Data from the
NATIONAL HEALTH SURVEY

Series 11
Number 151

Oral Hygiene

Among Youths 12-17 Years

United States

Estimates of the Simplified Oral Hygiene Index (OHI-S) for noninstitutionalized youths aged 12-17 years in the United States, by age, sex, race, family income, education of head of household, and geographic region, and a correlation analysis of the interrelation of oral hygiene, periodontal disease, and selected demographic characteristics.

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

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ORAL HYGIENE
AMONG YOUTHS 12-17 YEARS

Marcus J. Sanchez, *Division of Health Examination Statistics*

INTRODUCTION

This report presents estimates of the oral hygiene status of U.S. youths aged 12-17 years, according to race, sex, age, and other selected demographic characteristics. A correlation analysis of the interrelation of oral hygiene, periodontal disease, and selected demographic characteristics is also included. Oral hygiene was evaluated by the Simplified Oral Hygiene Index, [1] while the prevalence and severity of periodontal disease were measured by the Periodontal Index. [2]

Background (Source of Data)

During 1966-70 the Division of Health Examination Statistics conducted a survey of the health of the Nation's youths. The target population was the 22.7 million noninstitutionalized U.S. youths aged 12-17 years, living in the United States (including Alaska and Hawaii). Persons residing on lands reserved for American Indians were excluded from the target population. A probability sample of 7,514 youths was selected to represent the population of U.S. youths. [3] The sample design and the procedure by which the sample was selected are described in appendix I.

The 1966-70 survey was the third in the continuous series of sample surveys conducted by the Division of Health Examination Statistics on specified segments of the U.S. population whose health status was determined by direct examination. The first survey collected information about the health of the Nation's adults aged 18-79 years and focused primarily on selected chronic health conditions and various related physical and physiological measures. [4] The second survey was designed to assess health factors related to the growth and development of the Nation's children aged 6-11 years. [5] The survey of youths was similar in design and content to the children's survey. The examinations were conducted in mobile examination centers which visited 40 randomly selected locations in 25 States.

The Examination

A standardized examination was given to each consenting sample youth whose parents or guardians consented to his or her participation in the survey. Physicians, dentists, psychologists, nurses, and technicians performed tests which focused on factors related to biological and psychological aspects of growth and development. A pediatrician examined the nose, throat, ears, heart, and neurological and musculoskeletal systems of each youth. The teeth and their supporting structure were examined by a dentist. Intellectual development, school achievement, and personality development were measured by a psychologist. Other procedures included tests of vision, hearing, exercise tolerance, grip strength, and breathing capacity. Blood pressure levels and electrocardiograms were recorded as well as height, weight, and other body measurements.

The dental examination was conducted by seven specially trained dentists employed at various times during the survey. The examiners derived their findings on a uniform basis by

following as closely as possible written, objective standards. The standards were guidelines which narrowed the range of examiner variability by eliminating many borderline or questionable conditions that are persistent sources of examiner disagreement. To avoid procedures that might have introduced systematic bias, the examining dentists were instructed not to dry or isolate teeth nor to remove oral debris and calculus. Radiographs of the teeth were not taken. An adjustable examining chair, a standard light source, and a mouth mirror and explorer were used during the examination, which usually lasted about 10 minutes.

Definitions of dental conditions and procedures for conducting the examinations were largely the same as those followed during the Health Examination Surveys of adults during 1960-62 and of children during 1963-65.[6,7] The same two dentists who trained new examiners during both previous surveys also trained the other examiners and periodically reviewed the findings during the survey of youths. A comparison of the findings from replicate dental examinations (appendix III) suggests that interexaminer variability was reasonably well controlled and did not seriously bias the Periodontal Index (PI) findings. Appendix III contains a description of the training of examiners.

Nonresponse

At the close of the survey, 90 percent or 6,768 of the 7,514 sample youths had been examined. Although data pertaining to the dental conditions of the 746 nonrespondents are not available to the survey staff, it is assumed that nonresponse did not seriously bias the estimates contained in this report. This national sample and the examined group are closely representative of the 22.7 million noninstitutionalized youths 12-17 years old in the United States with respect to age, sex, race, geographic region, population size of place of residence, and rate of population change in size of place of residence from 1950 to 1960.

