Data from the
NATIONAL HEALTH SURVEY

Series 11
Number 156

Total Serum Cholesterol Values

of Youths 12-17 Years

United States

Serum cholesterol values are presented and discussed by age, sex, race, and socioeconomic level of youths 12-17 years of age in the United States, 1966-70.

DHEW Publication No. (HRA) 76-1638

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

Health Resources Administration
National Center for Health Statistics
Rockville, Md. May 1976

Library of Congress Cataloging in Publication Data

Main entry under title:

Total serum cholesterol values of youths 12-17 years, United States.

(Vital and health statistics: Series 11, Data from the National Health Survey, Data from the health examination survey; no. 156) (DHEW publication no. (HRA) 76-1638)

Includes bibliographical references.

Supt. of Docs. No.: HE 20.6209:11/156

1. Youth—Health and hygiene—United States—Statistics. 2. Blood cholesterol. 3. Health surveys—United States. I. Levy, Paul S. II. Series: United States. National Center for Health Statistics. Vital and health statistics: Series 11, Data from the National Health Survey, Data from the health examination survey; no. 156. III. Series: United States. Dept. of Health, Education, and Welfare. DHEW publication; no. (HRA) 76-1638) [DNLM: 1. Cholesterol—Blood. 2. Blood chemical analysis—In adolescence. W2 N148vk no. 156] RA407.3.A347 no. 156 [RA564.5] 312'.0973s [612'.12] ISBN 0-8406-0051-8 75-619260

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price ... cents

NATIONAL CENTER FOR HEALTH STATISTICS

DOROTHY P. RICE, *Director*

ROBERT A. ISRAEL, *Deputy Director*
JACOB J. FELDMAN, Ph.D., *Associate Director for Analysis*
GAIL F. FISHER, *Associate Director for the Cooperative Health Statistics System*
ELIJAH L. WHITE, *Associate Director for Data Systems*
GEORGE P. FAILLA, *Associate Director for Management*
PETER L. HURLEY, *Associate Director for Operations*
JAMES M. ROBEY, Ph.D., *Associate Director for Program Development*
ALICE HAYWOOD, *Information Officer*

DIVISION OF HEALTH EXAMINATION STATISTICS

ARTHUR J. McDOWELL, *Director*
JEAN-PIERRE HABICHT, M.D., Sc.D., *Special Assistant to Director*
PETER V. V. HAMILL, M.D., *Medical Adviser*
JEAN ROBERTS, *Chief, Medical Statistics Branch*
ROBERT MURPHY, *Chief, Survey Planning and Development Branch*

Vital and Health Statistics-Series 11-No. 156

DHEW Publication No. (HRA) 76-1638
Library of Congress Catalog Card Number 75-619260

CONTENTS

SYMBOLS

Data not available	- - -
Category not applicable	. . .
Quantity zero	-
Quantity more than 0 but less than 0.05	0.0
Figure does not meet standards of reliability or precision	*

TOTAL SERUM CHOLESTEROL VALUES
OF YOUTHS 12-17 YEARS

Paul S. Levy, Sc.D., Peter V. V. Hamill, M.D., M.P.H., Felix Heald, M.D., and Michael Rowland[a]

INTRODUCTION

This report of serum cholesterol values as determined from blood samples of youths 12-17 years of age in the United States is one of a series of reports presenting findings from Cycle III of the Health Examination Survey (HES). The means and selected percentiles of total serum cholesterol values are examined here by sex, age, race, family income, education, and geographic location in the United States. As described in a detailed report of its general plan and operation,[1] the Health Examination Survey is conducted in a succession of cycles.

Cycle I of the HES, conducted from 1959 to 1962, obtained information on the prevalence of certain chronic diseases and on the distribution of a number of anthropometric and sensory characteristics in the civilian, noninstitutionalized population of the continental United States aged 18-79 years. The detailed plan of Cycle I has been described,[2] and most of the results are published in other reports in Series 11 of *Vital and Health Statistics.*

Cycle II of the HES, conducted from July 1963 to December 1965, involved selection and examination of a probability sample of noninstitutionalized U.S. children aged 6-11 years. This program succeeded in examining 96 percent of the 7,417 children selected for the sample. The examination had two focuses: (1) factors related to healthy growth and development as determined by a physician, a nurse, a dentist, and a psychologist and (2) a variety of somatic and physiologic measurements performed by specially trained technicians. The detailed plan and operation of Cycle II and the response results are described in *Vital and Health Statistics,* Series 1-Number 5.[3]

HES Cycle III, conducted from March 1966 to March 1970, was essentially an agewise extension of Cycle II into adolescence. As described in detail in "Plan and Operation of a Health Examination Survey of U.S. Youths, 12-17 Years of Age,"[4] Cycle III was more similar to Cycle II than to Cycle I not only in form, content, and style but also in having its major emphasis on factors of "normal" growth and development rather than on chronic diseases. These analyses on "normal" growth and development of adolescents have been well underway since 1970, and some of the results from the battery of body measurements have already been published,[5-7] as have the initial results of the hematocrit findings[8] and the serum uric acid values.[9]

The present report of cholesterol values is the third in the series presenting findings from the sample of blood drawn from each youth. No blood specimens were obtained from children in Cycle II, but specimens were obtained from the adults in Cycle I.

The information from the analysis of blood is intended for use as much needed reference data both for clinical and for epidemiologic estimates of variation in a well-defined population. It also

[a]Associate Professor of Biometry, University of Illinois, School of Public Health; Medical Adviser, Children and Youth Programs, Division of Health Examination Statistics; Professor of Pediatrics, Director, Division of Adolescent Medicine, University of Maryland, School of Medicine; Analytical Statistician, Division of Health Examination Statistics, respectively.

enables examination of another aspect of growth and development during adolescence. The procedure by which the Division of Health Examination Statistics obtained advice on the selection of the analyses to be made on the blood specimens and the cooperative arrangements which were subsequently made with the Lipid Standardization Laboratory of the Center for Disease Control (CDC) have been described elsewhere.[4]

The authors and the Division of Health Examination Statistics are grateful for the technical advice given by Dr. Gerald Cooper, Dr. Myron Kuchmak, and Dr. Alan Mather and for their administrative assistance in arranging the laboratory determinations that were performed by the Lipid Standardization Laboratory at CDC, and to Mrs. Margie Sailors for coordination and verification of the laboratory data and its transmission.

METHOD

At each of 40 preselected locations (see appendix I for sample design) throughout the United States, the youths were brought to the centrally located mobile examination center for an examination that lasted about 3½ hours. Six youths were examined in the morning and six in the afternoon. Except during vacations, they were transported to and from school and/or home.

When the youths entered the examination center, their oral temperatures were taken, and a cursory screening for acute illness was made; if illness was detected, the youth was sent home and reexamined later. The examinees changed into gymnasium-type shorts; cotton sweat socks; a terry-cloth robe; and, for the girls, a light, sleeveless topper. All six then proceeded to different stages of the examination, each one following a different route. The 3½-hour examination was divided into six 35-minute time periods, each consisting of one or more detailed examinations at a designated station. At the end of each period, the youths rotated to other stations, so that at the end of 3½ hours each youth had been given essentially the same examinations by the same examiners, but in a different sequence. Four of these examination time periods were allocated to examinations by a pediatrician, a dentist, and a psychologist,[b] and the other two were allocated to a group of examinations performed by highly trained technicians. This last group of examinations consisted of X-rays of the chest and hand-wrist, hearing and vision tests, measures of respiratory function, a 12-lead electrocardiogram, a submaximal exercise tolerance test on a treadmill with chest leads to a continuous electrocardiogram, a battery of body measurements, grip strength measurements, examination of blood and (on girls only) urine cultures for bacteria, and a privately administered health behavior and health attitude questionnaire.

Race

Race was recorded as "white," "Negro," and "other races"[c] (see appendix II). In Cycle III, white youths constituted 84.74 percent of the total youths examined; Negro youths, 14.76 percent; and youths of other races, only 0.50 percent. In Cycle II, white children constituted 85.69 percent of the examined subjects and Negro children, 13.86 percent. (The differential response rate by age, sex, and race is analyzed and discussed in appendix I. The increased proportion of Negro subjects in Cycle III was

[b] The entire examination by the psychologists consisted of two consecutive time periods (70 minutes). Two psychologists performed identical examinations simultaneously at separate stations.

[c] The same classification scheme as used in the 1960 census was employed here. As described in the previously mentioned report on the operation of HES Cycle III,[4] this information was obtained at the initial household interview by the U.S. Bureau of the Census fieldworker. The accuracy of the information was checked at the subsequent home visit by the highly experienced representative from HES and again at the examination in the trailer. A final record check by birth certificate turned up only seven inconsistencies, and these were mostly pertaining to the category "other races." Hence, the possible extent of misclassification of the race variable, as described, is so minimal that it could have no effect on the data analyzed in this report. However, when comparing the present HES findings to those of other variously defined racial groupings in the world, the degrees of genetic admixture, as first discussed by Herskowits[10] in 1928 and later by Glass and Li,[11] by Roberts,[12] Roberts and Hiorns,[13] and by Reed[14] should be taken into consideration.

due to their better response rate—the overall Negro response rate was 96.6 percent and the overall white response rate was 89.1 percent.) As in Cycle II, because so few youths of "other races" were part of the sample, data for them have not been analyzed as a separate category. Whenever data are analyzed independently of a classification by race, however, data for these youths are included.

Blood Specimen and Total Serum Cholesterol Determination

The analyses for total serum cholesterol (i.e., both free cholesterol and esterified cholesterol) were performed for the Health Examination Survey at the Lipid Standardization Laboratory of the Center for Disease Control, Public Health Service, Atlanta, Ga. There, a semiautomated procedure was employed using the Abell-Kendall method,[15] details of which are presented in appendix III. This method, with a specificity for total cholesterol of 99 percent, is considered an accurate measure of total cholesterol.[15,16] It has the additional advantage of being used in most of the controlled studies on the role of cholesterol in heart disease, as it yields high comparability.

The development of the technique used by the HES for obtaining and processing the blood specimen is also described in appendix III. As described in the two previous reports,[8,9] the microhematocrit was the only complete laboratory determination performed on the blood specimen directly in the examination trailers. The bulk of each blood specimen, after preliminary laboratory preparation, was properly separated into its various subsamples and packed into specially devised styrofoam containers for shipment via air freight to either the Immunogenetics Laboratory of The Johns Hopkins University, Baltimore, Md., or the Center for Disease Control in Atlanta, Ga.

A frozen specimen for the total serum cholesterol was shipped directly to the Clinical Chemistry Section of the Center for Disease Control for analysis. A specimen of clotted blood was sent directly to the Venereal Disease Research Laboratory of the CDC for analysis.

FINDINGS

Age and Sex

The estimated number and percent distribution of male and female youths 12-17 years of age falling into each of 19 groups according to their levels of cholesterol are shown in tables 1 and 2, respectively. The patterns shown in these distributions are discussed below in terms of a few summary statistics.

The estimated mean cholesterol levels for each of the 12 age-sex classes are shown in table 3 and figure 1. Among male youths 12-17 years of age, mean cholesterol levels were highest in 12-year-olds (181.3 mg/100 ml), decreased in the next two age groups (174.7 mg/100 ml in 13-year-olds and 169.9 mg/100 ml in 14-year-olds), and remained relatively stable in the next three age groups. The mean cholesterol levels of females aged 12-16 ranged from 175 to 178 mg/100 ml; but for 17-year-olds, however, the mean level was 184.5 mg/100 ml—indicating a rise of more than 6 mg/100 ml from 16 to 17 years of age. With the exception of 12-year-olds,

Figure 1. Mean cholesterol levels for youths 12-17 years of age, by age and sex: United States, 1966-70.

females in each age group had higher mean cholesterol levels than males in the same age group.

Percentiles of the cholesterol distributions are shown by age for male and female youths (table 3 and figure 2). For each age-sex group, the mean cholesterol level was always greater than the median, which indicates that the cholesterol distribution was skewed to the right (positive skewness). This skewness was most pronounced in 17-year-old females for whom the mean cholesterol level was 5.3 mg/100 ml greater than the median. The age patterns described above for the mean were also apparent when percentiles at both the upper and lower ends of the distribution were examined.

Geographic Region, Age, and Sex

Mean cholesterol levels are shown by age and sex for the four geographic regions defined in the Health Examination Survey in table 4 and figure 3. In general, mean cholesterol levels were highest in the Northeast, and there were few, if any, differences in mean cholesterol levels among the other three regions.

Race, Age, and Sex

The estimated number and percent distribution of white and Negro youths falling into each of 19 groups according to their cholesterol levels are shown, respectively, in tables 5, 6, 7, and 8. Patterns observed in these distributions are discussed below in terms of a few summary statistics.

The main cholesterol patterns observed above for the entire sample of U.S. youths aged 12-17 years were similar to those observed for white and Negro youths separately (table 9 and figures 4 and 5). Mean cholesterol levels in white males were highest for 12-year-olds (180.2 mg/100 ml) and decreased with age to a low of 166.7 mg/100 ml for 16-year-olds. For white females, there was little change with age in mean cholesterol levels except for a sharp increase from 177.7 mg/100 ml for 16-year-olds to 184.2 mg/100 ml for 17-year-olds. Mean cholesterol

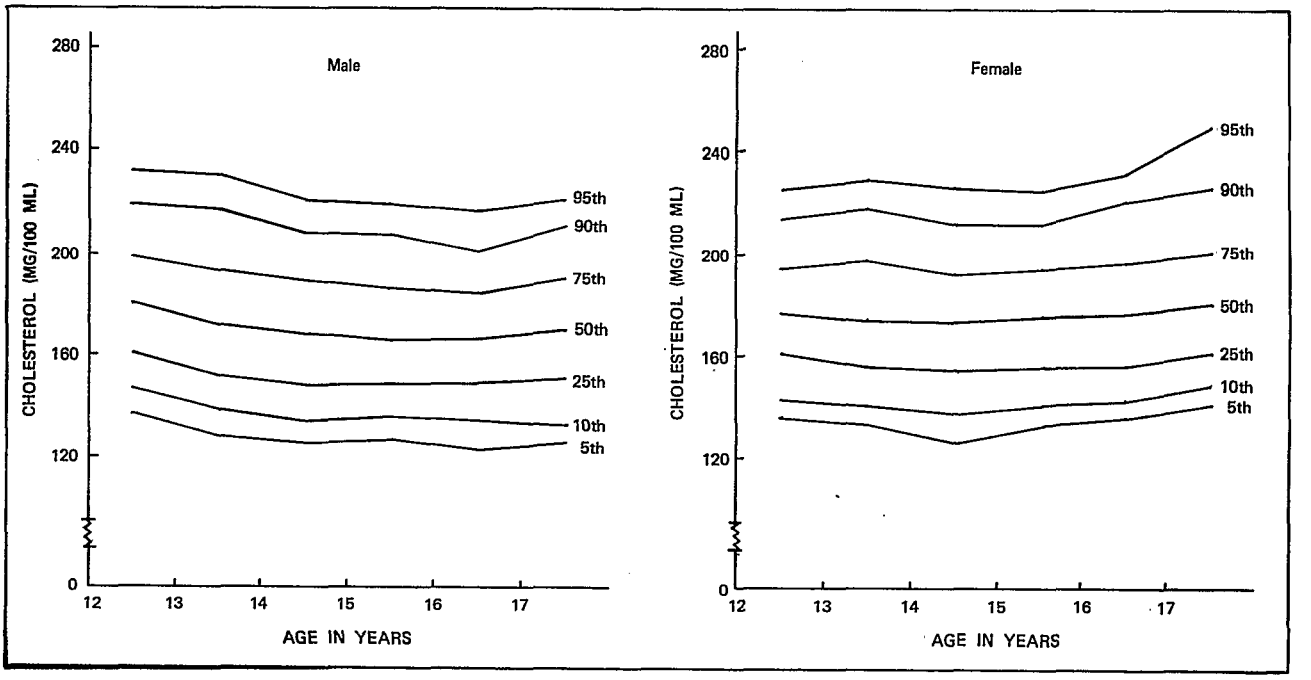

Figure 2. Selected estimated percentiles of the cholesterol distribution in youths aged 12-17 years, by age and sex: United States, 1966-70.

