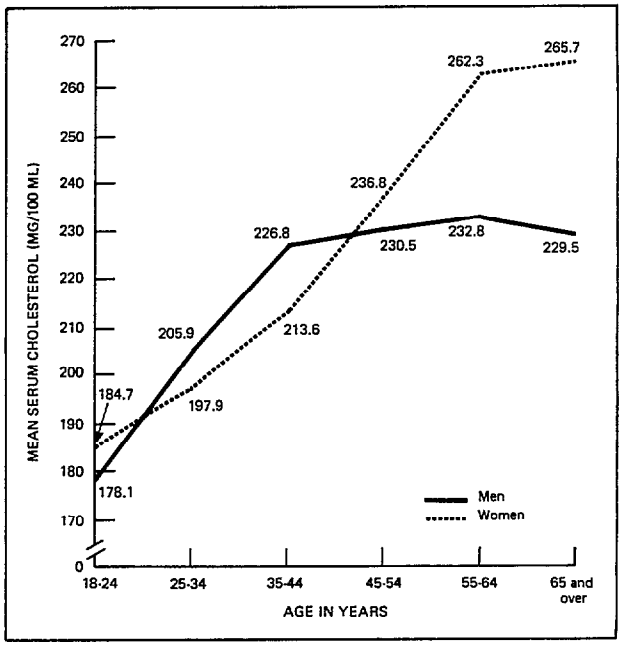

Figure 12. Mean serum cholesterol levels of adults aged 18-74 years, by age and sex: United States, 1960-62

Comparison of Sex Differences by Age

Table 8 and figure 12 show that during 1960-62 the mean serum cholesterol levels increased with age for each sex group, but in different patterns. Mean levels for men increased rapidly to age group 35-44; the rate of increase then flattened out, with levels reaching a peak at ages 55-64, and declined slightly thereafter. Mean levels were higher for women than for men at the youngest ages; they increased less rapidly for women than for men in their midthirties and midforties, and increased much more rapidly for women than for men after age 45. Thus the mean levels for women exceeded those for men at ages 45-54 and at all succeeding ages.

Table 8 and figure 13 show the mean serum cholesterol levels in 1971-74. As in 1960-62, mean levels for women were higher than those for men in the youngest age group. After age 25, the mean levels in the HANES sample generally showed the same pattern as those observed in the HES sample for women and for men. Mean levels increased less rapidly for women than for men in age groups 25-34 and 35-44 years, but they increased more rapidly for women than for men after age 45. Here, the levels for women

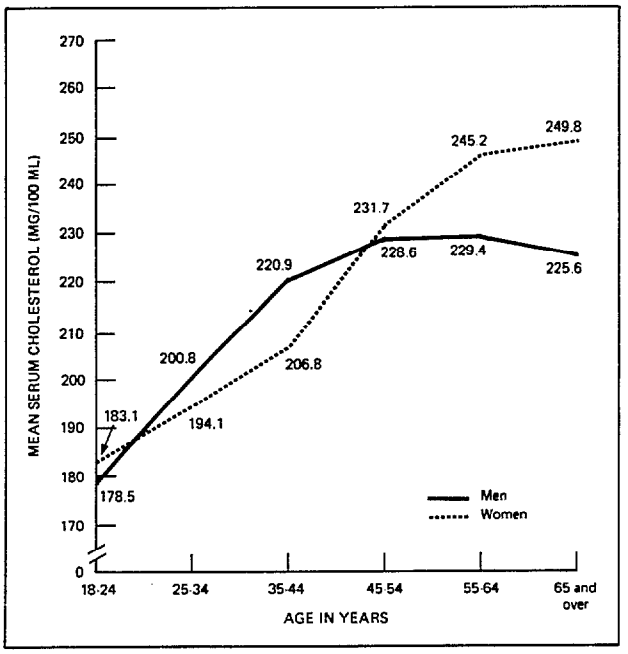

Figure 13. Mean serum cholesterol levels of adults aged 18-74 years, by age and sex: United States, 1971-74

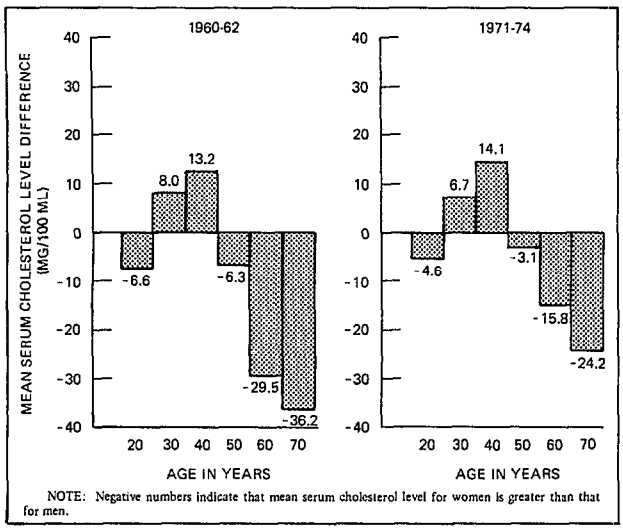

Figure 14. Mean differences in serum cholesterol levels of men and women aged 18-74 years, by age and sex: United States, 1960-62 and 1971-74

exceeded those for men in age group 45-54 years and at all older ages. The levels for men peaked at age group 55-64 years and then declined, but the levels for women continued to rise.

Figure 14 shows the mean differences in serum cholesterol levels between the sexes in 1960-62 and 1971-74. The pattern was similar in both surveys in that women had higher mean levels at the youngest ages, 18-24 years, and also at ages 45 years and older. Men had higher values in their midthirties and midforties. Differences in mean values between sexes were less in 1971-74 than in 1960-62 except at ages 35-44 years.

Elevated Serum Cholesterol Levels by Age and Sex

Table 9 and figure 15 show the proportion of persons by age group whose serum cholesterol levels were 260 mg/100 ml and over in 1960-62 and 1971-74. In 1960-62 the proportions of men varied from a low of 3.9 percent at ages 18-24 to a high of 25.7 percent at ages 45-54 years. Corresponding values for women in 1960-62 were from a low of 4.6 percent at ages 18-24 to a high of 51.0 percent at ages 65-74 years. Men and women in 1971-74 had their low and high values in the same age groups as those observed in 1960-62.