Limitations of Data

Several limiting factors need to be considered when using the data contained in this report. The target population does not include institutionalized persons nor does it include persons residing on lands reserved for American Indians. Hence, a portion of the U. S. population which may contain a high degree of dental morbidity is not represented in these data. Another consideration is that these data are based on a sample of the target population; therefore, national estimates are subject to sampling error. Sampling errors are prominently displayed in tables 6-10. In this report sampling error has been taken into account by the use of tests of statistical significance as specified in appendix I.

SIMPLIFIED ORAL HYGIENE INDEX (OHI-S)

Oral hygiene status was assessed by the Simplified Oral Hygiene Index (OHI-S), a method developed by Green and Vermillion.[1] In the simplified method the extent of oral debris and the extent of oral calculus are measured on selected surfaces of at least two of six predesignated teeth. The buccal surfaces of the upper molars, the lingual surfaces of the lower molars, and the labial surfaces of the upper and lower central incisors are included. The proportion (in thirds) of the total surface area overlaid by debris and the proportion overlaid by calculus are averaged to give the Simplified Debris Index (DI-S) and the Simplified Calculus Index (CI-S). The sum of the CI-S and DI-S is the Simplified Oral Hygiene Index (OHI-S). Thus, the OHI-S ranges from a low of 0.0 (no debris, calculus, or stain) to a high of 6.0 (more than two-thirds of the examined surfaces covered with debris and calculus).

Oral Hygiene Findings

The distribution of specified levels of the Simplified Oral Hygiene Index (OHI-S) scores among U.S. youths aged 12-17 years is shown in tables A and 1. The abundance of low OHI-S scores indicates a favorable level of oral hygiene among youths. Of the estimated 22.7 million adolescents, approximately two-thirds, 68.3 percent, had little or no calculus and debris (OHI-S score of 1.0 or less); about one quarter, 27

Table A. Number and percent distribution of youths by level of Simplified Oral Hygiene Index (OHI-S): United States, 1966-70

OHI-S	Number of youths in thousands	Percent distribution
Total----------	22,679	100.00
0.0-1.0----------	15,491	68.31
1.1-2.0----------	6,125	27.01
2.1-3.0----------	921	4.06
3.1-6.0----------	142	.62

percent, had scores ranging from 1.0 through 2.0; but less than 1 percent had scores greater than 3.0 (indicating poor oral hygiene).

The estimated average OHI-S for all youths was 0.89 (table 2). The means of the component indexes of the OHI-S which measure calculus (CI-S) and debris (DI-S) were 0.11 and 0.77, respectively. As illustrated in figure 1, the presence of oral debris is the main reason for poor oral hygiene among youths.

Although relatively small differences in the OHI-S and its components are usually not significant clinically, they may nevertheless indicate variations in the prevalence and distribution of oral hygiene levels that may be significant epidemiologically. In the following sections, differences that are statistically significant are cited even though such differences are not necessarily clinically significant.

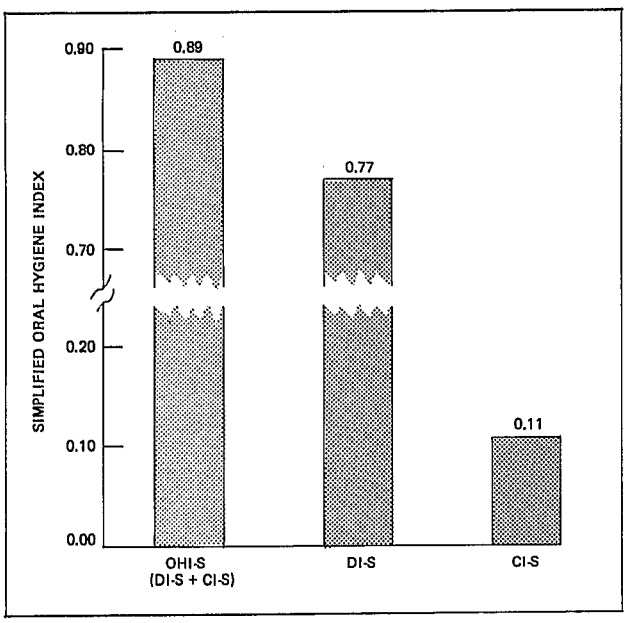

Figure1. Average Simplified Oral Hygiene Index (OHI-S),Debris Index (DI-S), and Calculus Index (CI-S) for youths aged 12-17 years: United States, 1966-70.