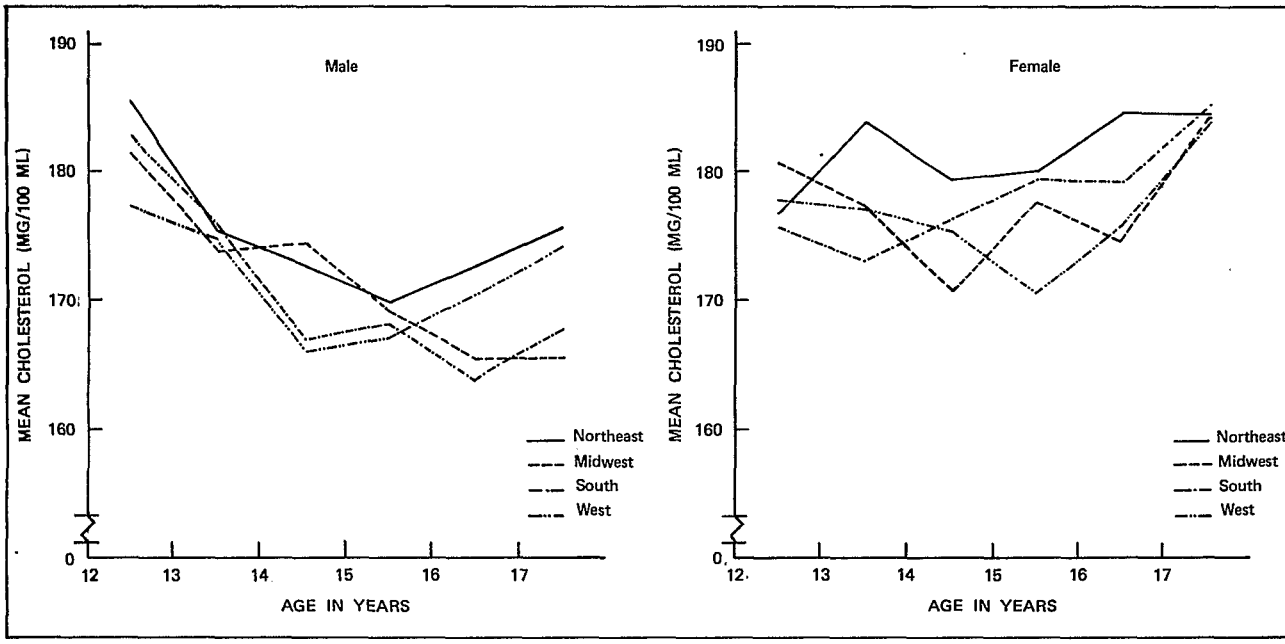

Figure 3. Mean cholesterol levels of male and female youths 12-17 years of age, by age and geographic region: United States, 1966-70.

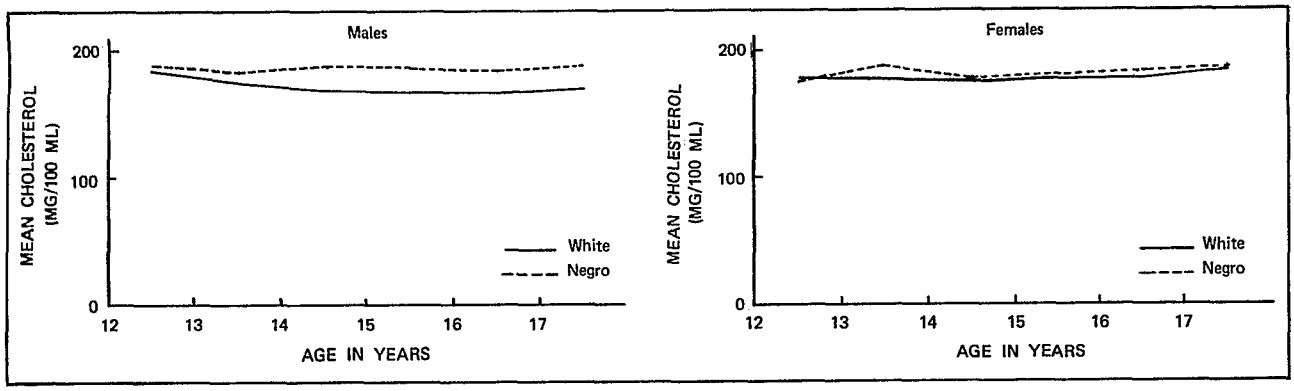

Figure 4. Mean cholesterol levels of male and female youths 12-17 years of age, by age and race: United States, 1966-70.

levels in Negro males were highest for 12-year-olds (187.2 mg/100 ml) and decreased with age to a low of 173.3 mg/100 ml for 16-year-olds.

At every age except 12 years, both white and Negro female youths had higher mean cholesterol levels than their male counterparts. At age 12, however, the mean levels were higher for boys of both races than for girls.

In addition, Negro male and female youths had higher mean serum cholesterol levels than their white counterparts at every age except 12, with interracial differences being greater for males than for females. The average differences between the mean cholesterol levels of white and Negro youths over the six age groups was 7.8 mg/100 ml for males and 2.7 mg/100 ml for females. In general, interracial differences were greater at the upper end of the cholesterol distribution than at the lower end (figure 5).

Annual Family Income, Education of Parent, Age, and Sex

Mean cholesterol levels are given by annual family income, age, and sex in table 10 and education of parent, age, and sex in table 11. No

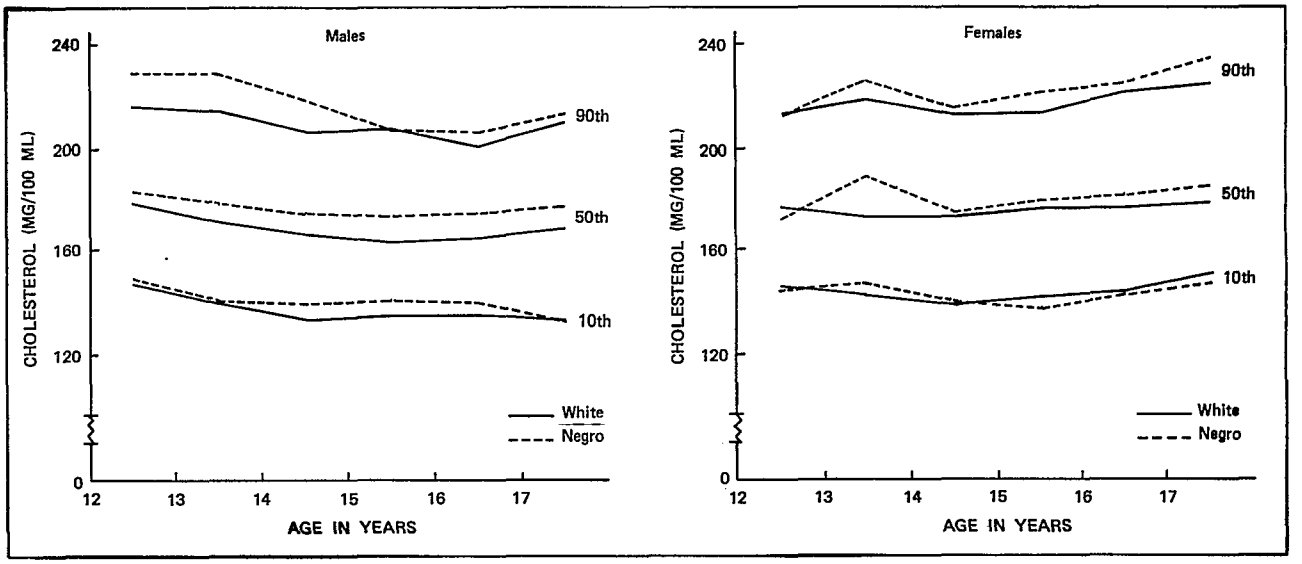

Figure 5. Selected estimated percentiles of the cholesterol distribution in male and female youths 12-17 years of age, by age and race: United States, 1966-70.

consistent relationship was observed between cholesterol levels and either annual family income or education of parent within individual age groups. However, when all age groups were combined, the mean cholesterol levels averaged 3.4 mg/100 ml higher for male youths and 6.8 mg/100 ml higher for female youths whose families had annual incomes of $10,000 or more than for those youths whose families had incomes of less than $3,000 per year (table 12). Similar patterns were observed in the relationship between mean cholesterol levels and parental education.

Mean cholesterol levels are shown separately for white and Negro youths by annual family income, age, and sex in table 13 and by education of parent, age, and sex in table 14. When all age groups were combined (table 12), a general increase in mean cholesterol with increase in family income was observed for both white and Negro youths. Likewise, both white and Negro youths whose parents had 12 years or more of education generally showed higher mean cholesterol levels than those whose parents had less than 12 years of education. When contrasting the socioeconomic extremes, youths of all ages in the highest socioeconomic groups had higher cholesterol levels than those in the lowest socioeconomic groups.

DISCUSSION

The role of cholesterol as a risk factor in increased morbidity and mortality from cardiovascular disease has been an issue for decades. Evidence of its central role in the development of atherosclerosis comes from three sources. First, certain disease states in man involving abnormally high serum cholesterol levels are also associated with accelerated atherosclerosis. Examples of such disease states are hyperlipoproteinemias (Fredrickson Types II, III, and IV) and poorly controlled diabetes mellitus, both entities known to be associated with accelerated atherosclerosis.[17] Second, "epidemics" of atherosclerosis currently occurring in the United States and the Scandinavian countries are unknown in populations where serum cholesterol levels are low. Although high levels of serum cholesterol in epidemiological studies are not always associated with high rates of atherosclerosis, low levels of serum cholesterol always appear to be associated with low levels of atherosclerosis.[18] Third, it has been known for many years from animal experiments and human autopsy data that esterified cholesterol is the principal lipid constituent of the fatty streak and the fibrous plaque.[19,20]

Despite these facts, there has been considerable debate over the role cholesterol plays in the

pathogenesis of atherosclerosis. The debate has ranged from advocating cholesterol as the major and primary determinant in the development of atherosclerosis to the other extreme of describing its role as only a secondary or facilitating one. Current opinion seems to implicate elevated levels of serum lipids as one of a number of major risk factors such as hypertension, smoking, and diabetes mellitus.[21] Nongenetic elevation of serum cholesterol occurring in one of the technologically developed countries is usually associated with a high-calorie diet characterized by significant amounts of cholesterol and animal fat. To complicate the issue even more, recent evidence implicates hypertriglyceridemia as an independent risk factor in the development of ischemic heart disease.[22] Therefore, it is possible that serum cholesterol may not be the only lipid in the serum to signify higher risk for heart disease in middle-aged adults.

It is important to note, however, that serum cholesterol may continue to be a useful index determination for high risk for cardiovascular disease for three reasons. First, the exact role of hypertriglyceridemia as a predicator of risk in cardiovascular disease is not as solidly based as that of hypercholesterolemia. Second, cholesterol levels are not as affected by the immediate fed or fasted state as are the serum triglycerides. Third, serum triglycerides may reflect the current nutritional status in days or weeks, whereas serum cholesterol is more likely to be representative of lipid metabolism over a period of months. Therefore the accurate measurement and interpretation of serum triglyceride levels requires immediate dietary knowledge which is not as important when using serum cholesterol for survey or screening purposes.

Much of our epidemiologic knowledge about the clinical implications of elevated serum cholesterol and triglycerides in adult morbidity and mortality is relatively recent, and it is based essentially on adult data such as the classical longitudinal study conducted in Framingham, Massachusetts.[21] There are no analogous longitudinal data gathered directly from adolescents that link elevated cholesterol in adolescence (whether it be of genetic and dietary origin or secondary to other diseases such as hypothyroidism, diabetes mellitus, and the nephrotic syndrome) with future morbidity and mortality. There is, however, evidence from autopsy studies that fatty streaking of the abdominal aorta, a precurser to atherosclerosis, can be well established during adolescence and may accelerate more rapidly at adolescence than at any other time,[23] and that accelerated coronary disease can be found (though uncommonly) in men in their twenties and with increasing frequency in men in their thirties.[24] Thus, if elevated serum cholesterol plays a significant causal role in adult atherosclerotic disease, and if it could be demonstrated that purposefully lowering these levels by dietary and/or other means significantly lowers the risk, then the adolescent period would not be too early to attempt its detection and control.

Age and Sex

The relationship between serum cholesterol levels and age is different in adolescent males and females in the United States. Mean cholesterol levels in males declined from a high of 181.3 mg/100 ml in 12-year-olds to 167.7 mg/100 ml in 16-year-olds, with the biggest differences between adjacent age groups occurring between ages 12 and 13 (6.6 mg/100 ml) and between ages 13 and 14 (4.8 mg/100 ml). From age 14 on, there appeared to be little if any change in mean cholesterol levels among males. On the other hand, there was little if any difference in mean cholesterol levels of females aged 12-16 years, with mean levels ranging from 175 to 178 mg/100 ml. At age 17, however, there was a sudden increase of 6.4 mg/100 ml in mean levels over that observed from 16-year-old females—178.1 mg/100 ml vs. 184.5, respectively. Except at age 12, female youths in each age group had higher mean cholesterol levels than their male counterparts (table 3).