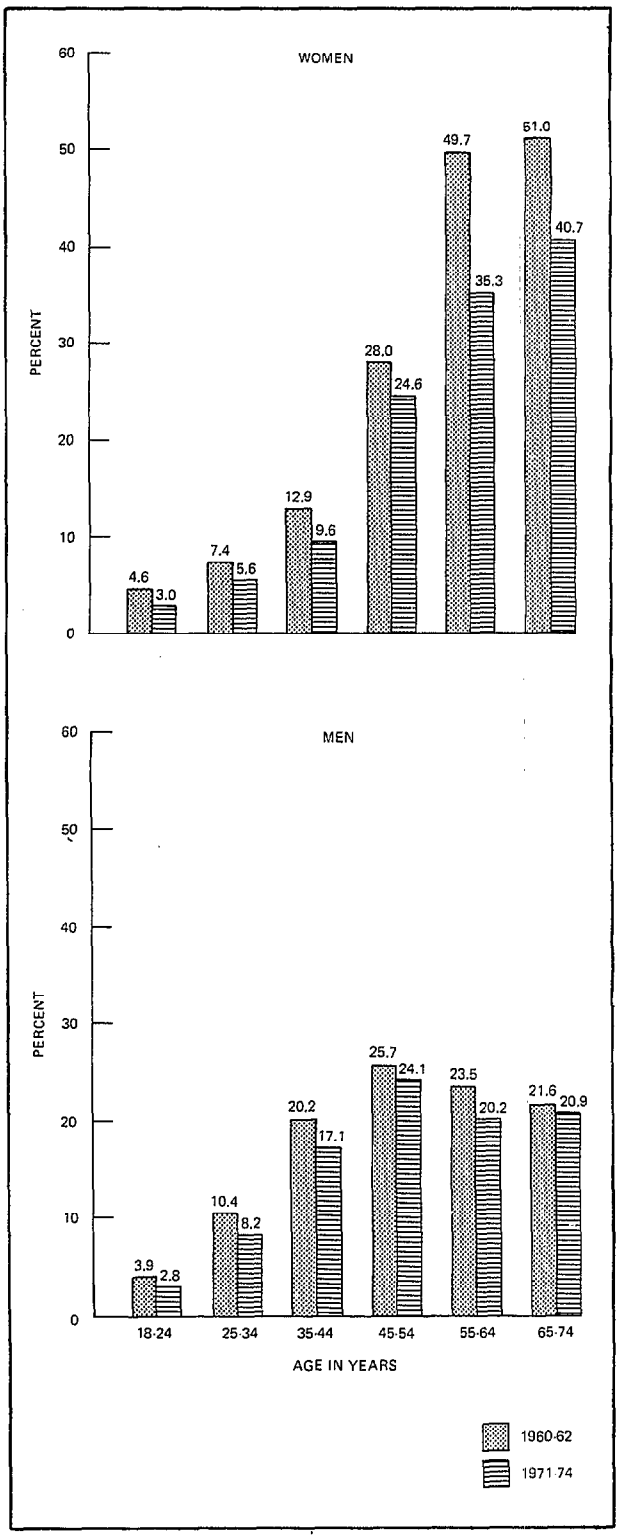

Figure 15. Percent of adults aged 18-74 years with serum cholesterol levels of 260 mg/100 ml and over, by age and sex: United States, 1960-62 and 1971-74

The proportions of men in each age group in 1971-74 were consistently lower than those of men in 1960-62 (figure 15). The differences in percentages between the two periods were small, ranging from a low of 0.7 percent at ages 65-74 years to a high of 3.3 percent at ages 55-64 years. This consistent pattern was also observed for women. At all ages, the proportions of women in 1971-74 were lower than those of women in 1960-62. The largest differences in percentages between survey periods were found at ages 55-64 years and 65-74 years, 14.4 and 10.3 percent, respectively, which were the only statistically ($P < .05$) significant differences between 1960-62 and 1971-74. Differences in other age groups were small, ranging from a low of 1.6 percent at ages 18-24 years to a high of 3.4 percent at ages 45-54 years.

For the youngest ages (18-24 years) and the older ages (45 years and over), there were higher proportions of women than of men in both the HES and HANES samples with serum cholesterol levels of 260 mg/100 ml and over (table 9). This pattern was reversed for age groups 25-34 and 35-44 years, when the proportions were higher for men than for women. At ages 45-54 years, the differences between the sexes from both samples were small—2.3 and 0.5 percent, respectively. These differences were much larger at ages 55 years and over. The proportions of person whose levels exceeded other specific amounts are shown in table 10 for men and in table 11 for women.

A similar pattern in age-cholesterol relationships for men and women in 1960-62 and 1971-74 was also evident in the mean serum cholesterol levels and in the prevalence rates for elevated serum cholesterol levels (tables 8 and 9).

DISCUSSION

Serum cholesterol is one of the important high-risk factors associated with the development of coronary heart disease. Data on serum cholesterol levels collected during the 1971-74 Health and Nutrition Examination Survey (HANES) of adults aged 18-74 years are presented and analyzed by age, sex, and race. These serum cholesterol levels are also compared with the earlier determinations made during the 1960-62 Health Examination Survey (HES). In this comparison, the data were converted to the reference method of Abell et al. HES and HANES provided cross-sectional data of serum cholesterol levels obtained for different age cohorts representative of the U.S. population. The age trends represented mean levels for successive cohorts of persons of different age groups.

Age and Sex

Serum cholesterol levels of men at ages 45-54 years showed a plateau or a flattening of the early increase of mean serum cholesterol levels with age. Although the serum cholesterol levels of women were slightly lower than those for men in their midthirties and midforties, the levels continued to rise after age 45 and exceeded those for men in the later years. The leveling off with age of the serum cholesterol levels of men may be due to the death of those with high serum cholesterol levels because a high incidence of coronary heart disease associated with a high-risk factor of serum cholesterol would tend to show a reduction in the serum cholesterol levels of the survivors. The crossover of mean serum cholesterol values at the end of the reproductive period suggests that women may have immunity to coronary heart disease during these years that disappears at about the age of menopause.

The values for the proportions of men and women with elevated serum cholesterol levels followed the same pattern observed when the mean levels for men and women by age were compared. The percents of elevated serum cholesterol and mean levels for men were slightly lower than those for women in the youngest age group. They were higher for men in their midthirties and midforties and lower for those in the older age groups, particularly those aged 55 years and over. A differential survival could effect such a large difference in elevated and mean serum cholesterol levels.

Race Differences

There was little difference in mean levels between sexes of either race. Differences in

mean serum cholesterol between black and white women were quite small and followed the same age pattern observed for all women. This picture was also evident for black and white men, with a slight exception. Serum cholesterol levels for black men continued to rise to age group 55-64 years and then declined in the oldest age group. However, the mean serum cholesterol level for white men leveled off at an earlier age group, 45-54 years.

Black women in all age groups except those ages 65-74 years showed higher mean serum cholesterol than white women of comparable ages. These differences in mean serum cholesterol levels between black and white women were quite small, however, ranging from 0.5 mg/100 ml to 4.5 mg/100 ml. There were no similar consistent differences between black and white men of comparable ages, and all differences were small—ranging from 1.0 to 6.8 mg/100 ml.

Response Rates and Techniques of Measurement—HES and HANES

Comparable response rates and similar laboratory techniques for determining serum cholesterol values are necessary in order to compare the mean levels from the two surveys.