Age

The oral hygiene of adolescents of all races tends to improve with advancing age. Although the decreases in mean OHI-S between successive years of age are not statistically significant, the mean OHI-S, nevertheless, appears to decrease slightly with advancing age and is significantly higher for younger than for older youths (table 2). For example, the mean OHI-S for 12-year-old youths was substantially greater than that for 17-year-old youths, 0.94 compared with 0.82. The inverse association between age and OHI-S is graphically illustrated in figure 2.

The improvement in oral hygiene with advancing age occurs because adolescents, as they grow older, have less debris on their teeth. As shown in figure 3, the mean DI-S scores for youths of all races decrease slightly with advancing age. The mean DI-S for 12-year-old youths was substantially higher than that for 15-, 16-, and 17-year-old youths. In contrast, calculus accumulates slightly with advancing age; the mean CI-S for 12-year-old youths was significantly lower than that for each of the higher age groups (figure 4).

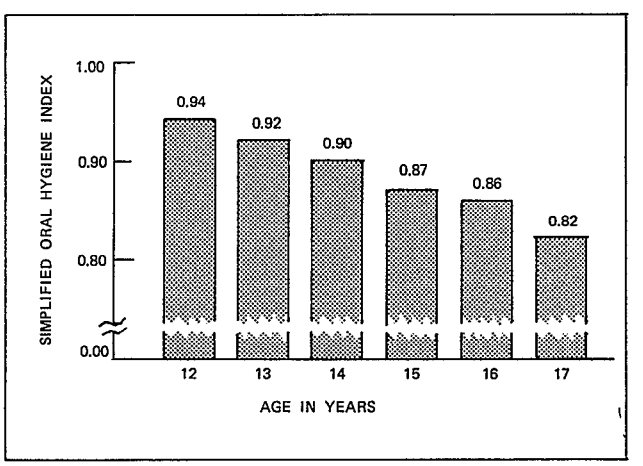

Figure 2. Average Simplified Oral Hygiene Index for youths by age: United States, 1966-70.

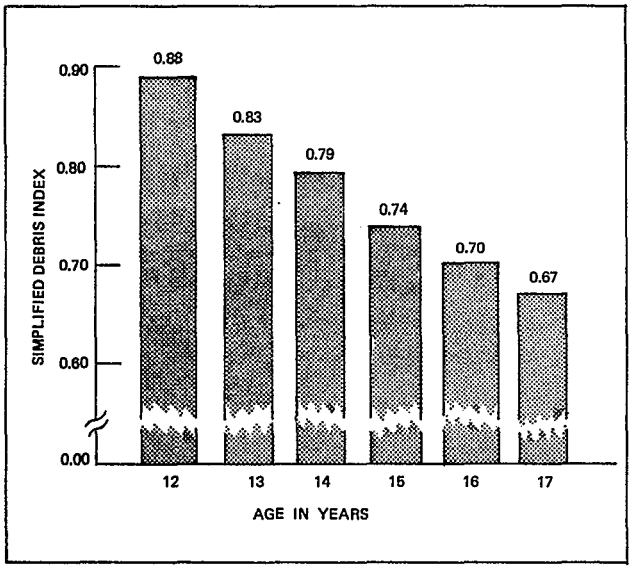

Figure 3. Average Simplified Debris Index for youths by age United States, 1966-70.