Among adolescent males and females of all ages, the distribution of cholesterol levels was not symmetric but skewed to the right (positive skewness). In male youths 12-17 years of age and in female youths 12-16 years of age, the mean of the cholesterol distribution was 1.5 to 3.0 mg/100 ml higher than the median. In 17-year-old females, however, the distribution

was much more skewed with the mean being 5.3 mg/100 ml greater than the median.

These estimates for U.S. youths with respect to age and sex can be compared with findings of other studies of cholesterol in adolescents. A study conducted in Tecumseh, Mich., in 1959-60 involved an extensive medical examination of 88 percent of the town's entire population (approximately 9,800 persons at that time). Included in this examination were serum cholesterol determinations.[25] The Tecumseh study represents more than just a collection of persons since its results can be extrapolated to a specified population (i.e., that of Tecumseh, Mich., 1959-60). Unfortunately, because Tecumseh findings on cholesterol were presented for the combined age groups 10-14 years and 15-19 years, a more detailed comparison with HES results is not possible. However, in both of the Tecumseh age groups, females had higher mean cholesterol levels than males, a finding consistent with that of the HES.[25]

In other studies such as the following, it was found that adolescent girls have higher cholesterol levels than adolescent males:

- Among 1,200 healthy males and females of all ages in New York City, females aged 13-17 years had higher mean cholesterol levels than males of comparable ages.[26]

- In a longitudinal study of 152 girls and 169 boys in Utah, girls were found to have higher mean cholesterol levels than their male counterparts.[27]

- Analysis by single years of age of data for 885 volunteer and nonvolunteer male and female students aged 12-18 attending public and parochial schools in Burlington, Vt., revealed that 12-year-old males had higher mean cholesterol levels than 12-year-old females; 13-year-old males and females had approximately equal cholesterol levels; but beginning with age 14, however, females had higher levels than their male counterparts.[28]

On the other hand, a study conducted in rural Georgia showed no consistent differences in mean cholesterol levels between male and female adolescents.[29]

The decrease with age in mean cholesterol levels found in HES adolescent males was observed through age 16 both in the Burlington, Vt., study[28] and in the survey of 613 school boys 11-18 years of age conducted in Sydney, Australia.[30] Different patterns were observed, however, among adolescent males in two rural surveys: the one already mentioned above conducted in Georgia[29] and another one conducted in Busselton, Australia.[31] The sharp increase in cholesterol levels from age 16 to age 17 observed in U.S. females was also apparent among females in the Burlington, Vt., survey.[28] The validity of the age-sex patterns found in Cycle III is further strengthened by the fact that when mean cholesterol levels are plotted by age and sex for white and Negro youths separately, the curves for white youths are parallel to those for Negro youths (figure 4), even though the curves for the latter group are based on relatively small sample sizes in each age group.

The estimates of cholesterol levels for U.S. adolescents obtained from Cycle III of the Health Examination Survey can be compared by extrapolation with those that have been reported for adults in HES Cycle I.[32] Table 13 shows mean levels of cholesterol obtained for adults in Cycle I by age and sex along with standard deviations of the population distribution, and figure 6 shows these mean cholesterol levels in conjunction with those found for U.S. adolescents in Cycle III. In comparing the mean levels of 17-year-old males (mean age 17.5 years), the oldest age group of Cycle III, with those of 18- to 24-year-old males (mean age 21.5 years), the youngest age group of Cycle I, we note an average increase of 1.82 mg/100 ml per year (figure 6). Similar examination of Cycle I data for males in other age groups shows an average yearly increase of 3.27 mg/100 ml from age 21.5 to age 30, 2.09 mg/100 ml from age 30 to age 40, and much smaller increases thereafter. Thus, the mean cholesterol level obtained for 17-year-old males in HES Cycle III is consistent with the Cycle I finding that cholesterol levels rise sharply with age in young men. Similar analysis of the mean cholesterol level in 17-year-old females (mean age 17.5 years) with those of

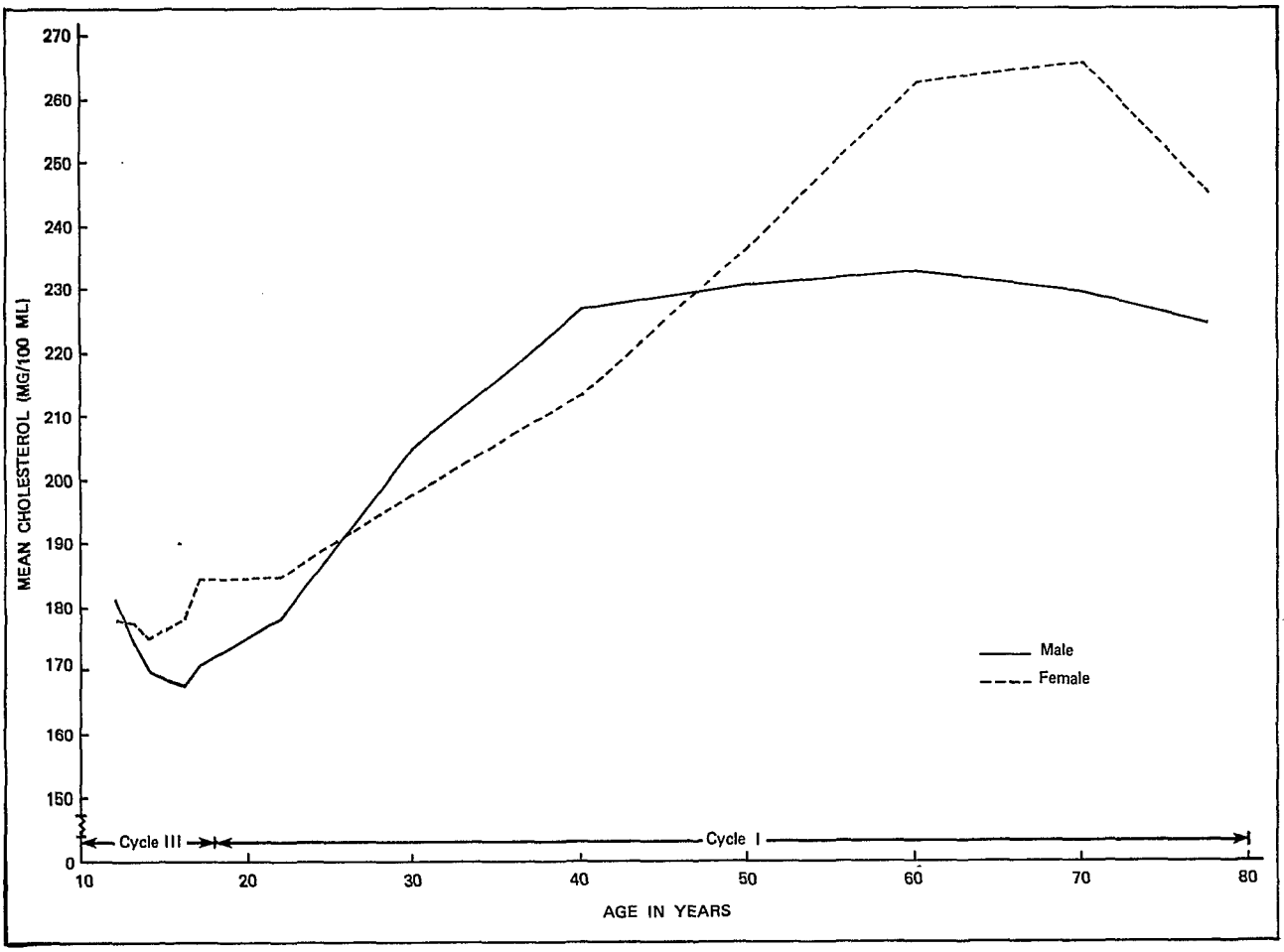

Figure 6. Mean cholesterol levels for adults in HES Cycle I (1960-62) and youths in HES Cycle III (1966-70): United States.

18- to 24-year-old Cycle I women (mean age 21.5) shows practically no difference in mean cholesterol levels between the two age groups (figure 6). Thus, the sharp increase in mean cholesterol level observed in these HES data between 16- and 17-year-old females[d] is not followed by continued increase during the age interval 18-24 years, and the gradual rise in cholesterol level among women apparently does not begin until the mid or late twenties, whereas in males the rise is not only steeper but it begins earlier.

[d]The 80.2 percent response rate in 17-year-old females was the lowest obtained in the survey (see appendix); and this may account for some of the unexplainable findings observed in this age-sex group.

Not only are the mean cholesterol levels higher in U.S. adults than in U.S. adolescents but also the distributions have greater variability in adults than in youths 12-17 years of age (tables 3 and 15). The coefficient of variation of the cholesterol distribution averages about 17 percent in adolescents, whereas it averages about 22 percent in adults.

All other major studies of cholesterol in adults have also obtained mean levels that were considerably higher than those obtained in this Cycle III survey of male and female youths 12-17 years of age.[21,25,26]

Race

One of the most striking findings of this survey was that both male and female Negro

youths showed higher cholesterol levels than white youths of comparable age and sex. These differences between white and Negro youths were greater in males than in females and were greatest at the upper percentiles of the distribution. The average difference over all six age groups in mean cholesterol levels between white and Negro youths was 7.8 mg/100 ml in males and 2.7 mg/100 ml in females. Racial differences also occurred in all socioeconomic classes as measured by family income or education of parent. Two other studies of cholesterol in U.S. adolescents have reported findings of little or no interracial differences in mean cholesterol.[29,33] However, the fact that one of these studies was in a very rural area[29] and the other was based on a very small sample from both groups[33] makes it difficult to relate the findings to HES results.

In the HES survey of U.S. adults (Cycle I), white males and females had consistently higher mean cholesterol levels than Negro adults of comparable age and sex. Other studies have shown racial differences in cholesterol levels. A study of cholesterol levels in Southwestern American Indians and white controls showed lower cholesterol levels among the Indians.[34] Outside of the United States, a survey of children and adolescents in South Africa among white, Bantu, and Cape Coloured populations showed findings of higher cholesterol levels in the white children than in either the Bantu or Cape Coloured children.[35]

Annual Family Income

It appears from these data on U.S. adolescents that a positive relationship exists between mean cholesterol levels and family income although the relationship is not consistent for all age-sex groups. However, when all age groups are combined (table 12), there is a consistent increase in the mean cholesterol levels of both male and female youths with increase in family income. The group of males whose families had annual incomes of less than $3,000 had a mean cholesterol level of 170.6 mg/100 ml, whereas males whose families had annual incomes of $10,000 or more had a mean level of 174.0 mg/100 ml, reflecting an increase of 3.4 mg/100 ml from the lowest to the highest of family income. The comparable increase for females, was 6.8 mg/100 ml, from a low of 172.7 mg/100 ml among those whose families had annual incomes of less than $3,000 to a high of 179.5 among those whose families had incomes of $10,000 or more.

Since 34.8 percent of the Negro youths as opposed to only 9.3 percent of the white youths come from families with annual incomes of less than $3,000, the income group showing the lowest cholesterol levels, and since Negro youths have higher mean cholesterol levels than white youths at all income levels (table 12), the relationships observed above between annual family income and mean cholesterol levels in the total population are greatly influenced by the disproportionate number of Negro youths in the lower income groups. These two factors working in opposite directions obscured and dampened the effective relationship between family income and cholesterol levels. Thus, we see that the relationship between mean cholesterol and annual family income is stronger when examined separately in the white population than when examined in the total population (table 12). In white males the gradient in mean cholesterol level from the lowest to the highest income group was 7.9 mg/100 ml, whereas in the total male population the gradient was only 3.4 mg/100 ml. The comparable gradients in females were 7.4 mg/100 ml for white females as opposed to 6.8 mg/100 ml for the total female population.

Other Studies

Several studies involving children and adolescents have investigated the relative influences of heredity and environment as determinants of cholesterol levels. The Busselton survey,[31] the Tecumseh study,[25] and a survey of residents of two Greek villages[36] indicated considerable evidence of familial aggregation of cholesterol levels. In each of these studies, correlational methods were used to demonstrate parent-child and sibling-sibling relationships. The general conclusion of these studies was that the findings

were more compatible with a quantitive multifactorial mechanism of inheritance than with a single-gene genetic model.

On the other hand, a study of 108 like-sex twin pairs showed that variation in cholesterol level between monozygotic twins was significantly smaller than that between dizygotic twins in female pairs but not in male pairs.[37] For this particular group of twins, it was concluded that genetic determinants of cholesterol levels were generally of a smaller order of magnitude than environmental determinants. Thus, it appears that both heredity and environment influence cholesterol levels.

OOO

REFERENCES

[1]National Center for Health Statistics: Origin, program, and operation of the U.S. National Health Survey. *Vital and Health Statistics*. PHS Pub. No. 1000-Series 1-No. 1. Public Health Service. Washington. U.S. Government Printing Office, Apr. 1965.

[2]National Center for Health Statistics: Plan and initial program of the Health Examination Survey. *Vital and Health Statistics*. PHS Pub. No. 1000-Series 1-No. 4. Public Health Service. Washington. U.S. Government Printing Office, July 1965.

[3]National Center for Health Statistics: Plan, operation, and response results of a program of children's examinations. *Vital and Health Statistics*. PHS Pub. No. 1000-Series 1-No. 5. Public Health Service. Washington. U.S. Government Printing Office, Oct. 1967.

[4]National Center for Health Statistics: Plan and operation of a Health Examination Survey of U.S. youths 12-17 years of age. *Vital and Health Statistics*. PHS Pub. No. 1000-Series 1-No. 8. Public Health Service. Washington. U.S. Government Printing Office, Sept. 1969.

[5]National Center for Health Statistics: Height and weight of youths 12-17 years, United States. *Vital and Health Statistics*. Series 11-No. 124. DHEW Pub. No. (HSM) 73-1606. Health Services and Mental Health Administration. Washington. U.S. Government Printing Office, Jan. 1973.

[6]National Center for Health Statistics: Body weight, stature, and sitting height: White and Negro youths 12-17 years, United States. *Vital and Health Statistics*. Series 11-No. 126. DHEW Pub. No. (HRA) 74-1608. Health Resources Administration. Washington. U.S. Government Printing Office, Aug. 1973.

[7]National Center for Health Statistics: Skinfold thickness of youths 12-17 years, United States. *Vital and Health Statistics*. Series 11-No. 132. DHEW Pub. No. (HRA) 74-1614. Health Resources Administration. Washington. U.S. Government Printing Office, 1974.

[8]National Center for Health Statistics: Hematocrit values of youths 12-17 years, United States. *Vital and Health Statistics*. Series 11-No. 146. DHEW Pub. No. (HRA) 75-1628. Health Resources Administration. Washington. U.S. Government Printing Office, Dec. 1974.