The HES sample had a response rate of 95 percent interviewed and 86 percent examined, a highly representative sample of the civilian noninstitutionalized population of the United States. The corresponding rates for HANES were over 95 percent interviewed and 70 percent examined. The lower examination rate in the HANES sample than in the HES sample might have biased the mean serum cholesterol level downward because persons with higher serum cholesterol might be less likely to come for examination. This is, however, unlikely because an analysis of medical histories comparing the nonexaminees with the examinees indicated no large differences between the nonexamined group and the examined group for the medical statistics compared. For example, 12 percent of persons examined reported having an illness or condition that interfered with their eating as compared with 10 percent of persons not examined. The percent of examined persons reporting ever being told by a doctor that they had arthritis was 20 percent, the percent of those with high blood pressure was 18 percent, and the percent of those with diabetes was 4 percent. The corresponding percents for nonexamined persons were: arthritis, 18 percent; high blood pressure, 22 percent; and diabetes, 4 percent.

Both methods (1960-62 and 1971-74) show positive biases relative to a common reference method. These biases were compared and corrected for in comparisons between the two surveys.

The 1971-74 data were diminished by 4.5 percent to make them comparable to the 1960-62 data which were presented already corrected by 7.6 percent to approximate the reference method. The reference method may be presumed to be stable over time, but there were no pools of sera which were analyzed in both study periods to assure that a shift in the accuracy of this reference method did not occur because such pools were not available.

Comparing serum cholesterol levels over time is difficult because of changing analytic techniques and the lack of stable reference samples. These methodological problems, however, do not explain the change in older females found in the NCHS data. The comparative analysis of the HES 1960-62 and HANES 1971-74 data, moreover, did include appropriate adjustments which were developed and approved by CDC as explained in our report. When serum cholesterol is being monitored, the sampling and measurement methods used during the surveys must be the same throughout. This is an extremely difficult requirement to fulfill. For instance, mean serum cholesterol levels in the U.S. male population appear to have decreased very slightly between 1960-62 and 1971-74. This finding is based on data collected by two surveys with comparable sample design, which permits calculation of the differences in cholesterol levels that could be accounted for by sampling variability alone. In this instance, the difference is not statistically significant. The serum cholesterol levels were measured by the same laboratory during both surveys. However, since no serum cholesterol standard exists which is stable over 10 years, no provisions could be made in 1960-62 to assure that subsequent cholesterol determinations would be completely comparable with the 1960-62 determinations. Therefore, for

both of these reasons, we cannot be sure whether or not the small measured change in mean serum cholesterol levels are real. The same kind of methodological problem would pertain in the analysis of data sets collected by other investigators over this time period.

The pattern in mean levels for women by age between the two survey periods was similar to that observed for men at ages 25-34 and 45-54 years. The mean levels at these ages showed a decrease in 1971-74 as compared with those in 1960-62, but the decrease in mean levels was small and statistically not significant. The difference in mean levels for women between the two surveys—6.8 mg/100 ml—did show a statistically significant but small decrease at ages 35-44 years. This could still be attributed to differences in laboratory methods. However, there was a larger decrease in mean levels of the 1971-74 data as compared with the 1960-62 data for women at ages 55 years and older—which differences are large enough to be statistically significant and also large enough not to be attributable to differences in laboratory methods.

In comparing the difference in prevalence rates of serum cholesterol levels by age between the two surveys, the 1971-74 data showed a consistent decrease over all age groups, though the decrease was large enough to be statistically significant only at ages 55 years and over.

Diet

Until 1968 the American Heart Association emphasized the use of prudent diet to lower serum cholesterol for persons with high risk of developing coronary heart disease and also with a family history of premature atherosclerotic disease.[16] It was not until 1973 that the American Heart Association stated that it is prudent for the general population to follow a diet moderately restricted in saturated fat and cholesterol to lower serum cholesterol levels.[17] The *Report of Inter-Society Commission for Heart Disease Resources* issued in 1970 urged an immediate nationwide campaign to reduce serum cholesterol levels by definite changes in dietary habits, beginning in early childhood, in order to decrease the risk of coronary heart disease in later life.[15] The Food and Nutrition Board of the National Academy of Sciences-National Research Council and The Council on Foods and Nutrition of the American Medical Association issued a joint statement *Diet and Coronary Heart Disease* in July 1972.[21] They recommended a reduced intake of saturated fat and cholesterol to lower the cholesterol in the plasma. The measurement of plasma lipids, particularly plasma cholesterol and other risk factors, becomes a routine part of all health maintenance physical examinations.

A task force established by the National Heart and Lung Institute issued similar suggestions on diet in June 1971 stating that "pending confirmation by appropriate diet or drug trials, it therefore would appear prudent for the American people to follow a diet aimed at lowering serum lipid concentrations. . . by lowering intakes of calories, dietary cholesterol, and saturated fat."[19] There is not complete agreement with the Report of the Inter-Society Commission for Heart Disease Resources recommending a nationwide change in the feeding practices for infants and children. The Committee on Nutrition of the American Academy of Pediatrics recommended against the adoption of dietary changes for all children[22] as urged by the Inter-Society Commission for Health Resources. The Committee believes that such dietary intervention is warranted only in special situations (usually hereditary), where children have been diagnosed as having elevated blood lipids. In spite of these recommendations aimed at lowering serum cholesterol levels and of the decrease in mortality rates from coronary heart disease,[20] there is no evidence of a decrease for men in mean cholesterol levels or of a decrease in the prevalence of high cholesterol levels, but there is such evidence among women of the older ages.

SUMMARY

Serum cholesterol findings among individuals 18-74 years of age in the civilian noninstitutionalized population of the United States as obtained by means of the Health and Nutrition Examination Survey of 1971-74 are presented and analyzed in this report. Age, sex, and race differences in serum cholesterol determinations are included. For this survey, a national proba-

bility sample of 28,043 persons was selected to represent 194 million persons in the target population aged 1-74 years. Of these, 20,749 or 74 percent were examined. The findings in this report are limited to those for the 13,671 adult examinees 18-74 years of age. The present publication provides basic data on the distribution of the total U.S. adult population with respect to serum cholesterol determinations. These distributions can identify the proportion of persons in any age-sex group that exceeds some specified level. Comparisons among age-sex-race subgroups provide evidence that age and sex are important variables influencing serum cholesterol levels, but race is not. Some of these principal findings are summarized in the following section.

Mean serum cholesterol levels for men increased rapidly with age from 186.9 mg/100 ml at 18-24 years to 231.3 mg/100 ml at 35-44 years. The rate of increase then showed a flattening or plateau effect, with the levels reaching a peak of 240.2 mg/100 ml at 55-64 years and declining to a low of 236.2 mg/100 ml at 65-74 years.

Mean serum cholesterol levels for women were slightly higher than those for men in the youngest age group, 18-24 years—191.7 versus 186.9 mg/100 ml. They were lower and increased less rapidly than those for men at ages 25-34 and 35-44 years. The levels exceeded those for men after age 45, and then increased rapidly from 242.6 mg/100 ml at 45-54 years to a maximum level of 261.6 mg/100 ml at 65-74 years.