The estimates in table 2 also indicate that there is an inverse association between the mean OHI-S and age for white youths, that is, as age increases oral hygiene among white youths tends to improve. For example, the mean OHI-S for 12-year-old white youths is significantly greater than that for 17-year-old white youths, 0.91 compared with 0.75. Similarly, the mean OHI-S for white girls and that for white boys are also inversely associated with age (figure 5). However, among Negro youths, the mean OHI-S does not appear to vary significantly with increasing age (table 2). It would appear that the weak association of OHI-S with age found among youths of all races is merely a reflection of that same association found among white youths.

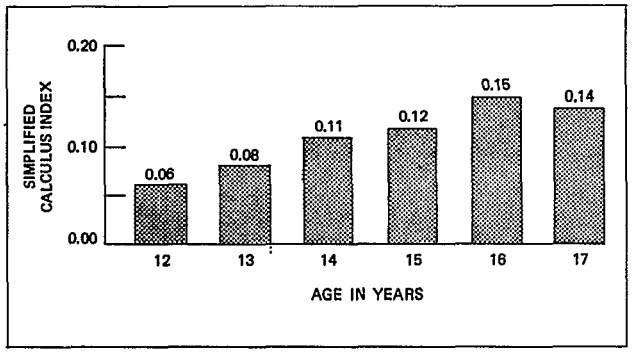

Figure 4. Average Simplified Calculus Index for youths by age: United States, 1966-70.

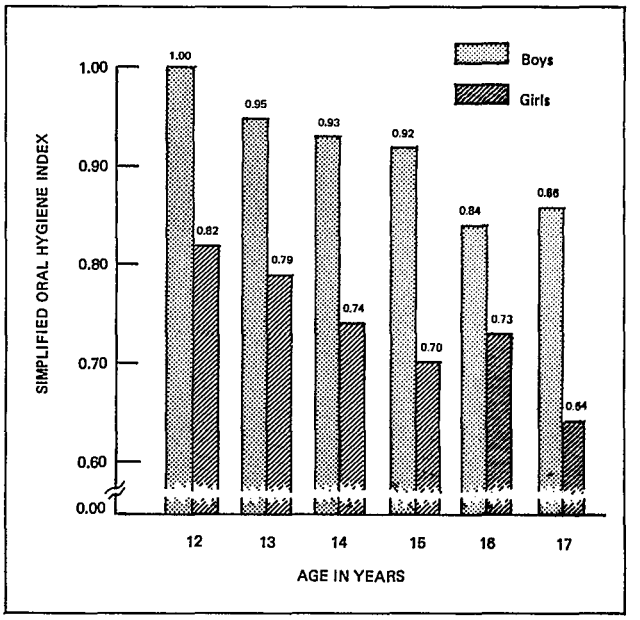

Figure 5. Average Oral Hygiene Index for white youths by sex and age: United States, 1966-70.

Sex

As measured by the OHI-S female youths had cleaner teeth than male youths. The mean OHI-S for girls of all races—0.80—was significantly less than that for boys—0.97 (table 2). The same difference by sex prevailed at each given year of age except for 16-year-olds. White boys also had a substantially higher mean OHI-S than white girls, 0.92 as compared with 0.74 (table 2).

The oral hygiene of Negro youths does not appear to be related to sex. The mean OHI-S for Negro boys is not significantly different from that for Negro girls. In addition, the mean indexes for Negro boys and girls within any of the age groups do not differ significantly. Regardless of age, the mean OHI-S for Negro youths is essentially independent of sex. Thus, the difference in oral hygiene status associated with sex among adolescents of all races may be attributed to that same difference among white youths.

Race

The oral hygiene of white youths was somewhat better than that of Negro youths. The mean OHI-S for all Negro youths (1.26) was substantially

higher than that for all white youths (0.83). Differences in the oral hygiene level of white and Negro youths were also found among youths of the same age. Within each of the six age groups, Negro youths consistently had higher mean indexes than white youths (table 2). In addition, both Negro boys and girls had an appreciably higher mean OHI-S than white youths of the same sex. For example, the mean OHI-S for white boys was 0.92 as compared with 1.30 for Negro boys. Thus, the mean OHI-S for Negro youths was significantly higher than that for white youths regardless of age or sex.