[9]National Center for Health Statistics: Serum uric acid values of youths 12-17 years, United States. *Vital and Health Statistics*. Series 11-No. 152. DHEW Pub. No. (HRA) 76-1634. Health Resources Administration. Washington. U.S. Government Printing Office, Aug. 1975.

[10]Herskowits, M.J.: *The American Negro; a Study in Racial Crossing*. New York. Alfred A. Knopf, 1928.

[11]Glass, B., and Li, C.C.: The dynamics of racial intermixture—an analysis based on the American Negro. *Am.J.Hum.Genet.* 5(1):1-20, Mar. 1953.

[12]Roberts, D.F.: The dynamics of racial intermixture in the American Negro: Some anthropological considerations. *Am.J.Hum.Genet.* 7(4):361-367, Dec. 1955.

[13]Roberts, D.F., and Hiorns, R.W.: The dynamics of racial intermixture. *Am.J.Hum.Genet.* 14(3):261-277, Sept. 1962.

[14]Reed, T.E.: Caucasian genes in American Negroes. *Science* 165(3895): 762-768, Aug. 22, 1969.

[15]Eavenson, E., Grier, O.T., Cisson, J.G. and Witter, R.F.: A semiautomated procedure for the determination of serum cholesterol using the Abell-Kendall method. *J. Am. Oil Chem. Soc.* 43(12):652-656, 1966.

[16]Henry, Richard J.: *Clinical Chemistry, Principles and Technics*. New York. Hoeber Medical Division, Harper & Row, 1965.

[17]Fredrickson, D.S., and Levy, R.I.: "Familial hyperlipoproteinemia," in J.B. Stanbury, J.B. Wyngaarden, and D.S. Fredrickson, eds., *The Metabolic Basis of Inherited Disease*, 3rd ed. New York. McGraw-Hill Book Co., 1972. pp. 545-614.

[18]Sherwin, R.: The epidemiology of atherosclerosis and coronary heart disease. *Postgrad. Med.* 56(6):81-87, 1974.

[19]Smith, E.B.: Intimal and medial lipids in human aortas. *Lancet*, Vol. 1, Part II: 799-803, Apr.-June, 1960.

[20]Smith, E.B.: The influence of age and atherosclerosis on the chemistry of aortic intima. Part I. The Lipids. *J.Atheroscler. Res.* 5:224-240, 1965.

[21]Kannel, W.B., and Gordon, T., eds.: Means at each examination and inter-examination variations of specified characteristics. Section 29, *The Framingham Study*, exam 1-exam. 10. DHEW Pub. No. (NIH) 74-478, Dec. 1973.

[22]Carlson, L.A., and Böttiger, L.E.: Ischaemic heart-disease in relation to fasting values of plasma triglycerides and cholesterol: Stockholm Prospective Study. *Lancet*, Vol. 1, Part II: 865-868, Apr.-June, 1972.

[23]Holman, R.L., *et al.*: The natural history of atherosclerosis: The early aortic lesions as seen in New Orleans in the middle of the 20th century. *Am.J.Path.* 34(2):209-236, Mar. 1958.

[24]Enos, W.F., Holmes, R.H., and Beyer, J.: Coronary disease among United States soldiers killed in action in Korea. Preliminary Report. *J.A.M.A.* 152(12):1090-1093, July 1953.

[25]Johnson, B.C., Epstein, F.H., and Kjelsberg, M.O.: Distributions and familial studies of blood pressure and serum cholesterol levels in a total community—Tecumseh, Michigan. *J.Chron.Dis.* 18, 147-160, Feb. 1965.

[26]Adlersberg, D.A., Schaefer, L.E., Steinberg, A.G., and Wang, C.-I.: Age, sex, serum lipids, and coronary atherosclerosis. *J.A.M.A.* 162(7):619-622, Oct. 1956.

[27]Milligan, C.A., Wilcox, E.B., and Galloway, L.S.: Serum cholesterol and physical characteristics of pre-adolescents and adolescents. *J.Am.Diet.Assoc.* 49(4): 309-315, Oct. 1966.

[28]Clarke, R.P., *et al.*: Interrelationships between plasma lipids, physical measurements, and body fatness of adolescents in Burlington, Vermont. *Am.J.Clin.Nutr.* 23(6):754-763, June 1970.

[29]Hames, C.G., and Greenberg, B.G.: A comparative study of serum cholesterol levels in school children and their possible relation to atherogenesis. *Am.J. Public Health* 51(3):374-385, Mar. 1961.

[30]Hickie, J.B., *et al.*: Serum cholesterol and serum triglyceride levels in Australian adolescent males. *Med. J. Aust.* 1, 825-828, 1974.

[31]Godfrey, R.C., Stenhouse, N.S., Cullen, K.J., and Blackman, V.: Cholesterol and the child: Studies of the cholesterol levels of Busselton school children and their parents. *Aust.Paediat.J.* 8, 72-78, 1972.

[32]National Center for Health Statistics: Serum cholesterol levels of adults, United States—1960-1962. *Vital and Health Statistics.* PHS Pub. No. 1000-Series 11-No. 22. Public Health Service. Washington. U.S. Government Printing Office, Mar. 1967.

[33]Baker, H., *et al.*: Vitamins, total cholesterol, and triglycerides in 642 New York City school children. *Am.J.Clin.Nutr.* 20(8):850-857, Aug. 1967.

[34]Sievers, M.L.: Serum cholesterol levels in southwestern American Indians. *J.Chronic Dis.* 21(2):107-115, 1968.

[35]Du Plessis, J.P., Vivier, F.S., and De Lange, D.J.: The biochemical evaluation of the nutrition status of urban school children aged 7-15 years: Serum cholesterol and phospholipid levels and serum and urinary amylase activities. *South African Medical Journal.* 41, 1216-22, 1967.

[36]Mayo, O., Fraser, G.R., and Stamatoyannopoulos, G.: Genetic influences on serum cholesterol in two Greek Villages. *Hum. Hered.* 19, 86-99, 1969.

[37]Rifkind, B.M., *et al.*: Study of serum lipid levels in twins. *Cardiovasc.Res.* 2, 148-156, 1968.

[38]National Center for Health Statistics: Sample design and estimation procedures for a national health examination survey of children. *Vital and Health Statistics.* Series 2-No. 43. DHEW Pub. No. (HRA) 74-1005. Health Resources Administration. Washington. U.S. Government Printing Office, Aug. 1971.

[39]National Center for Health Statistics: Replication: An approach to the analysis of data from complex surveys. *Vital and Health Statistics.* PHS Pub. No. 1000-Series 2-No. 14. Public Health Service. Washington. U.S. Government Printing Office, Apr. 1966.

LIST OF DETAILED TABLES

Table 1. Estimated number of youths aged 12-17 years in the population, by cholesterol group, sex, and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Estimated number of youths in population in thousands											
All groups	2,032	2,006	1,951	1,900	1,836	1,764	1,970	1,946	1,901	1,851	1,789	1,746
Under 100 mg percent ..	-	8	6	4	6	11	7	-	5	6	-	4
100-109 mg percent	3	3	19	16	14	15	10	-	3	11	-	-
110-119 mg percent	17	24	47	45	51	32	17	15	37	14	18	10
120-129 mg percent	43	65	59	57	71	68	20	53	75	19	37	31
130-139 mg percent	86	116	143	171	139	113	83	97	104	105	83	28
140-149 mg percent	136	224	228	210	210	194	131	185	142	181	173	115
150-159 mg percent	179	251	243	271	252	232	201	240	222	222	232	204
160-169 mg percent	269	255	289	290	276	242	317	245	227	218	179	222
170-179 mg percent	291	273	227	230	250	221	299	246	257	287	280	273
180-189 mg percent	287	217	226	229	229	198	279	236	278	239	232	214
190-199 mg percent	220	184	179	130	137	160	226	170	184	197	187	165
200-209 mg percent	183	94	102	77	56	92	141	159	142	116	87	144
210-219 mg percent	113	120	78	70	64	98	81	126	88	101	98	115
220-229 mg percent	85	70	44	23	26	37	85	78	60	52	82	51
230-239 mg percent	52	37	27	36	21	22	30	44	24	21	61	42
240-249 mg percent	25	29	16	25	13	7	18	38	17	23	10	52
250-259 mg percent	11	21	11	3	7	6	17	6	8	10	7	30
260-269 mg percent	5	5	3	9	8	7	3	5	16	5	9	12
270 mg percent and over .	27	10	6	4	7	10	4	3	13	22	15	33

Table 2. Percent distribution of youths aged 12-17 years by cholesterol group, according to sex and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Percent distribution											
All groups	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 100 mg percent ..	-	0.4	0.3	0.2	0.3	0.6	0.3	-	0.3	0.3	-	0.2
100-109 mg percent	0.2	0.1	1.0	0.9	0.8	0.8	0.5	-	0.2	0.6	-	-
110-119 mg percent	0.8	1.2	2.4	2.4	2.8	1.8	0.9	0.7	2.0	0.8	1.0	0.6
120-129 mg percent	2.1	3.2	3.0	3.0	3.9	3.9	1.0	2.7	4.0	1.0	2.1	1.8
130-139 mg percent	4.2	5.8	7.3	9.0	7.6	6.4	4.2	5.0	5.5	5.7	4.6	1.6
140-149 mg percent	6.7	11.2	11.7	11.1	11.4	11.0	6.6	9.5	7.4	9.8	9.7	6.6
150-159 mg percent	8.8	12.5	12.4	14.3	13.7	13.2	10.2	12.3	11.7	12.0	12.9	11.7
160-169 mg percent	13.2	12.7	14.8	15.3	15.0	13.7	16.1	12.6	11.9	11.8	10.0	12.7
170-179 mg percent	14.3	13.6	11.6	12.1	13.6	12.5	15.2	12.7	13.5	15.5	15.6	15.6
180-189 mg percent	14.1	10.8	11.6	12.1	12.5	11.2	14.2	12.1	14.6	12.9	13.0	12.2
190-199 mg percent	10.8	9.2	9.2	6.8	7.4	9.1	11.5	8.7	9.7	10.6	10.4	9.5
200-209 mg percent	9.0	4.7	5.2	4.1	3.1	5.2	7.1	8.1	7.4	6.3	4.9	8.3
210-219 mg percent	5.5	6.0	4.0	3.7	3.5	5.6	4.1	6.5	4.6	5.5	5.5	6.6
220-229 mg percent	4.2	3.5	2.2	1.2	1.4	2.1	4.3	4.0	3.1	2.8	4.6	2.9
230-239 mg percent	2.5	1.9	1.4	1.9	1.2	1.2	1.5	2.3	1.3	1.1	3.4	2.4
240-249 mg percent	1.2	1.4	0.8	1.3	0.7	0.4	0.9	1.9	0.9	1.3	0.6	3.0
250-259 mg percent	0.5	1.0	0.6	0.1	0.4	0.3	0.9	0.3	0.4	0.5	0.4	1.7
260-269 mg percent	0.3	0.2	0.2	0.5	0.4	0.4	0.2	0.3	0.9	0.3	0.5	0.7
270 mg percent and over .	1.3	0.5	0.3	0.2	0.4	0.5	0.2	0.2	0.7	1.2	0.8	1.9

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

Table 3. Unweighted and weighted sample sizes, mean cholesterol, standard deviation, standard error, and selected percentiles, by sex and age: United States, 1966-70

Sex and age	n	N	$\bar{X}$	s_X	$s_{\bar{X}}$	Percentile						
						5	10	25	50	75	90	95
Male	Cholesterol in mg/100 ml											
12 years	643	2,032	181.3	29.85	1.40	137.4	146.4	160.9	179.5	199.3	219.4	232.5
13 years	626	2,006	174.7	31.19	1.17	128.3	138.4	152.8	171.8	193.2	217.3	230.5
14 years	618	1,951	169.9	30.20	1.56	125.1	134.7	149.4	167.8	188.8	207.7	221.4
15 years	613	1,900	168.5	29.84	1.40	126.3	135.4	148.5	165.5	185.4	207.6	220.5
16 years	556	1,836	167.7	28.57	1.76	123.3	134.7	149.1	165.8	184.0	201.6	217.6
17 years	489	1,764	170.8	30.36	1.70	125.3	133.7	150.4	169.1	189.8	211.6	220.4
Female												
12 years	547	1,970	178.0	27.87	0.98	135.8	143.8	161.0	176.2	194.1	214.2	225.6
13 years	582	1,946	177.7	29.46	1.74	133.4	141.5	156.0	174.7	198.5	218.8	229.6
14 years	586	1,901	175.3	31.86	1.59	125.8	137.1	155.1	173.8	192.5	212.8	226.1
15 years	503	1,851	176.8	30.26	1.59	133.8	141.5	156.1	175.3	194.3	213.4	225.6
16 years	536	1,789	178.1	30.01	1.86	136.1	143.3	156.3	175.7	196.2	221.0	231.7
17 years	469	1,746	184.5	34.16	1.31	141.0	148.4	161.8	179.2	201.8	226.6	248.5

NOTE: n = sample size; N = estimated number of youths in thousands; $\bar{X}$ = mean; s_X = standard deviation; $s_{\bar{X}}$ = standard error of the mean.