In all age groups, with the exception of 65-74 years, black women had consistently higher mean serum cholesterol levels than white women had. This pattern in mean levels was not evident for white and black men. White and black women of older ages, particularly 55 years and over, showed higher proportions with serum cholesterol levels of 260 mg/100 ml and over than men of comparable ages showed.

Comparisons with previous national estimates obtained from the Health Examination Survey of 1960-62 among adults are included. Medical interest in the distribution of serum cholesterol levels of the U.S. population led to the inclusion of serum cholesterol determinations in the Health Examination Survey, 1960-62. This survey done by the same Division of Health Examination Statistics of the National Center for Health Statistics and the laboratory in the Center for Disease Control in Atlanta, Georgia, provided a baseline against which the values from the Health and Nutrition Examination Survey were measured.

Similarities and differences in laboratory methods that may account for agreement or lack of agreement between the 1971-74 and 1960-62 findings are noted.

The mean and prevalence rates of serum cholesterol levels (260 mg/100 ml and over) of men in 1971-74 across the age range 18-74 years were slightly lower than those in 1960-62. The differences were not large enough to be statistically significant.

For women, the mean values showed a statistically significant decrease in 1971-74 as compared with those in 1960-62 for ages 35-44 and 55 years and over. This was evident only at ages 55 years and over for the prevalence rates of those with cholesterol levels above 260 mg/100 ml.

The age trends with mean and prevalence rates of serum cholesterol levels found for men and women in 1971-74 were also found for men and women in 1960-62. Both values by age for women in 1960-62 and 1971-74 were higher than those for men in the youngest age group, 18-24 years, lower than the values for men in their midthirties and midforties, and exceeded those for men after age 45 years.

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LIST OF DETAILED TABLES

Table 1. Serum cholesterol levels of adults aged 18-74 years, by sex and age: sample size, mean, standard deviation, standard error of the mean, and selected percentiles; United States, 1971-74

Sex and age	n	N	$\bar{X}$	SD	$s_{\bar{X}}$	Percentile						
						5th	10th	25th	50th	75th	90th	95th
Both sexes			Serum cholesterol in mg/100 ml									
18-74 years	13,671	129,016	223.4	51.5	0.81	147.7	162.8	187.0	217.8	254.0	290.9	314.9
18-24 years	2,296	24,677	189.4	39.0	1.41	132.0	143.6	162.4	185.0	212.6	241.5	258.4
25-34 years	2,700	26,935	206.6	43.2	1.42	144.1	158.1	177.6	202.5	230.8	261.8	280.1
35-44 years	2,328	22,268	223.6	45.3	1.50	160.2	169.6	191.8	218.1	250.6	281.8	309.3
45-54 years	1,601	23,313	241.1	49.7	1.48	165.1	182.3	207.3	235.0	269.8	305.9	331.1
55-64 years	1,267	19,050	248.9	50.3	2.48	177.3	188.6	214.4	244.2	276.9	312.6	334.6
65-74 years	3,479	12,773	250.7	54.2	1.35	167.8	186.6	214.5	248.1	283.0	316.0	338.0
Men												
18-74 years	5,260	61,091	221.8	49.9	1.09	148.3	163.1	186.6	217.1	251.7	286.7	311.4
18-24 years	772	11,753	186.9	36.7	1.89	133.4	143.9	161.6	182.8	207.6	237.7	255.5
25-34 years	804	13,002	210.3	44.0	2.27	147.1	162.1	181.2	205.4	234.8	266.9	287.9
35-44 years	665	10,692	231.3	45.9	2.53	164.0	174.4	198.9	227.5	260.5	294.2	322.2
45-54 years	765	11,150	239.4	47.0	2.55	163.6	181.4	208.5	235.0	268.6	304.3	320.0
55-64 years	597	8,998	240.2	51.2	3.17	170.9	184.3	206.6	233.7	267.0	302.9	324.4
65-74 years	1,657	5,496	236.2	53.8	2.05	161.4	177.5	202.4	231.8	266.3	297.4	320.9
Women												
18-74 years	8,411	67,925	224.9	52.8	0.99	147.3	162.6	187.3	218.4	256.0	294.1	317.7
18-24 years	1,524	12,924	191.7	41.0	1.92	130.9	143.3	163.4	187.5	216.8	244.5	263.8
25-34 years	1,896	13,933	203.2	42.2	1.39	142.3	154.0	175.0	198.9	226.7	256.9	274.5
35-44 years	1,663	11,576	216.5	43.5	1.37	152.9	165.9	187.5	211.9	240.9	271.2	294.5
45-54 years	836	12,163	242.6	52.0	2.36	166.6	182.8	206.2	235.0	270.7	308.2	336.0
55-64 years	670	10,052	256.8	48.2	2.72	182.8	195.6	222.4	254.2	287.3	317.8	340.3
65-74 years	1,822	7,277	261.6	51.9	1.92	181.3	200.5	228.2	258.1	293.1	326.2	348.4

NOTE: Total includes all races; n = examined persons; N = estimated population in thousands; $\bar{X}$ = mean; SD = standard deviation; $s_{\bar{X}}$ = standard error of the mean.

Table 2. Percent distribution of serum cholesterol levels of men aged 18-74 years, by age: United States, 1971-74

Serum cholesterol level (mg/100 ml)	Men						
	All ages, 18-74 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	64-74 years
	Percent distribution						
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 100	0.1	0.1	-	-	0.4	0.1	0.2
100-119	0.4	1.0	0.3	0.1	0.3	0.0	0.3
120-139	2.1	5.6	2.8	0.8	0.3	1.3	1.2
140-159	5.6	16.4	5.3	2.3	3.0	1.1	2.8
160-179	11.5	23.5	15.4	9.1	5.4	4.4	5.9
180-199	15.6	23.1	20.6	12.9	8.3	13.6	12.3
200-219	16.2	13.4	19.9	18.1	16.4	12.8	17.3
220-239	16.0	7.4	13.9	17.2	20.1	23.2	16.0
240-259	12.0	5.5	9.8	14.3	15.7	13.8	14.8
260-279	8.8	2.0	5.6	11.7	11.3	12.7	12.7
280-299	4.6	0.8	3.4	4.8	7.3	6.2	7.1
300-319	3.3	1.0	0.9	3.3	6.5	5.3	4.3
320-339	1.7	0.0	0.8	3.7	1.6	2.2	2.4
340-359	1.1	0.2	0.3	1.1	2.9	1.2	0.8
360-379	0.3	-	0.4	0.0	0.2	0.9	0.9
380 and over	0.6	-	0.6	0.6	0.3	1.2	1.0

NOTE: Percents may not add to 100.0 due to rounding.