Expected Value (Age-Control)

In order to control for age, the expected value is used. Since the previous estimates indicate that age is related to mean OHI-S, an adjustment is made for differences in the age distribution of the children within each income and education group by calculating an expected value. In the income and education sections of this report, a comparison of mean actual and expected values for the 12-17 year age range is used instead of a comparison of mean age-specific values. Sampling variability for specific age groups is usually larger than that for the total age span because of the smaller number of sample youths at each age. Because the larger sampling variability for age-specific groups frequently masks the relationship that exists with respect to socioeconomic variables, summary comparison (actual minus expected) is used here instead of mean age-specific comparisons.

Expected values were calculated by weighting the age-specific mean OHI-S for the total U.S. population of youths by the number of youths in that age group within specified ranges of a given demographic variable such as family income. Actual and expected values may differ by chance, but when the difference between them is statistically significant, one may conclude that the actual mean OHI-S of a given demographic group is excessively larger or smaller than the mean of the same group for the United States and that the excess may not be attributed to age.

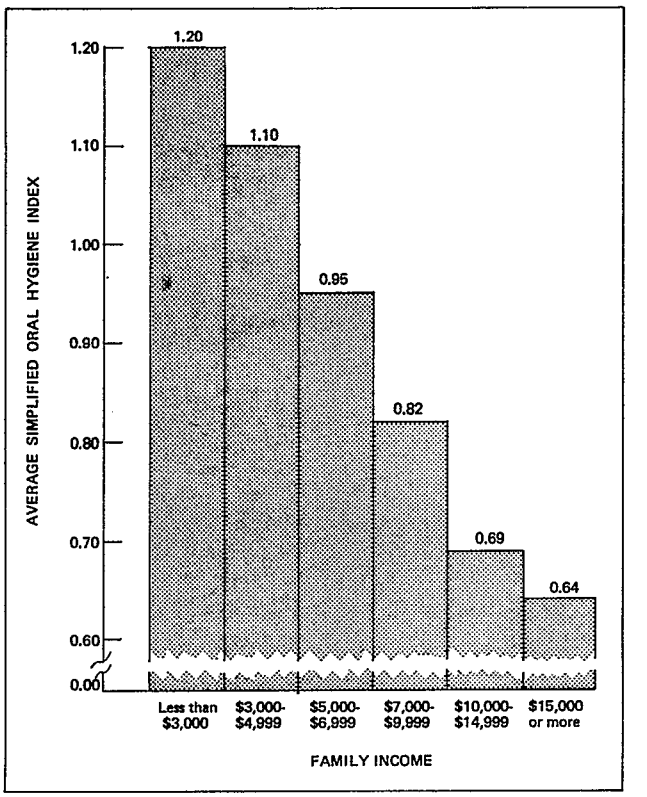

Figure 6. Average Simplified Oral Hygiene Index for youths aged 12-17 years by family income: United States, 1966-70.

Family Income

The degree of oral cleanliness among youths of all races varied according to annual family income; the average OHI-S tended to decrease as family income increased. As illustrated in figure 6, adolescents in the lower income groups had appreciably poorer oral hygiene (higher mean OHI-S) than those in the higher income groups. For example, youths whose families earned less than $3,000 per year had a mean OHI-S of 1.20,