Table 4. Mean cholesterol and standard error of the mean for youths aged 12-17 years, by geographic region, sex, and age: United States, 1966-70

Sex and age	Geographic region									
	Total	North-east	Mid-west	South	West	Total	North-east	Mid-west	South	West
Male	Mean cholesterol in mg/100 ml					Standard error				
12 years	181.3	185.2	181.1	182.4	177.0	1.40	4.12	2.36	1.90	3.25
13 years	174.7	175.2	173.8	175.3	174.5	1.17	1.58	2.69	1.98	3.10
14 years	169.9	172.6	174.3	166.3	165.9	1.56	2.16	3.79	2.92	2.15
15 years	168.5	169.9	169.2	168.0	166.9	1.40	3.76	2.25	3.50	3.06
16 years	167.7	172.6	165.3	163.9	170.4	1.76	3.22	2.25	2.76	4.84
17 years	170.8	175.6	165.4	167.6	175.3	1.70	2.61	3.42	1.91	3.28
Female										
12 years	178.0	176.5	180.8	175.7	177.9	0.98	1.52	2.02	2.21	3.64
13 years	177.7	183.9	177.2	173.1	177.1	1.74	3.87	2.49	3.69	3.67
14 years	175.3	179.5	170.9	176.2	175.6	1.59	3.03	3.01	3.02	3.09
15 years	176.8	180.0	177.6	179.6	170.7	1.59	4.13	3.26	2.48	3.32
16 years	178.1	184.7	174.5	179.3	175.9	1.86	3.57	2.64	3.65	3.97
17 years	184.5	184.6	184.4	185.2	184.0	1.31	3.50	2.58	1.87	3.64

Table 5. Estimated number of white youths aged 12-17 years in the population by cholesterol group, sex, and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Estimated number of youths in population in thousands											
All groups	1,747	1,729	1,686	1,646	1,594	1,528	1,685	1,667	1,633	1,594	1,542	1,502
Under 100 mg percent ..	-	8	6	4	6	11	7	-	2	6	-	4
100-109 mg percent	3	-	17	14	14	15	10	-	3	11	-	-
110-119 mg percent	17	20	43	45	37	32	14	12	27	8	18	8
120-129 mg percent	35	55	56	49	64	54	20	42	66	19	23	28
130-139 mg percent	81	102	125	157	132	101	70	92	98	85	78	23
140-149 mg percent	118	211	208	195	201	168	102	162	118	167	159	88
150-159 mg percent	161	201	216	257	233	195	176	212	204	199	197	173
160-169 mg percent	212	230	258	237	225	232	270	214	180	177	157	187
170-179 mg percent	266	241	190	178	218	190	246	223	221	251	250	263
180-189 mg percent	253	205	168	200	186	178	242	213	245	203	202	199
190-199 mg percent	193	160	160	107	110	133	208	131	160	180	148	129
200-209 mg percent	160	69	88	58	47	73	123	129	121	90	67	132
210-219 mg percent.....	92	104	69	54	57	74	68	98	73	93	91	90
220-229 mg percent	63	39	28	23	18	32	68	62	51	40	68	42
230-239 mg percent	42	34	27	31	18	19	28	35	21	14	51	28
240-249 mg percent	21	22	13	25	9	7	12	35	12	19	6	38
250-259 mg percent	8	11	8	3	7	6	14	3	3	10	5	27
260-269 mg percent	3	5	3	9	8	4	3	-	13	5	7	12
270 mg percent and over	19	10	3	3	7	3	4	3	13	19	15	30

Table 6. Estimated number of Negro youths aged 12-17 years in the population by cholesterol group, sex, and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Estimated number of youths in population in thousands											
All groups	280	262	256	241	231	225	272	275	266	235	243	237
Under 100 mg percent	-	-	-	-	-	-	-	-	3	-	-	-
100-109 mg percent	-	3	2	2	-	-	-	-	-	-	-	-
110-119 mg percent	-	3	4	-	14	-	3	2	10	6	-	2
120-129 mg percent	8	10	3	9	7	14	-	7	10	-	14	3
130-139 mg percent	5	14	18	14	4	12	13	5	5	21	5	6
140-149 mg percent	18	13	20	16	9	26	29	23	24	12	14	26
150-159 mg percent	18	38	27	14	19	37	25	28	18	18	35	31
160-169 mg percent	57	24	31	50	50	10	47	32	47	31	22	31
170-179 mg percent	24	29	34	52	33	31	53	23	36	37	30	10
180-189 mg percent	34	12	52	23	39	17	37	23	30	37	27	15
190-199 mg percent	27	24	19	23	27	24	18	39	23	17	37	36
200-209 mg percent	19	25	14	19	10	19	12	30	21	23	19	12
210-219 mg percent	21	16	8	13	8	24	13	27	15	8	7	25
220-229 mg percent	22	31	15	-	8	-	12	16	8	12	13	9
230-239 mg percent	10	3	-	5	-	3	2	9	3	7	10	14
240-249 mg percent	3	7	3	-	3	-	2	3	5	4	5	10
250-259 mg percent	3	10	3	-	-	-	3	3	5	-	2	3
260-269 mg percent	3	-	-	-	-	2	-	5	3	-	2	-
270 mg percent and over	8	-	2	2	-	6	-	-	-	3	-	2

Table 7. Percent distribution of white youths aged 12-17 years by cholesterol group, according to sex and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Percent distribution											
All groups	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 100 mg percent ..	-	0.5	0.3	0.3	0.4	0.7	0.4	-	0.1	0.4	-	0.3
100-109 mg percent	0.2	-	1.0	0.9	0.9	1.0	0.6	-	0.2	0.7	-	-
110-119 mg percent	1.0	1.2	2.5	2.7	2.3	2.1	0.8	0.7	1.7	0.5	1.2	0.5
120-129 mg percent	2.0	3.2	3.3	3.0	4.0	3.6	1.2	2.5	4.0	1.2	1.5	1.9
130-139 mg percent	4.6	5.9	7.4	9.5	8.3	6.6	4.2	5.5	6.0	5.3	5.0	1.5
140-149 mg percent	6.8	12.2	12.3	11.8	12.6	11.0	6.1	9.7	7.2	10.4	10.3	5.9
150-159 mg percent	9.2	11.6	12.8	15.6	14.6	12.8	10.4	12.7	12.5	12.5	12.8	11.5
160-169 mg percent	12.2	13.3	15.3	14.4	14.1	15.2	16.0	12.8	11.0	11.1	10.2	12.4
170-179 mg percent	15.3	13.9	11.3	10.8	13.7	12.4	14.6	13.4	13.5	15.7	16.2	17.5
180-189 mg percent	14.5	11.9	10.0	12.2	11.7	11.7	14.4	12.8	15.0	12.7	13.1	13.2
190-199 mg percent	11.1	9.2	9.5	6.5	6.9	8.7	12.3	7.9	9.8	11.3	9.6	8.6
200-209 mg percent	9.1	4.0	5.2	3.5	2.9	4.8	7.3	7.7	7.4	5.6	4.4	8.8
210-219 mg percent	5.3	6.0	4.1	3.3	3.6	4.9	4.1	5.9	4.5	5.8	5.9	6.0
220-229 mg percent	3.6	2.2	1.7	1.4	1.1	2.1	4.0	3.7	3.1	2.5	4.4	2.8
230-239 mg percent	2.4	2.0	1.6	1.9	1.1	1.2	1.7	2.1	1.3	0.9	3.3	1.9
240-249 mg percent	1.2	1.3	0.8	1.5	0.6	0.5	0.7	2.1	0.7	1.2	0.4	2.6
250-259 mg percent	0.4	0.6	0.5	0.2	0.4	0.4	0.8	0.2	0.2	0.6	0.3	1.8
260-269 mg percent	0.1	0.3	0.2	0.5	0.5	0.3	0.2	-	0.8	0.3	0.5	0.8
270 mg percent and over .	1.1	0.6	0.2	0.2	0.4	0.2	0.2	0.2	0.8	1.2	1.0	2.0

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

Table 8. Percent distribution of Negro youths aged 12-17 years by cholesterol group, according to sex and age: United States, 1966-70

Cholesterol group	Male						Female					
	12 years	13 years	14 years	15 years	16 years	17 years	12 years	13 years	14 years	15 years	16 years	17 years
	Percent distribution											
All groups	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 100 mg percent ..	-	-	-	-	-	-	-	-	1.1	-	-	-
100-109 mg percent	-	1.0	0.9	0.9	-	-	-	-	-	-	-	-
110-119 mg percent	-	1.3	1.5	-	6.0	-	1.1	0.8	3.6	2.6	-	1.0
120-129 mg percent	2.8	3.7	1.3	3.6	3.1	6.2	-	2.6	3.7	-	5.9	1.1
130-139 mg percent	1.8	5.2	7.0	5.8	1.7	5.5	4.9	2.0	2.0	8.7	2.1	2.3
140-149 mg percent	6.6	4.8	7.7	6.5	3.9	11.3	10.5	8.4	8.9	4.9	5.7	11.2
150-159 mg percent	6.5	14.7	10.6	5.6	8.3	16.4	9.2	10.3	6.7	7.7	14.4	13.3
160-169 mg percent	20.2	9.2	12.1	20.7	21.8	4.4	17.4	11.4	17.6	13.3	9.0	13.0
170-179 mg percent	8.7	11.0	13.3	21.5	14.1	13.7	19.7	8.4	13.5	15.7	12.5	4.2
180-189 mg percent	12.2	4.6	20.4	9.6	16.8	7.7	13.6	8.3	11.3	15.7	11.2	6.3
190-199 mg percent	9.5	9.3	7.4	9.7	11.5	10.7	6.8	14.0	8.8	7.1	15.2	15.4
200-209 mg percent	6.6	9.4	5.4	8.0	4.2	8.3	4.4	10.9	7.9	9.7	8.0	5.0
210-219 mg percent	7.4	6.2	3.2	5.2	3.4	10.5	4.8	9.9	5.7	3.6	2.8	10.6
220-229 mg percent	7.9	12.0	5.9	-	3.7	-	4.6	5.8	3.1	5.1	5.4	4.0
230-239 mg percent	3.6	1.2	-	2.1	-	1.3	0.9	3.2	1.0	2.9	4.2	5.9
240-249 mg percent	1.2	2.6	1.1	-	1.4	-	0.9	0.9	1.9	1.7	1.9	4.4
250-259 mg percent	1.1	3.8	1.1	-	-	-	1.3	1.1	2.0	-	0.7	1.3
260-269 mg percent	1.0	-	-	-	-	1.1	-	1.8	1.1	-	1.0	-
270 mg percent and over .	2.8	-	0.9	0.8	-	2.8	-	-	-	1.3	-	1.0

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

Table 9. Unweighted and weighted sample sizes, mean cholesterol, standard deviation, standard error, and selected percentiles, by race, sex, and age: United States, 1966-70

Race, sex, and age	n	N	$\bar{X}$	s_X	$s_{\bar{X}}$	Percentile						
						5	10	25	50	75	90	95
White male	Cholesterol in mg/100 ml											
12 years	540	1,747	180.2	29.22	1.59	137.3	146.0	160.3	178.7	197.3	216.1	231.1
13 years	542	1,729	173.5	30.40	1.26	130.7	138.2	152.1	171.3	191.3	214.4	228.9
14 years	527	1,686	168.8	29.57	1.46	124.1	133.6	148.4	165.8	188.2	206.4	220.0
15 years	525	1,646	167.3	29.46	1.48	125.7	134.6	147.0	163.3	184.6	207.4	221.6
16 years	496	1,594	166.7	28.59	1.75	124.0	134.7	147.8	164.7	183.5	201.0	216.1
17 years	417	1,528	169.7	29.62	1.40	123.0	133.8	150.3	168.4	187.2	209.1	219.6
White female												
12 years	455	1,685	178.0	27.97	1.23	135.3	144.0	161.2	176.6	194.7	213.8	225.6
13 years	490	1,667	176.6	28.92	1.82	133.6	141.2	155.4	173.8	196.8	217.6	228.5
14 years	484	1,633	175.0	31.75	1.67	126.9	137.0	154.8	173.5	192.2	212.2	224.4
15 years	425	1,594	176.5	30.27	1.58	134.4	141.5	155.7	175.2	193.7	213.0	223.8
16 years	441	1,542	177.7	29.91	2.02	136.9	143.3	155.9	175.0	195.2	220.3	231.5
17 years	393	1,502	184.2	33.97	1.23	141.2	149.3	162.7	178.7	201.1	224.3	248.6
Negro male												
12 years	101	280	187.2	33.02	3.01	141.1	148.8	163.0	183.4	209.1	229.4	241.8
13 years	80	262	183.1	35.41	3.80	126.8	138.6	155.2	177.0	210.8	228.5	242.2
14 years	88	256	176.9	33.62	4.74	134.1	137.7	158.3	174.8	190.6	217.7	227.5
15 years	84	241	175.6	31.50	3.04	134.3	139.1	161.9	173.3	190.6	207.2	218.6
16 years	57	231	173.3	26.64	4.46	118.8	138.5	159.8	174.0	186.4	206.3	218.2
17 years	69	225	176.8	33.94	6.44	127.9	133.0	150.2	176.2	196.4	217.8	236.4
Negro female												
12 years	88	272	175.4	25.98	3.87	138.7	143.1	158.9	172.7	187.7	213.7	224.8
13 years	91	275	185.5	31.08	3.03	138.4	145.2	161.7	187.8	207.2	225.1	235.4
14 years	101	266	177.0	32.60	2.53	122.5	138.5	158.0	174.6	194.1	215.6	239.2
15 years	73	235	179.7	30.71	4.25	131.7	136.0	161.5	178.2	199.6	221.2	231.9
16 years	93	243	180.9	30.72	2.46	127.8	142.6	158.5	180.9	199.3	224.0	231.9
17 years	74	237	185.9	34.91	4.27	140.4	146.2	157.6	184.1	215.9	234.3	245.6

NOTE: n = sample size; N = estimated number of youths in thousands; $\bar{X}$ = mean; s_X = standard deviation; $s_{\bar{X}}$ = standard error of the mean.

Table 10. Weighted sample size, mean cholesterol, and standard error of the mean for youths aged 12-17 years, by age, sex, and annual family income: United States, 1966-70

Sex and annual family income	12 years			13 years			14 years			15 years			16 years			17 years		
	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$
Male	Cholesterol in mg/100 ml																	
All incomes	2,032	181.3	1.40	2,006	174.7	1.17	1,951	169.9	1.56	1,900	168.5	1.40	1,836	167.7	1.76	1,764	170.8	1.70
Less than $3,000	180	177.2	5.57	212	176.4	5.63	200	163.8	3.66	241	164.7	5.03	201	163.9	5.00	226	178.2	3.70
$3,000-$4,999	308	179.3	3.58	264	175.1	5.10	240	171.2	5.56	219	169.4	2.99	265	163.7	4.40	245	167.0	5.08
$5,000-$9,999	869	182.7	1.95	767	173.6	2.10	746	169.8	2.24	719	166.3	1.69	719	167.3	2.31	692	169.2	1.90
$10,000 or more	575	180.5	2.00	619	175.5	1.82	597	172.2	2.60	598	172.7	2.08	516	170.7	2.92	479	171.6	2.99
Don't know	55	187.0	5.13	65	176.3	4.11	100	163.4	6.38	76	174.4	3.69	82	170.1	5.55	49	163.0	9.10
Blank or refused	46	185.4	10.92	80	171.0	5.12	67	174.1	7.06	46	153.5	6.56	55	173.4	6.92	74	176.1	8.14
Female																		
All incomes	1,970	178.0	0.98	1,946	177.7	1.74	1,901	175.3	1.59	1,851	176.8	1.59	1,789	178.1	1.86	1,746	184.5	1.31
Less than $3,000	257	172.9	3.84	268	166.9	4.31	213	164.8	4.24	258	176.4	5.13	246	178.9	3.48	182	176.7	6.15
$3,000-$4,999	274	177.5	4.33	301	179.8	2.71	300	169.5	4.22	264	173.2	3.16	166	172.8	3.22	206	194.9	7.04
$5,000-$9,999	722	177.5	2.50	802	181.3	2.31	720	180.9	1.82	700	175.3	2.32	650	177.3	2.96	586	182.9	2.43
$10,000 or more	600	180.2	2.00	494	176.2	2.68	554	176.1	2.62	533	181.0	2.57	594	179.5	2.92	628	183.0	2.29
Don't know	79	179.8	4.39	46	183.1	9.08	72	178.2	7.21	63	171.3	5.21	83	177.8	3.94	92	190.5	5.61
Blank or refused	37	183.9	42.82	35	176.2	11.03	42	157.5	11.13	32	181.7	10.17	50	188.6	11.50	52	197.5	9.69

NOTE: N = estimated number of youths in thousands; $\bar{X}$ = mean, $s_{\bar{X}}$ = standard error of the mean.