Table 3. Percent distribution of serum cholesterol levels of women aged 18-74 years, by age: United States, 1971-74

Serum cholesterol level (mg/100 ml)	Women						
	All ages, 18-74 years	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years
	Percent distribution						
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 100	0.1	0.3	0.3	0.1	-	-	-
100-119	0.4	1.2	0.6	0.3	0.1	0.1	0.4
120-139	2.2	6.1	3.1	1.3	0.6	0.2	0.8
140-159	5.8	13.6	8.1	4.9	2.6	1.0	1.6
160-179	10.6	21.1	16.2	11.0	5.0	2.6	2.0
180-199	15.2	19.6	21.8	19.0	11.7	7.4	5.1
200-219	16.2	14.9	20.6	21.5	15.4	11.8	9.1
220-239	14.6	11.9	12.2	16.4	18.5	14.8	14.3
240-259	11.7	5.7	8.0	11.8	14.4	16.2	17.7
260-279	9.1	3.2	5.4	6.3	12.0	16.8	14.7
280-299	5.6	0.9	1.6	3.2	8.1	10.8	13.6
300-319	3.8	0.9	1.0	2.5	3.9	8.9	9.0
320-339	2.2	0.4	0.4	1.0	3.3	4.4	5.4
340-359	1.0	0.0	0.3	0.3	1.2	2.0	3.0
360-379	0.8	-	0.1	0.1	1.7	1.9	1.8
380 and over	0.7	0.2	0.3	0.3	1.5	1.1	1.5

NOTE: Percents may not add to 100.0 due to rounding.

Table 4. Serum cholesterol levels of men aged 18-74 years by race and age: sample size, mean, standard deviation, standard error of the mean, and selected percentiles, United States, 1971-74

Race and age	n	N	$\bar{X}$	SD	$s_{\bar{X}}$	Percentile						
						5th	10th	25th	50th	75th	90th	95th
White men			Serum cholesterol in mg/100 ml									
18-74 years	4,343	54,606	222.2	49.7	1.09	148.4	163.3	187.1	218.0	252.1	286.2	311.0
18-24 years	625	10,271	187.3	37.2	2.07	133.5	143.8	161.3	183.1	208.7	240.2	256.2
25-34 years	672	11,594	209.9	42.4	2.38	146.7	162.0	180.9	205.6	235.1	265.4	284.2
35-44 years	570	9,532	231.5	45.5	2.49	164.4	175.2	200.8	227.7	258.8	293.3	322.2
45-54 years	628	10,039	239.9	47.4	2.61	163.4	180.9	209.2	235.5	269.7	304.7	321.9
55-64 years	504	8,200	239.9	50.6	3.41	170.7	184.3	206.6	233.8	266.6	301.2	332.4
65-74 years	1,344	4,970	236.4	54.3	2.40	161.8	178.0	202.8	231.5	266.1	297.4	321.2
Black men												
18-74 years	847	5,753	218.9	52.7	3.41	148.0	162.0	182.6	208.7	247.8	294.4	316.6
18-24 years	132	1,270	185.0	32.5	3.75	133.4	144.7	163.8	182.1	200.7	221.2	237.8
25-34 years	119	1,232	214.2	57.0	9.26	147.9	161.1	180.4	202.8	231.8	291.6	345.3
35-44 years	87	1,005	224.7	51.7	8.56	158.0	166.4	185.5	216.1	263.0	298.9	324.4
45-54 years	130	1,057	237.1	42.2	5.61	172.6	184.6	203.5	231.7	258.2	303.0	316.0
55-64 years	85	703	243.8	58.8	11.65	170.3	183.0	202.8	233.3	271.9	313.3	367.1
65-74 years	294	486	237.3	48.4	3.40	154.8	174.3	198.9	237.3	270.9	298.8	321.0

NOTE: n = examined persons; N = estimated population in thousands; $\bar{X}$ = mean; SD = standard deviation; $s_{\bar{X}}$ = standard error of the mean.

Table 5. Serum cholesterol levels of women aged 18-74 years, by race and age: sample size, mean, standard deviation, standard error of the mean, and selected percentiles, United States, 1971-74

Race and age	n	N	$\bar{X}$	SD	$s_{\bar{X}}$	Percentile						
						5th	10th	25th	50th	75th	90th	95th
White women			Serum cholesterol in mg/100 ml									
18-74 years	6,758	60,011	225.1	53.0	1.02	147.5	162.6	187.4	218.3	256.5	294.6	318.1
18-24 years	1,165	11,161	191.1	41.1	2.11	131.0	143.3	163.1	186.7	215.6	243.2	263.7
25-34 years	1,539	12,161	202.8	42.4	1.47	142.3	154.1	174.2	198.1	226.1	256.6	274.4
35-44 years	1,301	10,095	216.4	42.8	1.56	152.6	166.1	187.8	211.8	240.6	271.1	293.8
45-54 years	705	10,879	242.5	52.5	2.49	166.3	183.1	205.8	234.5	270.6	308.1	337.7
55-64 years	552	9,112	256.4	47.8	2.89	182.7	195.0	221.8	254.6	287.5	317.3	337.2
65-74 years	1,496	6,603	261.8	52.3	2.02	181.0	200.3	228.1	258.7	293.8	326.4	348.5
Black women												
18-74 years	1,557	7,302	224.0	50.5	1.78	146.4	162.5	187.7	220.7	253.6	289.6	316.0
18-24 years	329	1,578	194.7	38.9	3.33	132.2	144.3	165.1	190.5	223.0	246.7	261.3
25-34 years	335	1,646	207.3	40.7	3.42	142.2	154.2	184.5	205.4	230.8	261.3	276.5
35-44 years	334	1,318	216.9	42.2	3.25	155.5	165.6	185.5	212.5	244.4	270.5	292.9
45-54 years	126	1,237	244.7	46.5	6.49	168.0	180.6	214.4	241.6	272.9	310.6	328.6
55-64 years	115	871	260.8	52.6	5.68	182.9	210.1	224.4	250.7	289.5	337.4	368.7
65-74 years	318	652	259.7	47.7	3.78	186.0	204.1	228.9	254.3	285.6	323.3	347.3

NOTE: n = examined persons; N = estimated population in thousands; $\bar{X}$ = mean; SD = standard deviation; $s_{\bar{X}}$ = standard error of the mean.

Table 6. Prevalence rates for serum cholesterol levels 260 mg/100 ml and over among adults aged 18-74 years, by age, race, and sex, with standard errors: United States, 1971-74