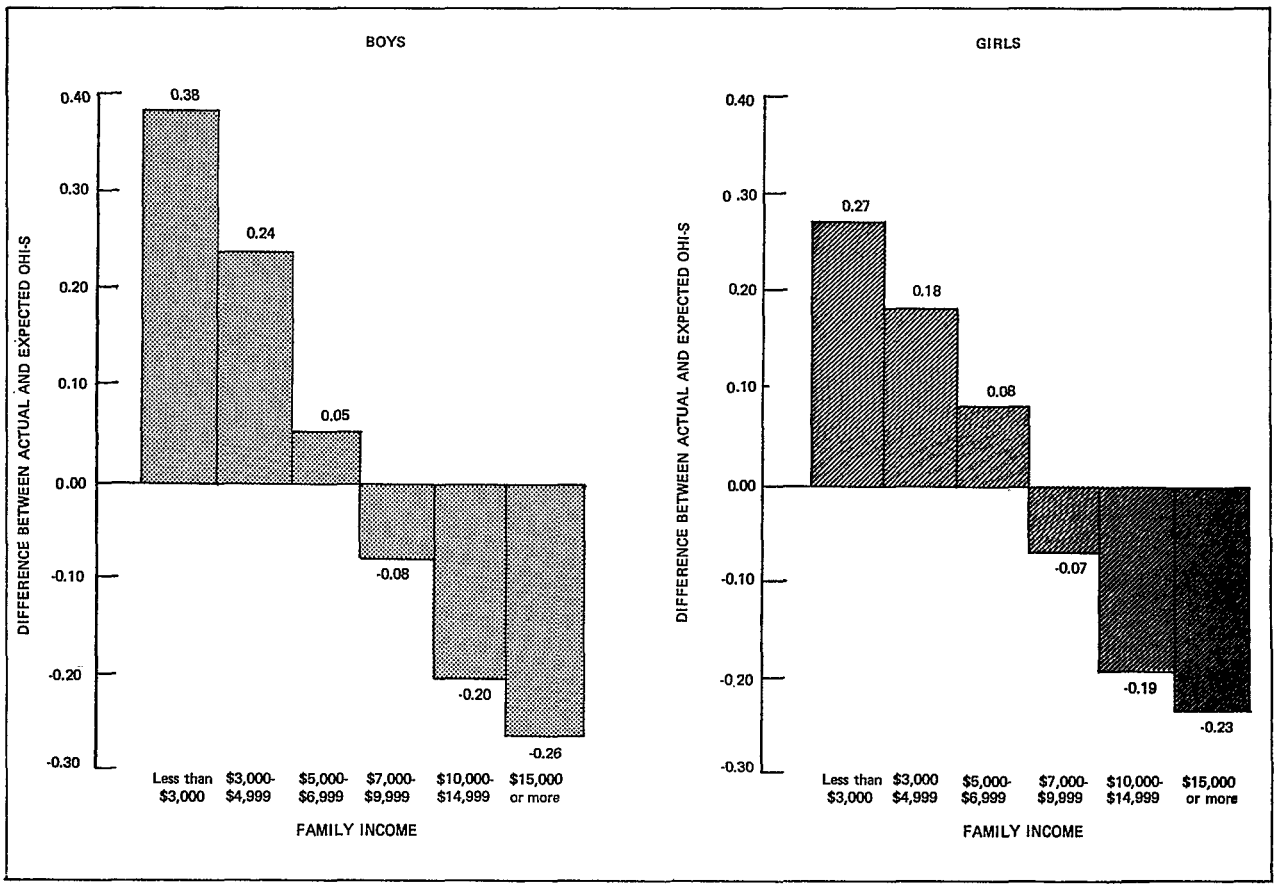

Figure 7. Difference between actual and expected average Simplified Oral Hygiene Index (OHI-S) for girls and boys aged 12-17 years by family income: United States, 1966-70.

while youths whose families earned $15,000 or more per year had a mean OHI-S of only 0.64 (figure 6 and table 3).

When age was taken into consideration by contrasting mean actual and expected values, the inverse relationship between mean OHI-S and family income continued to be evident (table 3). For instance, youths whose families earned less than $3,000 per year had a substantially higher mean OHI-S than expected, whereas, youths whose families earned $15,000 or more had a substantially lower OHI-S than expected.

After stratifying by sex, the inverse association of the mean OHI-S with family income prevailed among both female and male adolescents. The mean OHI-S scores for female youths in the lower income groups (less than $3,000 and $3,000-$4,999) were significantly greater than expected and those for girls in the higher income groups ($10,000-$14,999, $15,000 or more) were significantly lower than expected (figure 7). Similarly, the mean OHI-S scores for boys in the lower income groups were appreciably greater than expected while those for male youths in the

higher income groups were appreciably lower than expected.