Table 11. Weighted sample size, mean cholesterol, and standard error of the mean for youths aged 12-17 years, by age, sex, and education of parent: United States, 1966-70

Sex and education of parent	12 years			13 years			14 years			15 years			16 years			17 years		
	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$
Male	Cholesterol in mg/100 ml																	
All education groups	2,032	181.3	1.40	2,006	174.7	1.17	1,951	169.9	1.56	1,900	168.5	1.40	1,836	167.7	1.76	1,764	170.8	1.70
Less than 8 years	176	177.1	4.77	175	166.8	3.79	172	161.3	5.86	196	161.8	4.10	217	164.1	4.85	208	169.4	6.00
8-11 years	543	182.3	2.89	502	176.6	3.34	474	172.2	3.27	487	167.3	2.70	474	167.0	3.00	446	171.2	3.14
12 years	736	180.5	2.04	780	175.0	2.28	730	169.1	1.47	727	170.9	1.96	630	168.6	2.90	668	169.2	2.53
13 years or more	562	182.5	2.96	527	174.6	2.24	549	172.2	2.29	472	169.6	2.28	480	169.1	2.35	388	173.4	2.11
Unknown	16	186.2	45.40	23	182.1	9.27	25	157.4	18.05	18	144.7	12.26	35	162.7	5.79	54	174.2	9.44
Female																		
All education groups	1,970	178.0	0.98	1,946	177.7	1.74	1,901	175.3	1.59	1,851	176.8	1.59	1,789	178.1	1.86	1,746	184.5	1.31
Less than 8 years	211	174.1	4.58	228	172.9	8.39	160	168.5	4.86	178	172.1	6.16	167	175.2	6.18	146	185.9	11.96
8-11 years	480	176.1	2.82	507	177.4	1.70	537	176.9	2.20	598	176.7	2.80	453	173.2	2.49	465	183.4	2.08
12 years	729	178.8	1.86	727	181.3	2.43	719	174.8	2.38	640	179.2	2.66	623	177.0	2.64	525	184.7	2.52
13 years or more	509	180.2	1.84	463	175.3	2.45	465	175.8	3.71	411	175.5	1.32	512	183.8	4.17	542	181.9	2.57
Unknown	41	176.5	10.39	22	*	*	21	194.0	29.66	22	170.8	42.38	34	195.7	25.53	67	209.1	17.72

NOTE: N = estimated number of youths in thousands; $\bar{X}$ = mean; $s_{\bar{X}}$ = standard error of the mean.

Table 12. Weighted sample size, mean cholesterol, and standard error of the mean for youths aged 12-17 years, by race, sex, annual family income, and education of parent: United States, 1966-70

Variable	Total			White			Negro		
	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$
MALE	Cholesterol in mg/100 ml								
Annual family income									
Less than $3,000	1,259	170.6	1.72	771	165.6	2.83	487	178.5	3.06
$3,000-$4,999	1,540	171.3	2.34	1,122	167.4	2.60	402	180.9	4.58
$5,000-$9,999	4,512	171.9	0.86	4,055	171.5	0.98	424	175.2	2.89
$10,000 or more	3,383	174.0	1.34	3,280	173.5	1.38	87	189.4	5.66
Education of parent									
Less than 8 years	1,145	166.7	2.13	818	164.1	2.49	322	172.9	2.70
8-11 years	2,925	173.0	1.27	2,237	170.4	1.52	671	181.6	2.49
12 years	4,271	172.4	1.10	3,913	171.5	1.11	335	181.5	3.22
13 years or more	2,977	173.8	1.11	2,822	173.5	1.04	132	178.5	4.97
FEMALE									
Annual family income									
Less than $3,000	1,424	172.7	2.50	928	171.8	3.46	495	174.4	2.85
$3,000-$4,999	1,511	177.5	2.44	1,102	175.1	2.74	400	183.7	3.42
$5,000-$9,999	4,182	179.2	1.09	3,760	178.7	1.17	407	183.5	3.22
$10,000 or more	3,404	179.5	0.97	3,258	179.2	1.03	117	185.8	5.32
Education of parent									
Less than 8 years	1,090	174.4	5.16	784	173.4	6.90	302	177.2	4.70
8-11 years	3,040	177.3	1.21	2,337	176.0	1.57	679	181.9	2.98
12 years	3,963	179.1	1.18	3,600	178.7	1.20	363	182.4	3.54
13 years or more	2,903	179.0	1.56	2,752	178.7	1.65	127	180.7	4.96

NOTE: N = estimated number of youths in thousands; $\bar{X}$ = mean; $s_{\bar{X}}$ = standard error of the mean.

Table 13. Weighted sample size, mean cholesterol, and standard error of the mean for youths aged 12-17 years, by age, race, sex, and annual family income: United States, 1966-70

Race, sex, and annual family income	12 years			13 years			14 years			15 years			16 years			17 years		
	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$
	Cholesterol in mg/100 ml																	
White male																		
All incomes	1,747	180.2	1.59	1,729	173.5	1.26	1,686	168.8	1.46	1,646	167.3	1.48	1,594	166.7	1.75	1,528	169.7	1.40
Less than $3,000	111	172.2	7.71	127	170.4	9.80	110	155.2	2.73	153	157.8	6.79	129	162.2	3.69	142	175.9	7.84
$3,000-$4,999	209	174.8	3.96	180	172.3	6.84	190	165.6	4.73	151	167.0	3.71	211	162.4	5.23	181	162.0	5.35
$5,000-$9,999	786	182.7	1.94	681	173.1	2.28	662	169.4	2.24	653	165.9	1.90	632	166.0	2.11	640	169.4	2.03
$10,000 or more	557	179.6	2.04	606	175.3	1.90	579	172.2	2.63	578	172.1	2.14	501	169.8	2.82	459	170.9	2.88
Don't know	41	186.6	6.86	58	175.4	4.62	87	162.2	7.32	64	171.3	3.54	67	167.4	6.84	37	162.8	11.08
Blank or refused	43	183.7	11.23	76	168.6	4.86	57	173.7	8.14	46	153.5	6.56	55	173.4	6.92	68	174.6	8.36
White female																		
All incomes	1,685	178.0	1.23	1,667	176.6	1.82	1,633	175.0	1.67	1,594	176.5	1.58	1,542	177.7	2.02	1,502	184.2	1.23
Less than $3,000	180	173.2	5.46	160	160.9	5.20	138	163.8	6.39	183	178.5	6.38	156	179.6	5.30	111	173.5	9.62
$3,000-$4,999	195	176.8	5.42	229	176.4	2.82	211	167.2	4.92	207	170.2	3.51	113	165.2	4.02	146	196.8	8.24
$5,000-$9,999	641	177.4	2.66	729	180.2	2.38	661	179.9	1.99	611	175.1	2.25	589	176.9	3.16	529	183.2	2.72
$10,000 or more	571	179.9	2.17	482	176.5	2.72	535	176.3	2.56	508	180.4	2.72	571	179.3	3.17	591	182.1	2.25
Don't know	63	180.3	5.28	36	179.2	10.76	51	173.8	9.30	59	171.0	5.79	69	177.5	4.26	86	191.3	6.14
Blank or refused	34	187.0	43.42	31	172.0	11.82	36	156.3	13.84	27	180.8	13.18	44	193.0	12.13	40	199.5	46.12
Negro male																		
All incomes	280	187.2	3.01	262	183.1	3.80	256	176.9	4.74	241	175.6	3.04	231	173.3	4.46	225	176.8	6.44
Less than $3,000	69	185.2	7.82	85	185.4	6.86	89	174.5	5.16	88	176.7	6.20	72	166.9	10.81	85	182.0	10.55
$3,000-$4,999	96	188.4	8.55	80	182.3	4.13	50	192.3	12.95	65	172.3	5.17	54	168.6	3.84	58	177.7	12.30
$5,000-$9,999	81	182.0	7.30	78	179.1	7.91	78	171.9	8.60	59	170.2	7.73	80	178.0	7.40	48	164.3	10.67
$10,000 or more	18	206.4	8.40	9	*	*	15	171.2	13.71	17	189.8	14.29	10	*	*	17	187.2	12.65
Don't know	14	188.1	42.62	6	*	*	13	171.2	6.81	12	*	*	15	*	*	12	163.6	40.21
Blank or refused	2	*	*	3	*	*	11	*	*	—	—	—	—	—	—	6	*	*
Negro female																		
All incomes	272	175.4	3.87	275	185.5	3.03	266	177.0	2.53	235	179.7	4.25	243	180.9	2.46	237	185.9	4.27
Less than $3,000	77	172.4	4.06	108	175.8	4.91	75	166.7	3.80	75	171.2	9.21	89	177.6	2.57	71	181.7	5.66
$3,000-$4,999	75	176.9	6.49	72	190.4	7.86	89	174.9	7.09	53	185.8	5.59	52	189.3	8.01	60	190.4	9.75
$5,000-$9,999	81	178.3	8.51	74	192.6	6.31	57	192.0	9.29	81	179.0	9.14	57	180.2	5.48	58	180.2	7.42
$10,000 or more	19	171.4	8.93	9	182.9	14.69	19	172.7	20.08	17	200.2	10.62	23	183.8	13.58	30	197.5	11.59
Don't know	16	*	*	9	*	*	21	188.9	9.82	3	*	*	14	179.2	8.08	6	*	*
Blank or refused	4	*	*	4	*	*	6	*	*	6	*	*	7	*	*	12	190.9	18.72

NOTE: N = estimated number of youths in thousands; $\bar{X}$ = mean; $s_{\bar{X}}$ = standard error of the mean.

Table 14. Weighted sample size, mean cholesterol, and standard error of the mean for youths aged 12-17 years, by age, race, sex, and education of parent: United States, 1966-70

Sex and education of parent	12 years			13 years			14 years			15 years			16 years			17 years		
	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$	N	$\bar{X}$	$s_{\bar{X}}$
White male	Mean cholesterol in mg/100 ml																	
All education groups	1,747	180.2	1.59	1,729	173.5	1.26	1,686	168.8	1.46	1,646	167.3	1.48	1,594	166.7	1.75	1,528	169.7	1.40
Less than 8 years	119	173.6	5.67	104	162.5	3.04	145	159.9	6.44	139	160.5	5.85	169	161.3	4.96	143	168.3	8.34
8-11 years	412	178.7	3.06	391	175.2	3.72	341	167.8	3.09	380	164.3	3.49	371	167.3	2.40	342	167.6	2.87
12 years	675	180.3	2.31	713	173.5	2.43	662	168.6	1.46	652	169.5	1.92	580	167.4	3.13	632	168.8	2.63
13 years or more	528	182.8	2.95	501	174.2	2.47	523	172.2	2.21	461	169.2	2.24	446	167.9	2.19	363	173.0	2.07
Unknown	13	*	*	19	177.4	9.75	14	*	*	14	149.5	13.96	28	158.6	5.44	49	175.0	11.41
White female																		
All education groups	1,685	178.0	1.23	1,667	176.6	1.82	1,633	175.0	1.67	1,594	176.5	1.58	1,542	177.7	2.02	1,502	184.2	1.23
Less than 8 years	165	173.3	7.04	182	172.2	8.01	107	166.3	6.93	127	170.1	9.25	106	176.1	9.93	96	185.4	19.16
8-11 years	379	174.9	3.08	356	174.8	2.28	429	175.9	2.54	479	176.8	2.69	349	171.3	2.92	344	182.3	2.42
12 years	650	179.5	2.15	661	180.2	2.46	648	174.6	2.36	578	179.0	2.82	572	176.0	2.75	491	184.1	2.46
13 years or more	464	180.3	2.14	452	174.4	2.56	440	176.0	3.87	391	174.8	1.43	490	183.3	4.50	515	181.9	2.48
Unknown	26	177.3	15.77	16	*	*	9	*	*	20	*	*	24	200.7	28.73	55	217.2	23.21
Negro male																		
All education groups	280	187.2	3.01	262	183.1	3.80	256	176.9	4.74	241	175.6	3.04	231	173.3	4.46	225	176.8	6.44
Less than 8 years	57	184.6	5.25	71	173.1	7.00	27	168.8	39.68	57	165.0	4.43	48	173.8	8.61	62	170.6	7.77
8-11 years	130	193.5	7.43	102	183.4	4.92	130	183.6	7.94	103	176.8	4.08	103	165.9	10.28	104	183.1	7.71
12 years	58	180.8	5.11	64	192.7	8.79	68	173.9	9.17	69	184.0	6.53	46	182.3	7.43	31	169.6	10.49
13 years or more	32	175.4	10.09	23	182.3	8.06	20	170.3	12.63	8	*	*	27	183.7	11.79	23	178.1	17.80
Unknown	3	*	*	3	*	*	11	*	*	3	*	*	7	*	*	6	*	*
Negro female																		
All education groups	272	175.4	3.87	275	185.5	3.03	266	177.0	2.53	235	179.7	4.25	243	180.9	2.46	237	185.9	4.27
Less than 8 years	46	177.2	2.06	46	175.6	13.66	53	173.1	3.45	47	178.0	4.41	61	173.5	6.59	50	187.0	12.64
8-11 years	96	178.8	7.21	147	185.1	5.57	106	180.5	3.85	109	178.1	7.27	104	179.3	3.82	117	187.5	5.76
12 years	79	173.3	9.40	65	192.2	5.13	71	176.5	6.37	63	180.4	8.45	50	187.7	6.79	35	192.7	11.78
13 years or more	35	168.5	7.32	11	*	*	25	171.5	13.40	14	196.5	16.20	18	*	*	24	173.4	7.27
Unknown	15	175.0	12.16	5	*	*	12	*	*	3	*	*	10	*	*	12	*	*

NOTE: N = estimated number of youths in thousands; $\bar{X}$ = mean; $s_{\bar{X}}$ = standard error of the mean.