Sex and age	Population estimate in thousands	Rate/100 population	Standard error of rate	Rate/100 population		Standard error of rate	
				White	Black	White	Black
Both sexes		Serum cholesterol in mg/100 ml					
18-74 years	27,974	21.9	0.58	22.1	20.4	0.60	1.30
18-24 years	1,134	4.8	0.54	4.9	4.0	0.62	0.82
25-34 years	2,812	10.5	0.84	10.3	12.5	0.84	3.50
35-44 years	4,353	19.3	1.22	19.2	18.4	1.18	3.43
45-54 years	7,289	31.0	1.61	31.2	30.2	1.69	4.58
55-64 years	7,203	38.2	2.32	38.2	40.3	2.44	4.54
65-74 years	5,182	40.6	1.27	40.9	38.7	1.37	3.32
Men							
18-74 years	12,358	20.4	0.87	20.6	19.0	0.92	1.87
18-24 years	451	4.0	0.78	4.1	2.5	0.88	1.69
25-34 years	1,538	12.1	1.46	11.7	14.9	1.54	5.10
35-44 years	2,735	25.3	2.13	24.9	25.6	2.03	7.00
45-54 years	3,392	30.1	2.22	30.9	24.2	2.25	5.82
55-64 years	2,636	29.7	2.39	29.4	34.0	2.59	10.20
65-74 years	1,605	29.2	1.38	29.2	30.3	1.57	3.38
Women							
18-74 years	15,615	23.2	0.79	23.5	21.6	0.83	1.58
18-24 years	683	5.6	0.87	5.6	5.3	1.05	1.48
25-34 years	1,275	9.1	0.97	9.0	10.4	0.98	2.87
35-44 years	1,618	13.7	1.19	13.7	14.1	1.22	2.71
45-54 years	3,897	31.8	2.08	31.5	36.0	2.19	6.81
55-64 years	4,567	45.9	3.04	46.2	44.6	3.19	5.67
65-74 years	3,577	49.2	1.81	49.7	44.9	1.90	4.29

Table 7. Number of examined persons with serum cholesterol measurements, by sex and age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Sex and age	HES 1960-62	HANES 1971-74
	Number of examined persons	
Men		
18-24 years	406	772
25-34 years	661	804
35-44 years	691	665
45-54 years	533	765
55-64 years	410	597
65-74 years	262	1,657
Women		
18-24 years	515	1,524
25-34 years	729	1,896
35-44 years	762	1,663
45-54 years	679	836
55-64 years	426	670
65-74 years	289	1,822

NOTE: The distribution of the number of persons examined by age and sex is different for HES and HANES because different sampling rates were applied to the subgroups, but within the subgroups, sampling rates are representative of the U.S. population at the time of the survey.

Table 8. Mean serum cholesterol levels and standard deviations of the population distribution of adults aged 18-74 years, by sex and age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Age	Men				Women			
	HES, 1960-62		HANES, 1971-74		HES, 1960-62		HANES, 1971-74	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Serum cholesterol in mg/100 ml							
18-24 years	178.1	40.7	178.5	35.0	184.7	47.9	183.1	39.1
25-34 years	205.9	44.6	200.8	42.0	197.9	41.9	194.1	40.3
35-44 years	226.8	49.4	220.9	43.9	213.6	45.3	206.8	41.5
45-54 years	230.5	45.6	228.6	44.9	236.8	50.0	231.7	49.6
55-64 years	232.8	49.0	229.4	48.9	262.3	63.0	245.2	46.0
65-74 years	229.5	47.3	225.6	51.3	265.7	58.8	249.8	49.6

NOTE: SD = standard deviation.

Table 9. Percent of adults with serum cholesterol levels of 260 mg/100 ml and over, by sex and age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Age	HES, 1960-62		HANES, 1971-74	
	Men	Women	Men	Women
	Percent			
Total, 18-74 years	17.6	22.7	14.7	17.5
18-24 years	3.9	4.6	2.8	3.0
25-34 years	10.4	7.4	8.2	5.6
35-44 years	20.2	12.9	17.1	9.6
45-54 years	25.7	28.0	24.1	24.6
55-64 years	23.5	49.7	20.2	35.3
65-74 years	21.6	51.0	20.9	40.7

Table 10. Cumulative percent distribution of serum cholesterol levels of men aged 18-74 years, by age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Serum cholesterol level (mg/100 ml)	18-74 years		18-24 years		25-34 years		35-44 years		45-54 years		55-64 years		65-74 years	
	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74
	Cumulative percent distribution													
Under 100	0.1	0.2	0.4	0.1	-	0.1	0.1	-	-	0.7	0.2	0.1	-	0.2
Under 120	0.8	0.9	2.9	2.4	0.6	1.1	0.6	0.1	0.1	0.7	0.7	0.1	-	0.7
Under 140	3.3	4.1	14.4	11.8	2.6	4.1	1.5	1.7	0.3	1.4	1.5	1.7	1.3	2.7
Under 160	9.6	12.2	33.1	31.1	10.2	14.7	5.3	6.2	3.7	6.0	4.4	3.3	4.1	6.2
Under 180	21.2	25.7	57.9	55.1	27.5	32.7	14.1	17.6	9.4	11.8	11.1	12.4	10.3	14.6
Under 200	35.7	42.3	73.8	76.6	47.7	53.6	25.4	32.8	22.6	24.2	22.1	24.2	26.5	29.8
Under 220	53.4	59.0	86.8	87.5	66.5	70.8	45.8	51.6	42.6	41.8	36.4	42.9	43.3	47.9
Under 240	70.4	74.5	93.6	94.1	81.4	84.3	66.1	68.5	60.8	62.6	58.3	63.2	62.0	65.5
Under 260	82.4	85.3	96.1	97.2	89.6	91.8	79.8	82.9	74.3	75.9	76.5	79.8	78.4	79.1
Under 280	90.6	91.8	99.1	98.6	95.5	96.3	88.3	90.0	86.3	86.4	87.8	87.3	86.7	88.8
Under 300	95.3	95.9	99.4	99.8	98.0	97.9	93.0	93.8	94.7	94.4	93.0	93.3	93.9	94.3
Under 320	97.9	97.8	99.6	99.8	99.8	98.7	96.9	97.8	98.6	96.5	96.4	96.2	96.5	96.9
Under 340	98.9	99.0	99.8	100.0	99.8	99.0	97.9	99.3	99.4	98.9	98.6	97.9	98.3	97.8
Under 360	99.4	99.4	99.8	100.0	99.8	99.4	99.0	99.4	99.9	99.7	99.1	98.8	98.9	98.9
Under 380	99.6	99.6	99.8	100.0	99.8	99.4	99.6	99.7	99.9	100.0	99.3	99.1	99.5	99.1