The relationship between mean OHI-S and family income for white youths was similar to that for youths of all races. As among all races, the mean OHI-S for white youths varied inversely with annual family income. The mean OHI-S for white youths whose families earned less than $3,000 was substantially greater than that for white youths in each of the higher income groups. For instance, the mean OHI-S for white youths in families with less than $3,000 annual income was 1.14 as compared with 0.64 for youths whose families earned $15,000 or more (figure 8).

After age and sex were taken into consideration, the inverse association between mean OHI-S and family income continued to prevail among both white boys and girls (figure 9). Regardless of age and sex, the mean OHI-S for white youths is inversely associated with annual family income.

The relationship between mean OHI-S and family income among Negro youths (table 3) is not clear. With the exception of the $10,000-$14,999 income group, differences between the mean OHI-S for the lowest income group and that for each higher income group are negligible. For example, the mean OHI-S for Negro adolescents whose families earned $15,000 or more per year is not significantly different from that for Negro adolescents whose families earned less than $3,000. An age control was not applied to estimates for Negro youths in this and the following sections, since it was previously shown that the mean OHI-S for Negro youths was essentially independent of age. Similarly, sex-specific estimates were not discussed because no relationship between mean OHI-S and sex of Negro youths was noted.

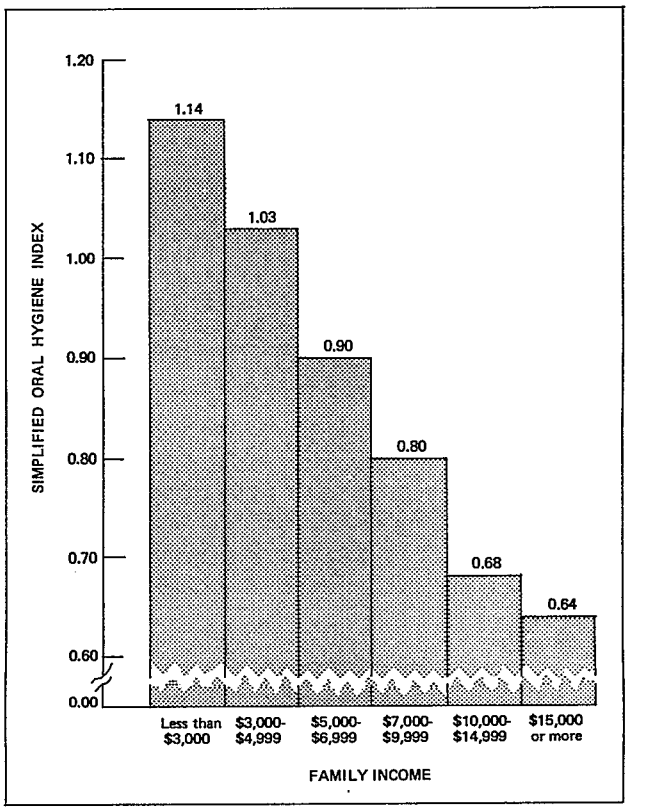

Figure 8. Average Simplified Oral Hygiene Index for white youths aged 12-17 years by family income: United States, 1966-70.

Education of Parent

The estimated actual and expected mean OHI-S scores for youths according to sex, race, and educational attainment of the youth's parent or guardian are shown in table 4. The education of parents was inversely associated with the oral hygiene of adolescents. Thus, mean OHI-S decreased from a high of 1.34 for youths whose parents had less than 5 years of education to a low of 0.59 for those whose parents had 17 or more years of education (figure 10). After allowances were made for differences in age, the inverse association continued to be evident. The mean OHI-S index for youths whose parents had