Table 15. Mean cholesterol levels and standard deviations of the population distribution for adults, by sex and age: United States, 1960-62

Age	Men		Women	
	$\bar{X}$[1]	s_X	$\bar{X}$[1]	$s_{\bar{X}}$
18-24 years	178.1	40.7	184.7	47.9
25-34 years	205.9	44.6	197.9	41.9
35-44 years	225.8	49.4	213.6	45.3
45-54 years	230.5	45.6	236.8	50.0
55-64 years	232.8	49.0	262.3	63.0
65-74 years	229.5	47.3	265.7	58.8
75-79 years	224.5	48.7	245.3	65.7

[1]Mg per 100 ml.
NOTE: $\bar{X}$ = mean; s_X = standard deviation.

APPENDIX I

TECHNICAL NOTES ON METHODS

The Survey Design

The sampling plan of Cycle III of the Health Examination Survey followed a multistage, stratified probability sample of clusters of households in land-based segments in which a sample of the U.S. population (including Alaska and Hawaii) aged 12 through 17 years was selected. Excluded were those youths confined to institutions and those residing on any of the reservation lands set aside for use by American Indians.

The sample design of Cycle III is similar to that of Cycle II in that it uses the same 40 sample areas and the same segments. The decision to incorporate this feature into Cycle III was not made prior to the selection of the Cycle II sample, although it is consistent with the initial concept of a single program for persons 6-17 years old. The final decision to use this identical sampling frame was made during the operation of the Cycle II program.

The successive elements for this sample design are primary sampling unit; census enumeration district; segment (a cluster of households); household; all eligible youths; and finally, the sample youth. Every eligible youth within the defined population has a known and approximately equal chance for selection into the sample.

The steps of drawing the sample were carried out jointly with the U.S. Bureau of the Census; the starting points were the 1960 decennial census lists of addresses and the nearly 1,900 primary sampling units (PSU's) into which the entire United States was divided. Each PSU is a standard metropolitan statistical area (SMSA), a county, or a group of two or three contiguous counties. These PSU's were grouped into 40 strata so that each stratum had an average size of about 4.5 million persons. This grouping maximized the degree of homogeneity of the PSU's within each strata with regard to the population size, degree of urbanization, geographic proximity to one another, and degree of industrialization. The 40 strata were then classified into four broad geographic regions of 10 strata each and, within each region, cross-classified by four population density classes and by the rates of population change from 1950 to 1960. Using a modified Goodman-Kish controlled-selection technique, one PSU was drawn from each of the 40 strata.

The sampling within the PSU's was carried out in several steps. The first step was the selection of census enumeration districts (ED's)—small, well-defined areas of about 250 housing units. The entire nation was divided into ED's for the 1960 population census, and each ED was assigned a "measure of size" equal to the rounded whole number resulting from a "division by nine" of the number of children aged 5-9 in the ED at the time of the 1960 census. A sample of 20 ED's in the sample PSU was selected according to a systematic sampling technique, with each ED having a probability of selection proportional to the population of children aged 5-9 years at the time of the 1960 census date. From each ED a random selection of one measure of size (segment) was taken.

Minor changes required in the Cycle III design were (1) that it be supplemented for new construction to a greater extent than had been necessary in Cycle II and (2) that reserve segments be added. Although it was the plan for Cycle III to use the Cycle II segments, it was recognized that within several PSU's additional reserve segments would be needed to avoid the

risk of having an insufficient number of examinees. This was prompted by the fact that four of the PSU's in Cycle II had yields of less than 165 eligible children and several others were marginal in their yield. In addition, there was a 3-year interval between Cycle II and Cycle III, so that it was quite possible for some segments to have been completely demolished due to highway construction or urban redevelopment.

The time available for examinations at a particular location, or stand, is necessarily set far in advance of any preliminary field work at the stand. Therefore, the number of examinations that can be performed at a particular location is dependent on the number of examining days available. At the majority of locations, the number of days available, excluding Saturdays, is 17. At the rate of 12 examinations each day, this provides for 204 examination slots. Examinations are conducted on Saturdays if necessary. Because of rescheduling for cancellations or no-shows, the maximum number of youths that is considered for inclusion in the sample is 200. When the number of eligible youths exceeds the maximum, subsampling is performed to reduce the number to manageable limits. This is accomplished through the use of a master list, which is a listing of all eligible youths in order by segment, serial number (household order within segment), and column number (order in the household by age). After the subsampling rate has been determined, every nth name on the list is deleted, starting with the yth name, y being a randomly selected number between 1 and n. Youths who are deleted from the Cycle III sample but who were examined in Cycle II and any twin who may have been deleted are scheduled, if time permits, for an examination to be included only in the longitudinal study portion or twin study portion of the survey. Their data are not included in the report as part of the regular sample.

Since the strata are roughly equal in population size and a nearly equal number of sample youths were examined in each of the sample PSU's, the sample design is essentially self-weighting with respect to the target population; that is, each youth 12 through 17 years old had about the same probability of being drawn into the sample.

The adjustment upward for nonresponse is intended to minimize the impact of nonresponse on final estimates by imputing to nonrespondents the characteristics of "similar" respondents. Here "similar" respondents were judged to be examined youths in a sample PSU having the same age (in years) and sex as those not examined in that sample PSU.

The poststratified ratio adjustment used in Cycle III achieved most of the gains in precision that would have been attained if the sample had been drawn from a population stratified by age, color, and sex, and it made the final sample estimates of population agree exactly with independent controls prepared by the U.S. Bureau of the Census for the noninstitutional population of the United States as of March 9, 1968 (approximate midsurvey point) by color and sex for each single year of age 12 through 17. The sampling weight of every youth examined in each of the 24 age, race, and sex classes is adjusted upward or downward so that the weighted total within the class equals the independent population control.

A more detailed description of the sampling plan and estimation procedures is included in *Vital and Health Statistics,* Series 2-Number 43,[38] and in Series 1-Numbers 1[1], 5[3], and 8[4], which describe the plan and operation of the first three cycles of the Health Examination Survey.

Some Notes on Response Rates

As mentioned previously, the sample designs of the second and third cycles of the HES were similar. Differences did occur, however, in response rates of various subgroups of these samples, and these differences deserve some consideration here.

Most importantly, the number of youths selected for examination increased from 7,417 in Cycle II to 7,514 in Cycle III. The response rate—i.e., the number of youths selected who were actually examined—decreased from 96 percent in Cycle II to 90 percent in Cycle III. Of the youths examined in Cycle II, 13.9 percent were Negro, compared with 14.8 percent of

Note.—A list of references follows the text.

those examined in Cycle III. This difference does not reflect a difference in the percentage of Negro youths selected for examination, but rather, a smaller decrease in response rate for Negro youths between the two cycles than was the case for white youths. In actuality, 13.8 percent of the sample selected for examination was Negro in Cycle III, corresponding to 13.5 percent in Cycle II. However, whereas the response rate for white youths dropped from 95.6 percent in Cycle II to 89.1 percent in Cycle III, the response rate for Negro youths dropped far less, from 98.4 percent to 96.6 percent. Thus, relatively better response from the Negro portion of the sample in Cycle III increased their percentage of actual examinations as compared with the previous cycle.

Examination of sample sizes in this report clearly shows that at every age group, fewer females than males were actually examined. This, again, is not attributed to differences in numbers of youths selected in the sampling design, but rather to the following differential response rates between males and females:

Age	Male	Female
Total	91.4	88.7
12	93.5	91.3
13	93.2	91.9
14	91.7	90.7
15	91.6	87.9
16	89.8	87.7
17	87.6	81.8

Note that at each age group the response rate for males exceeded that for females.

A similar analysis of response rates can be done by age, race, and sex, as follows:

Age	White male	Negro male	White female	Negro female
Total	90.5	97.6	87.4	95.8
12	92.6	99.0	90.1	98.9
13	92.5	98.8	91.1	96.8
14	91.0	97.8	89.6	96.2
15	90.7	97.7	86.4	98.6
16	89.2	95.0	86.6	93.0
17	86.5	95.8	80.2	91.4

The above clearly indicates that for all ages under consideration in Cycle III of the HES, the response rate for Negro youths exceeded that for white youths of the same sex and age.

Reasons for differences in response rates are many, but may range from the incentive to get examined in order to miss a day of school, to fear of the examination itself, to inhibitions with respect to being examined. The worst response rate was recorded for the oldest females, that is, those aged 17 years.

Parameter and Variance Estimates

Because each of the 6,768 sample children has an assigned statistical weight, all estimates of population parameters presented in HES publications are computed taking this weight into consideration. Thus, $\bar{X}$, the estimate of a population mean μ is computed as follows:

$$\bar{X} = \frac{\sum_{i=1}^{n} W_i X_i}{\sum W_i}$$

where X_i is the observation or measurement taken on the ith person and W_i is the statistical weight assigned to that person.

The HES has an extremely complex sampling plan, and obviously, by the very nature of the sample, the estimation procedure is complex as well. For estimating the reliability of findings, a method is required that "reflects both the losses from clustering sample cases at two stages and the gains from stratification, ratio estimation, and poststratification."[39]

The method for estimating variances in the HES is the half-sample replication technique. The method was developed at the U.S. Bureau of the Census prior to 1957 and has at times been given limited use in the estimation of the reliability of results from the Current Population Survey. This half-sample replication technique is particularly well suited to the HES because the sample, although complex in design, is relatively small (6,768 cases) and is based on but 40 strata. This feature permitted the development of a variance estimation computer program that produces tables containing desired estimates of

aggregates, means, or distributions, together with a table identical in format but containing the estimated variance of the estimated statistics. The computations required by the method are simple, and the internal storage requirements are well within the limitation of the IBM 360-50 computer system used at the National Center for Health Statistics.

Variance estimates computed for this report were based on 20 balanced half-sample replications. A half sample was formed by choosing one sample PSU from each of 20 pairs of sample PSU's. The composition of the 20 half samples was determined by an orthogonal plan. To compute the variance of any statistic, that statistic is computed for each of the 20 half samples. Using the mean, $\bar{X}_i$, as an example, the weighted mean of the entire undivided sample ($\bar{\bar{X}}$) is computed. The variance of the mean is the mean square deviation of each of the 20 half-sample means about the overall mean. Symbolically,

$$\mathrm{Var}(\bar{\bar{X}}) = \frac{\sum_{i=1}^{20} (\bar{X}_i - \bar{\bar{X}})^2}{20}$$

and the standard error of the mean is the square root of $\mathrm{Var}(\bar{\bar{X}})$. In a similar manner the standard error of any statistic may be computed.

A detailed description of this replication process has been published in *Vital and Health Statistics,* Series 2-Number 14.[39]

Standards of Reliability and Precision

All means, variances, and percentages appearing in this report met defined standards before they were considered acceptably precise and reliable.

The rule for reporting means and percentiles consisted of two basic consecutive criteria: that a sample size be at least five; and that the estimated coefficient of variation (i.e., the standard error of the mean divided by the mean, or $(S_{\bar{\bar{X}}}/\bar{\bar{X}})$ be less than 25 percent. Thus, if the sample size was too small, or if, given adequate sample size, the variation with respect to the mean was too large, then the estimate was considered neither precise nor reliable enough to meet the standards established for publication.

Imputation

In addition to the subject nonresponse discussed above, the problem of item nonresponse merits consideration here. In this situation, information about a respondent is complete with the exception of a missing cholesterol value.

A regression method was initially chosen for the imputation of missing cholesterol values. If other variables could have been found which correlated with cholesterol, this other information could have been effectively used in a regression scheme of imputation. Two "best possible" predictor variables were chosen in triceps and subscapular skinfolds. After standardizing these two variables by age, race, and sex group, a regression was run. However, the resultant multiple R of 0.1316 was not considered to be sufficiently high to justify a regression approach to replacing missing cholesterol values.

Instead, the technique of replacing a missing datum by the value recorded for a randomly selected respondent of the same age, sex, and race was employed. When only one of the two cholesterol values was missing, the recorded measurement was substituted for the unknown value. This occurred in only one instance. Imputation where there was no value recorded for examinees was necessary in 175 cases (i.e., for 2.6 percent of total respondents).

APPENDIX II

DEMOGRAPHIC VARIABLES

Regional and demographic characteristics by which the population has been classified for this report are defined as follows:

Age and sex.—Population was classified into 12 age-sex groups—the six ages 12-17 years by sex. Birth certificates verified the age of 92 percent of the youths. Age stated by the parents was accepted as the true age for the other 8 percent. Age is expressed as years attained at last birthday.

Race.—Serum cholesterol value was reported by race for white and Negro youths. Youths of other races were not sampled sufficiently for comparison purposes and represented only 0.55 percent of the sample.

Region.—Regional data are presented for four regions of the continental United States.

Region	*States Included*
Northeast	Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey
Midwest	Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana, Ohio
South	Delaware, Maryland, Virginia, District of Columbia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana
West	Washington, Oregon, Idaho, Montana, North Dakota, South Dakota, Wyoming, Nebraska, Kansas, Colorado, Utah, Nevada, California, Arizona, New Mexico, Texas, Oklahoma, Alaska, Hawaii

Family income.—The income recorded was the total income received during the past 12 months by the head of the household and all other household members related to the head by blood, marriage, or adoption. This income was the gross cash income (excluding pay in kind) except in the case of a family with its own farm or business, in which case net income was recorded.

Education of parent or guardian.—This item was recorded as the highest grade that had been completed in school. The only grades counted were those that had been completed in a regular school in which persons were given formal education: graded or private schools, either day or night schools, with either full-time or part-time attendance. A "regular" school is one that advances a person toward an elementary or high school diploma, or a college, university, or professional school degree. Education in vocational, trade, or business schools outside the regular school system was not counted in determining the highest grade of school completed.

APPENDIX III

TECHNIQUES OF MEASUREMENT AND QUALITY CONTROL

MEASUREMENT

The HES Blood-Drawing Technique and Its Historical Development

For a variety of reasons, it was decided not to attempt to draw blood specimens from children 6-11 years of age in Cycle II. The children included in the national probability sample came from all regions of the country and all cultural and socioeconomic groupings and ways of life. It was assumed, therefore, that some had never been to a physician before and that others would have very bad memories of and associations with such visits. In addition, because the sample covered the entire spectrum of behavioral and physical development extant in the United States, severe technical and behavioral problems resulting from immaturity of 6- and 7-year-olds would be likely. It was believed that fear or extreme distaste for having a blood sample drawn on the part of many potential subjects might severely affect the response rate, which is so crucial to a survey like this. When it is remembered that the overall response rate for Cycle II was a remarkable 96 percent, it is difficult to argue with this line of reasoning. Now, of course, it can never be known how great a diminution of the response rate would have been caused by the inclusion of a blood sample from younger children in Cycle II.