Table 11. Cumulative percent distribution of serum cholesterol levels of women aged 18-74 years, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Serum cholesterol level (mg/100 ml)	18-74 years		18-24 years		25-34 years		35-44 years		45-54 years		55-64 years		65-74 years	
	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74	1960-62	1971-74
	Cumulative percent distribution													
Under 100	0.1	0.2	0.3	0.4	-	0.6	-	0.3	-	-	-	-	0.3	-
Under 120	0.8	1.1	2.9	2.9	0.8	1.6	0.6	0.7	-	0.3	-	0.1	0.7	0.6
Under 140	2.8	4.5	9.2	11.5	4.4	7.1	1.8	3.2	0.6	0.7	-	0.4	1.1	1.7
Under 160	9.3	12.3	28.3	28.9	15.1	17.4	6.5	11.0	2.7	4.8	0.1	2.7	1.5	3.1
Under 180	20.9	24.3	49.4	49.7	33.8	36.3	19.6	23.5	7.9	11.6	3.5	6.3	6.0	6.0
Under 200	35.2	41.4	69.8	69.5	55.8	60.4	38.3	46.3	18.1	25.7	7.7	15.3	8.8	13.0
Under 220	51.9	57.9	84.9	83.5	74.5	77.5	62.1	67.0	35.0	43.7	17.9	29.8	17.6	24.9
Under 240	64.9	71.8	91.0	92.1	86.5	88.3	76.8	80.7	53.0	61.8	29.9	47.3	31.4	42.5
Under 260	77.3	82.5	95.4	97.0	92.6	94.4	87.1	90.4	72.0	75.5	50.3	64.7	49.0	59.3
Under 280	85.5	89.4	97.5	97.9	95.7	97.5	93.0	94.7	84.7	85.0	64.1	76.9	64.8	76.0
Under 300	91.8	94.3	98.2	99.3	98.6	98.8	97.1	97.8	93.7	90.8	79.1	88.1	73.3	86.1
Under 320	95.4	97.1	99.0	99.8	99.3	99.1	98.4	98.9	96.3	95.3	88.3	94.4	84.7	92.2
Under 340	97.8	98.2	99.7	99.8	99.6	99.7	98.9	99.5	98.6	96.5	95.3	96.4	91.8	96.2
Under 360	98.8	99.2	99.9	99.8	99.7	99.8	99.3	99.6	99.5	98.4	98.3	98.9	94.2	98.3
Under 380	99.4	99.5	99.9	99.9	99.9	99.8	99.5	99.7	99.6	99.0	99.6	99.4	97.0	99.1

APPENDIXES

CONTENTS

LIST OF APPENDIX TABLES

APPENDIX I

STATISTICAL NOTES

Survey Design

The sampling plan of the Health and Nutrition Examination Survey (HANES) followed a highly stratified multistage probability design in which a sample of the civilian noninstitutionalized population of the coterminous United States, 1-74 years of age, was selected. Excluded from the selection process were those persons confined to institutions or residing on any of the reservation lands set aside for use by American Indians. Successive elements dealt within the process of sampling are the primary sampling unit (PSU), census enumeration district (ED), segment (a cluster of households), household, eligible person, and finally, sample person.

The starting points in the first stage of this design were the 1960 decennial census lists of addresses and the nearly 1,900 PSU's into which the coterminous United States was divided. Each PSU is either a standard metropolitan statistical area, a single county, or two or three contiguous counties. The PSU's were grouped into 357 strata for use in the Health Interview Survey and subsequently collapsed into 40 superstrata for the Health and Nutrition Examination Survey.

Of the 40 superstrata, 15 contained a single large metropolitan area of more than 2 million population. These 15 large metropolitan areas were chosen for the sample with certainty. The remaining 25 superstrata were formed by classifying the noncertainty strata into 4 population density groups within each of 4 geographic regions. Then using a modified Goodman-Kish controlled-selection technique to assure proportionate representation of specified State groups and rate-of-population-change classes, 2 PSU's were chosen from each of the 25 noncertainty superstrata with the probability of selection of a PSU proportionate to its 1960 population. In this manner, a total first-stage sample of 65 PSU's or "stands" included the areas within which a sample of persons would be selected for examination. The PSU's were scheduled to be sampled over a 3-year period with 300-600 persons to be examined per stand.

Although the 1970 census data were used as the frame for selecting the sample within the PSU when they became available, the calendar of operations required that the 1960 census data be used for the first 44 locations in the HANES sample. The 1970 census data were used for the last 21 stands of the sample.

Beginning with the use of the 1970 census data, the segment size was changed from an expected 6 households selected from compact clusters of 18 households to an expected compact cluster of 8 households. The change was made because of operational advantages, and research by the Census Bureau indicated that precision of estimates would not be appreciably affected by the change from noncompact clusters to compact clusters.

For ED's not having usable addresses (generally located in rural areas), area sampling was employed and consequently some variation in the segment size occurred. To make the sample representative of the current population of the United States, the address or ED segments were supplemented by a sample of housing units that had been constructed since the 1960 and 1970 Decennial Censuses.

Within each PSU, a systematic sample of segments was selected. The enumeration districts that fell into the sample were coded into one of two economic classes. The first class, identified as the "poverty stratum," was composed of

"Current Poverty Areas" that had been identified by the Bureau of the Census in 1970 (pre-1970 census), plus other ED's in the PSU with a mean family income of less than $3,000 in 1959 (based on the 1960 census). The second economic class, the "nonpoverty stratum," included all ED's not designated as belonging to the poverty stratum.

All sample segments classified as being in the poverty stratum were retained in the sample. For the first 42 stands, sample segments in nonpoverty stratum ED's were divided into 8 random subgroups and one of the subgroups was chosen to remain in the HANES sample. Research indicated that efficiency of estimates could be increased by changing the ratio of poverty to nonpoverty segments from 8:1 to 2:1. Therefore in the later stands, the selected segments in the nonpoverty-stratum ED's were divided into two random subgroups and one of the subgroups was chosen to remain in the HANES sample. The differential sampling permits a separate analysis with adequate reliability of those classified as being below the poverty level and those classified as being above the poverty level.

After identification of the sample segments, a list of all current addresses within the segment boundaries was made and the households were interviewed to determine the age and sex of each household member as well as other demographic and socioeconomic information required for the survey. If no one was at home after repeated calls or if the household members refused to be interviewed, the interviewer tried to determine the household composition from neighbors.

To select the persons in sample segments to be examined in HANES and at the same time to oversample certain groups at high risk of malnutrition, all household members aged 1-74 years in each segment were first listed on a sample selection worksheet with each household in the segment listed serially. The number of household members in each of the six age-sex groups shown in table I were then listed on the worksheet under the appropriate age-sex group column. The sample selection worksheets were next put in segment-number order and a systematic random sample of persons in each age-sex group was selected to be examined using the sampling rates shown in table I.

Table I. Sampling rates by age-sex groups

Age and sex	Rate
1-5 years (men and women)	1/2
6-19 years (men and women)	1/4
20-44 years (men)	1/4
20-44 years (women)	1/2
45-64 years (men and women)	1/4
65-74 years (men and women)	1

The persons selected in the 65-stand sample of HANES comprised a representative sample of the target population and included 28,043 sample persons 1-74 years of age of whom 20,749 or 74 percent were examined. When adjustments were made for different sampling for high-risk groups, the response rate became 75 percent.

All data presented in this report are based on "weighted" observations. That is, data recorded for each person are inflated to characterize the subuniverse from which that sample person was drawn. The weight for each examined person is a product of the reciprocal of the probability of selecting the person, an adjustment for nonresponse cases (i.e., persons not examined), and poststratified ratio adjustment which increases precison by bringing survey results into closer alignment with known U.S. population figures for 20 age, race, and sex groups as of November 1, 1972, the approximate midpoint of HANES.

A more detailed description of the survey design and selection technique can be found in "Plan and Operation of the Health and Nutrition Examination Survey, United States, 1971-73," *Vital and Health Statistics,* Series 1-Number 10a.[1]

Nonresponse

In any health examination survey, after the sample is identified and the sample persons are requested to participate in the examination, the survey meets one of its more severe problems, namely that of nonresponse. Usually a sizable number of sample persons will not participate in the examination. A further potential for bias results if the sample persons who do not participate differ from the sample persons examined with respect to the characteristics under examination. Intensive efforts were made in HANES to develop and implement procedures

NOTE: The list of references follows the text.

and inducements that would reduce the number of nonrespondents and thereby reduce the potential of bias due to nonresponse. These procedures and inducements are discussed in "Plan and Operation of the Health and Nutrition Examination Survey, United States, 1971-73," Series 1-Number 10a.[1]

Despite these intensive efforts, 25 percent of the sample persons from 65 stands were not examined as compared to previous surveys with response rates of more than 86 percent. Consequently, the potential for a sizable bias does exist in the 1971-74 estimates in the publication. Because more than 95 percent of the sample persons responded to a medical questionnaire in 1971-74, one could examine the characteristics of the nonrespondents and the nature of nonresponse. This examination indicated that the likelihood of sizable bias is small. For instance, there was no greater proportion of persons with characteristics related to serum cholesterol who were examined as compared with those who were not examined.

As was mentioned earlier, the data in this report were based on weighted observations, and one of the components of the weight assigned to an examined person was an adjustment for nonresponse. A procedure was adopted which multiplies the reciprocal of the probability of selection of sample persons who were examined by a factor that brings estimates based on examined persons up to a level that would have been achieved if all sample persons had been examined. The nonresponse-adjustment factor was calculated by dividing the sum of the reciprocals of the probability of selection for all selected sample persons in each of five income groups within each stand by the sum of the reciprocals of the probability of selection for examined sample persons in the same stand and income group. The five income groups were: under $3,000; $3,000-$6,999; $7,000-$9,999; $10,000-$14,999; and $15,000 and over. For sample weighting purposes, income group was imputed for 5.6 percent of the sample persons using educational level of the head of the household. To the extent that the income-within-stand classes were homogeneous with respect to the health characteristics under study, the adjustment procedure was effective in reducing the potential of bias due to nonresponse. The percent distribution of the nonresponse adjustment factors computed for the 65-stand sample of HANES is shown in table II.

Missing Data

In addition to persons not examined, there were some persons whose examinations were incomplete in that there was a failure to obtain and record all items of information for examined persons. The number of missing data cases was low for serum cholesterol determinations over the entire sample of examined persons aged 18-74 years—457 or 3.3 percent (table III). Any potential for bias arising from these omissions is believed to be small. Estimates in this report include imputed values for all missing

Table II. Percent distribution of nonresponse adjustment factors, stands 1-65, Health and Nutrition Examination Survey (HANES): United States, 1971-74

Size of factor	Percent distribution
Total	100.0
1.00-1.24	32.6
1.25-1.49	38.5
1.50-1.74	18.2
1.75-1.99	7.4
2.00-2.49	2.8
2.50-2.99	0.3
3.00[1]	0.3

[1]A size of 3.00 was assigned for all factors greater than 3.00. The final poststratified ratio adjustment corrects for this truncation.

Table III. Number of examined persons with missing serum cholesterol measurements, by sex and age: United States, 1971-74

Age	Both sexes	Men	Women
	Number of examined persons		
Total, 18-74 years	457	150	307
18-24 years	100	24	76
25-34 years	81	21	60
35-44 years	77	20	57
45-54 years	38	19	19
55-64 years	37	11	26
65-74 years	124	55	69

data cases. This was done by randomly assigning a value for the missing item from among examined persons similar in age, sex, race, and region with that item of information recorded. This process preserves both the expected values and the distribution of values of the recorded information.

Small Numbers

In some tables, magnitudes are shown for cells for which the sample size is so small that the standard error may be several times as great as the statistic itself. In such instances the numbers, if shown, have been included only to convey an impression of the overall story of the table.

Standard Errors

The probability design of the survey makes possible the estimation of standard errors corresponding to the weighted estimates presented. The standard error is primarily a measure of sampling variability, that is, the variations might occur by chance because only a sample of the population is surveyed. As calculated for this report, the standard error also reflects part of the variation that arises in the measurement process. It does not include estimates of any biases which might lie in the data. The chances are about 68 out of 100 that an estimate from the sample would differ from a complete census by less than the standard error. The chances are about 95 out of 100 that the difference would be less than twice the standard error and about 99 out of 100 that it would be less than 2 1/2 times as large.

Estimates of standard errrors are obtained from the sample data and are themselves subject to sampling error when the number of cases in a cell is small, or even occasionally, when the number of cases is substantial.

Estimates of the standard errors for selected statistics used in this report are presented in tables 1 and 4-6. Estimates of sampling variability for comparison of 1960-62 and 1971-74 data are presented in tables IV and V. These estimates have been prepared by a replication technique which yields overall variability through observation of variability among random subsamples of the total sample. Again, readers are reminded that these estimated standard errors do not reflect any residual bias which might still be present after the attempted correction for nonresponse.

Table IV. Standard errors of mean serum cholesterol levels, by sex and age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Age	Men		Women	
	HES 1960-62	HANES 1971-74	HES 1960-62	HANES 1971-74
	Standard error in mg/100 ml			
18-24 years	5.10	1.80	4.10	1.83
25-34 years	3.07	2.17	2.79	1.32
35-44 years	3.01	2.42	2.83	1.31
45-54 years	3.25	2.43	3.14	2.25
55-64 years	4.37	3.03	4.01	2.60
65-74 years	7.45	1.96	5.60	1.83

Table V. Standard errors for percent of adults with serum cholesterol levels of 260 mg/100 ml and over, by sex and age: United States, Health Examination Survey (HES) 1960-62 and Health and Nutrition Examination Survey (HANES) 1971-74

Age	Men		Women	
	HES 1960-62	HANES 1971-74	HES 1960-62	HANES 1971-74
	Standard error in percent			
18-24 years	2.35	0.63	1.17	0.56
25-34 years	1.86	1.17	1.48	0.69
35-44 years	0.93	2.08	2.00	0.89
45-54 years	2.48	2.11	1.82	1.80
55-64 years	3.23	2.00	2.43	2.90
65-74 years	3.80	1.27	3.07	1.79

APPENDIX II

DEMOGRAPHIC TERMS

The demographic characteristics of the population sampled are defined as follows:

Age.—The age recorded for each examinee was the age at his last birthday on the date of examination. The age criterion for inclusion in the sample used in this survey was defined in terms of his age at time of census interview. Some of those who were 74 years old at the time of interview became 75 years old by the time of the examination. There were 20 such cases. In the adjustment and weighting procedures used to produce national estimates, these persons were included in the 74-year-old group.

Race.—For each individual, race was recorded by observation as "white," "black," or "other races." The last category included American Indians, Chinese, Japanese, and all races other than white or black. Mexican persons were included with "white" unless definitely known to be American Indian or of another race other than white. Blacks and persons of mixed black and other parentage were recorded as "black."

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