In the early planning stages of Cycle III, it was decided to obtain a blood specimen from the youths 12-17 years if at all feasible, that is, primarily if the price in terms of diminished response rate and cooperation of the examinees would not be too high. Accordingly, in three separate pretests, investigations were conducted regarding the problem of developing a satisfactory blood-collection technique for this age group and examination setting. What was desired was to draw the optimum amount of blood, without causing emotional upset to the examinee, or without affecting his performance in any of the procedures to follow. The amount of usable blood that could be drawn posed a limiting factor on the number of blood chemistry tests that could be performed and greatly influenced the acceptance or rejection of an entire possible area of the examination, such as the nutritional assessment. Logistical problems also had to be resolved involving the handling, separating, and packaging of drawn blood so that there would be a minimum of blood loss and packaging error. For the refrigerated but unfrozen blood, time from shipment to delivery was critical; therefore, arrangements had to be made with postal authorities to assure prompt delivery to the laboratories in order to avoid spoilage.

There was a trial-and-error process, and there was good advice and help from many sources in developing a satisfactory blood-drawing technique. The chief sources of help, outside of the immediate HES technical staff, were Dr. Wilma Bias and Dr. Bernice Cohen of The Johns Hopkins University; Dr. Gerald Cooper, Chief of Laboratories, Center for Disease Control, Public Health Service, Atlanta, Ga.; the many teenage subjects during our pretest who gave valuable suggestions and who pointed out, either as overt advice or by their immediate reactions, specific

points to be avoided; and, finally, the professional and technical division of the Becton-Dickinson Company, Rutherford, N.J. The latter, through several personal visits by a representative of their technical division, not only gave excellent technical advice on blood-collection techniques and the use of alternative equipment, but also devised a special fitting that made the transfer from one vacutainer tube to another much smoother.

During the pretesting, it was learned that many subjects did not like to see any part of the blood-drawing procedure, including their own blood in tubes. Therefore, a technique was employed that minimized the subject's attention to the operation. Effective screening was achieved by having the subject lie down and by draping and keeping the arm and tubes well below the level of the examination table. After the skin area was cleansed with alcohol, the blood was drawn from the antecubital fossa by the physician-nurse team. At the discretion of the physician, a tourniquet was used to fill the vein; however, once the needle was inserted into the vein, the tourniquet was taken off the arm so that the blood flowed freely.

A B-D blood culture needle and tube were used to draw blood. Using the specially prepared link fitting, the nurse inserted the short needle into a vacutainer tube holder. The tube was clamped with a hemostat until the vein was punctured and the vacutainer was inserted into the holder.

From the one free-flowing venipuncture, a total of only 55 cm^3 of blood was collected in four separate vacutainer tubes from all male and almost half of the female subjects. (The difference was that all males had a separate specimen drawn to be frozen and stored as plasma for future testosterone determination and almost half of the females provided a replicate blood specimen for quality control of the laboratory determinations; the remaining females had 40 cm^3 drawn.)

Each test tube was labeled with the examinee's number and left in the test-tube holding rack at room temperature for 1 hour. The nurse then placed the tubes in the laboratory refrigerator, along with 10 extra examinee identification labels for use by the technicians.

An analysis that attempts to estimate the impact of the addition of a blood sample on the Cycle III sample response rate is in progress.

Cholesterol Chemistry Determinations

The serum samples were shipped to the Lipid Standardization Laboratory at the Center for Disease Control in Atlanta, Ga., where they were kept frozen until assay.

After being thawed, samples were divided and stored in two vials. All sample vials were then randomized over a 6-day period so that a pair of duplicate samples might have been analyzed on the same day or as many as 6 days apart.

A semiautomated method based on the Abell-Kendall procedure was employed to measure total cholesterol. Determinations were carried out on an assembly-line basis so that two analysts could analyze more than 120 samples in duplicate per day.

MONITORING SYSTEMS

In addition to the sampling considerations already discussed, the quality of data collected is also a special concern. One of the main purposes of the monitoring system employed in the survey was to indicate whether the measurements produced by our measurement process attained the desired quality. A second major purpose was to make possible quantitative summary descriptions of residual measurement errors to aid in the interpretation of survey data.

The monitoring system as applied to the taking of blood samples consisted of a formal system of replicate examinations (described later in this appendix). Replicate measurements are useful for a variety of reasons; for example, as a means of increasing precision of estimates of individual measurements, as a training technique, and as a monitoring system that includes the objective of overall evaluation of measurement errors. These objectives are not incompatible, and replicate data collected primarily for one of these objectives often indirectly, if not directly, accomplish one or both of the remaining two. For this reason replicate data are most often collected with a combination of these objectives in mind.

Methods of Taking Replicate Measurements

A major source of uncertainty in estimates derived from replicate measurements is in the inability to make the replicate measurement under precisely the same conditions and in the same manner as the original measurement. This uncertainty is difficult to evaluate, and most attempts are restricted to subjective statements concerning the direction and/or size of the bias and the need for concern in the analysis of data.

In this study two extra blood samples were drawn from a subsample of Cycle III examinees and were included in the shipment sent for processing to the Lipid Standardization Laboratory at the Center for Disease Control in Atlanta, Ga. Replicate blood samples were taken from the same venipuncture as the regular blood samples and, from shipment to final processing at the CDC, were treated the same as the original samples. These replicates were labeled with dummy examination identification numbers and were recorded by the nurse in a replicate log book. All samples were submitted for laboratory analysis with no indication that any two samples came from the same examinee. Each replicate was analyzed as usual, where each sample was split by the technician and duplicate determinations were performed; if a difference greater than 9 mg/100 ml was found (it was usually a reading or recording error), a second set of duplicate determinations was performed. The analyses of replicates and originals were performed under identical laboratory conditions by the same technician in a true double-blind manner.

Cycle III examinees were chosen systematically for replicate blood determinations. On every third day for the first 15 days of each examination center, two extra blood samples were drawn (preferably from girls) for the replicate study. Since in a voluntary survey it is impossible to follow a statistically random process in scheduling subjects, the replicate design did not ensure that its subjects would be "representative" of those in the larger Cycle III Health Examination Survey. It is felt, however, that this is not a crucial issue since the matter of concern in undertaking the replicate study is not the determination of possible differences in the values of the measurements, but rather the determination of possible differences in errors associated with the measurements.

Results of the Replicate Study for Cholesterol

Two readings were made of the original split sample obtained for each of the 6,592 examinees (97 percent of the total sample) by the same technician. An extra blood sample was drawn for replicate studies on 424 examinees, of which 98 percent were adequate.

Frequency and percent distributions of the absolute differences between the duplicated determinations on the original specimen and also between the duplicated determinations on the replicate and original specimens are presented in table I. The first two columns represent the differences between the duplicated determinations on the original specimen; the second two columns represent the differences between the first recorded determination values of the original specimen and that of the replicate specimen; and the third two columns represent differences between the second (or duplicated) recorded values of the original and replicate specimens.

As a summary statistic of the distribution of differences between replicate and original cholesterol determinations presented in table I, we have computed V, the percentage technical error of measurement which is given by

$$V = \frac{100}{\bar{X}} \sqrt{\frac{\sum_{i=1}^{n} d_i^2}{2n}}$$

where

n is the number of pairs of measurements in the study,

d_i^2 is the square of the difference between members of the ith pair of measurements (i=1,...,n), and

$\bar{X}$ is the arithmetic mean of the $2n$ measurements in the study.

The percentage technical error, V, can be interpreted as a "coefficient of variation" and is a

Table I. Frequency and percent distribution of absolute differences between duplicated determinations of original specimens and between original and replicated specimens

Absolute difference (mg/100 ml)	Difference between duplicated determinations of original specimens		Difference between original and replicated specimens			
			First determinations		Second determinations	
	Frequency	Percent of total	Frequency	Percent of total	Frequency	Percent of total
Total	6,592	100.0	408	100.0	407	100.0
0	996	15.1	32	7.8	35	8.6
1	1,285	19.5	46	11.3	46	11.3
2	1,037	15.7	57	14.0	37	9.1
3	881	13.4	40	9.8	43	10.6
4	752	11.4	52	12.7	42	10.3
5	510	7.7	34	8.3	34	8.4
6	390	5.9	14	3.4	25	6.1
7	308	4.7	21	5.1	27	6.6
8	225	3.4	29	7.1	22	5.4
9	141	2.1	16	3.9	17	4.2
10	43	0.7	3	0.7	15	3.7
11	1	-	5	1.2	12	2.9
12	4	0.1	14	3.4	11	2.7
13	4	0.1	6	1.5	6	1.5
14	1	-	4	1.0	5	1.2
15	1	-	4	1.0	6	1.5
16	2	-	2	0.5	6	1.5
17	1	-	5	1.2	2	0.5
18	-	-	2	0.5	1	0.2
19	-	-	3	0.7	-	-
20	-	-	1	0.2	-	-
21	-	-	3	0.7	1	0.2
22	-	-	1	0.2	1	0.2
23	-	-	1	0.2	-	-
24	-	-	-	-	1	0.2
28	1	-	1	0.2	1	0.2
30	-	-	-	-	2	0.5
31	-	-	1	0.2	-	-
33	-	-	-	-	1	0.2
35	-	-	1	0.2	-	-
37	2	-	-	-	-	-
38	1	-	1	0.2	-	-
39	-	-	1	0.2	-	-
43	-	-	1	0.2	-	-
44	-	-	1	0.2	-	-
47	-	-	-	-	2	0.5
49	-	-	1	0.2	1	0.2
50	-	-	1	0.2	-	-
53	-	-	-	-	1	0.2
58	1	-	-	-	1	0.2
59	-	-	1	0.2	-	-
69	1	-	-	-	-	-
71	-	-	1	0.2	1	0.2
73	-	-	-	-	1	0.2
75	1	-	1	0.2	-	-
79	1	-	-	-	-	-
80	1	-	-	-	-	-
82	-	-	-	-	1	0.2
91	-	-	1	0.2	-	-
101	1	-	-	-	-	-

dimensionless constant. It essentially describes the size of measurement error relative to the mean value of a measurement. As one measure of the differences between specified determinations, the values of V are given below.

Specified Determinations	V
First determinations on original and replicate specimens	4.7 percent
Second determinations on original and replicate specimens	4.6 percent
Duplicated determinations on original specimen	1.9 percent

The reason for the contrast in V in the figures above is that the original split sample was subject to a repeat analysis if the readings diverged by more than 9 mg percent. Cholesterol values were not as easily replicated at the Center for Disease Control as uric acid values had been.[9] When the cumulative frequency and percent distributions in table I are examined, it is found that more than 15 percent of each of the two distributions on the right side of the table are above the 9 mg/100 ml level. However, the fact that the coefficient of variation is less than 5 percent in each case above does attest to the overall reproducibility of cholesterol.

Data Handling Verification

Quality control considerations were not confined to the laboratory. Data were subject to the possibility of error every time a human hand touched a keyboard or moved a pencil across a page. After the data had been put on punchcards, they were transferred to magnetic tape. Subsequent handling of the data by programmers and transcription by clerks provided other sources of error.

To verify all operations, the entire cohort of 16-year-old Negro males was subjected to a thorough independent manual audit. The computer tape printout of each subject's serum cholesterol value was listed opposite his identification. These were individually checked against the values originally recorded at the Center for Disease Control. The mean was then computed manually on the desk calculator and proved identical to the computer's mean value.

In addition, all age, race, and sex identification for members of this cohort were found to correspond exactly to the information given on the household interview forms completed by census interviewers.

○○○

☆U.S. GOVERNMENT PRINTING OFFICE: 1976—210—981:37

VITAL AND HEALTH STATISTICS PUBLICATIONS SERIES

Formerly Public Health Service Publication No. 1000

Series 1. Programs and Collection Procedures.—Reports which describe the general programs of the National Center for Health Statistics and its offices and divisions, data collection methods used, definitions, and other material necessary for understanding the data.

Series 2. Data Evaluation and Methods Research.—Studies of new statistical methodology including experimental tests of new survey methods, studies of vital statistics collection methods, new analytical techniques, objective evaluations of reliability of collected data, contributions to statistical theory.

Series 3. Analytical Studies.—Reports presenting analytical or interpretive studies based on vital and health statistics, carrying the analysis further than the expository types of reports in the other series.

Series 4. Documents and Committee Reports.—Final reports of major committees concerned with vital and health statistics, and documents such as recommended model vital registration laws and revised birth and death certificates.

Series 10. Data from the Health Interview Survey.—Statistics on illness; accidental injuries; disability; use of hospital, medical, dental, and other services; and other health-related topics, based on data collected in a continuing national household interview survey.

Series 11. Data from the Health Examination Survey.—Data from direct examination, testing, and measurement of national samples of the civilian, noninstitutionalized population provide the basis for two types of reports: (1) estimates of the medically defined prevalence of specific diseases in the United States and the distributions of the population with respect to physical, physiological, and psychological characteristics; and (2) analysis of relationships among the various measurements without reference to an explicit finite universe of persons.

Series 12. Data from the Institutionalized Population Surveys.—Discontinued effective 1975. Future reports from these surveys will be in Series 13.

Series 13. Data on Health Resources Utilization.—Statistics on the utilization of health manpower and facilities providing long-term care, ambulatory care, hospital care, and family planning services.

Series 14. Data on Health Resources: Manpower and Facilities.—Statistics on the numbers, geographic distribution, and characteristics of health resources including physicians, dentists, nurses, other health occupations, hospitals, nursing homes, and outpatient facilities.

Series 20. Data on Mortality.—Various statistics on mortality other than as included in regular annual or monthly reports. Special analyses by cause of death, age, and other demographic variables; geographic and time series analyses; and statistics on characteristics of deaths not available from the vital records, based on sample surveys of those records.

Series 21. Data on Natality, Marriage, and Divorce.—Various statistics on natality, marriage, and divorce other than as included in regular annual or monthly reports. Special analyses by demographic variables; geographic and time series analyses; studies of fertility; and statistics on characteristics of births not available from the vital records, based on sample surveys of those records.

Series 22. Data from the National Mortality and Natality Surveys.—Discontinued effective 1975. Future reports from these sample surveys based on vital records will be included in Series 20 and 21, respectively.

Series 23. Data from the National Survey of Family Growth.—Statistics on fertility, family formation and dissolution, family planning, and related maternal and infant health topics derived from a biennial survey of a nationwide probability sample of ever-married women 15-44 years of age.

For a list of titles of reports published in these series, write to:

Scientific and Technical Information Branch
National Center for Health Statistics
Public Health Service, HRA
Rockville, Md. 20852

DHEW Publication No. (HRA) 76-1638
Series 11-No. 156

NCHS

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Health Resources Administration
5600 Fishers Lane
Rockville, Md. 20852

OFFICIAL BUSINESS
Penalty for Private Use, $300

For publications in the *Vital and Health Statistics* Series call 301-443-NCHS.

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HEW

HEW 390

THIRD CLASS
BLK. RATE