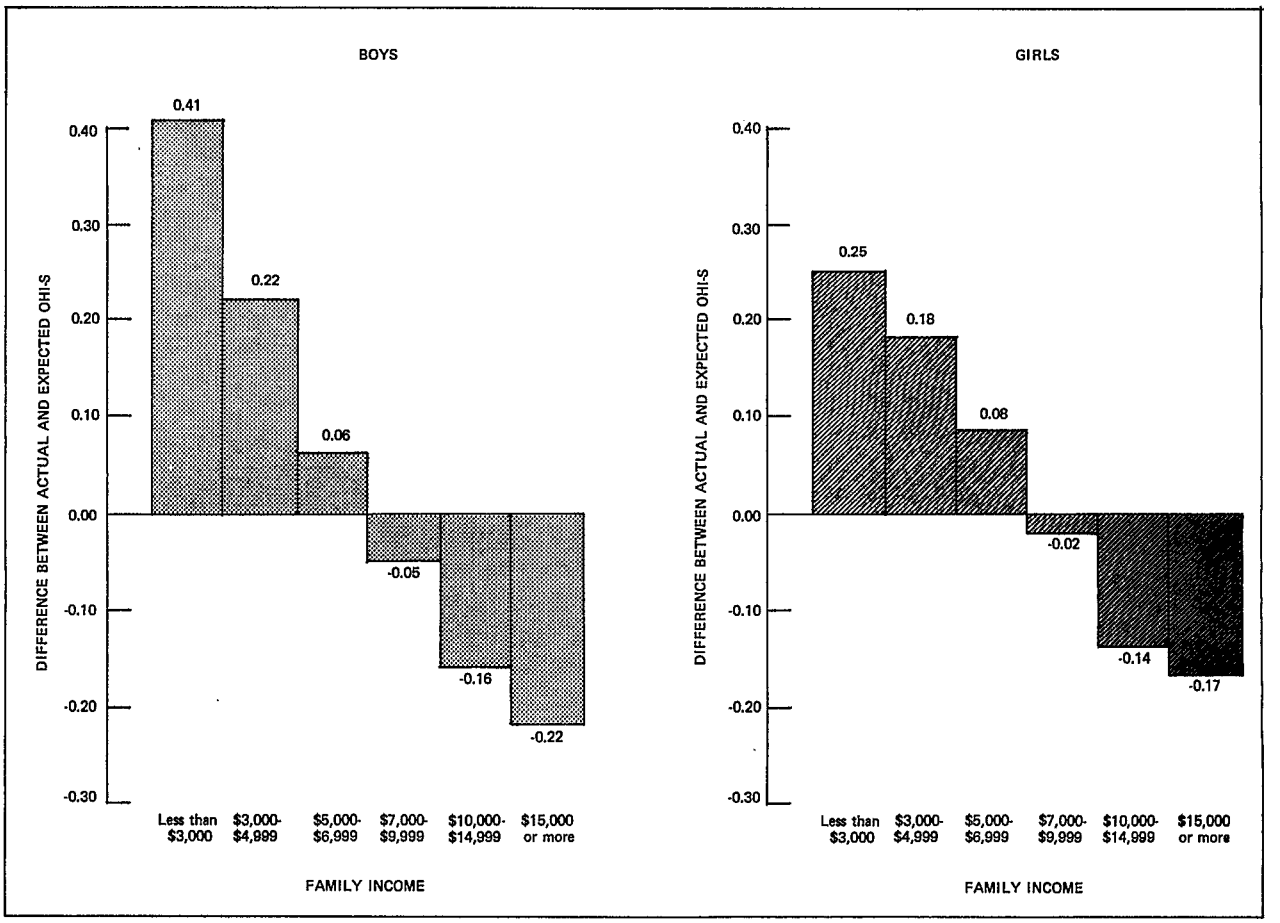

Figure 9. Difference between actual and expected average Simplified Oral Hygiene Index (OHI-S) for white boys and girls aged 12-17 years by family income: United States, 1966-70.

little or no formal education was greater than expected while the mean index for those whose parents had 17 or more years of education was substantially less than expected. The inverse association also prevailed between education and mean OHI-S after stratifying by sex (figures 12 and 13).

As noted for youths of all races, the mean OHI-S for white adolescents is inversely associated with the educational achievement of their parents figure 11). The mean OHI-S for white youths decreased from a high of 1.30 for those whose parents had less than 5 years of education to a low of 0.57 for those whose parents had 17 or more years. After age and sex were taken into consideration, the mean OHI-S for white boys and girls continued to be inversely associated with the educational attainment of their parents (table 4).

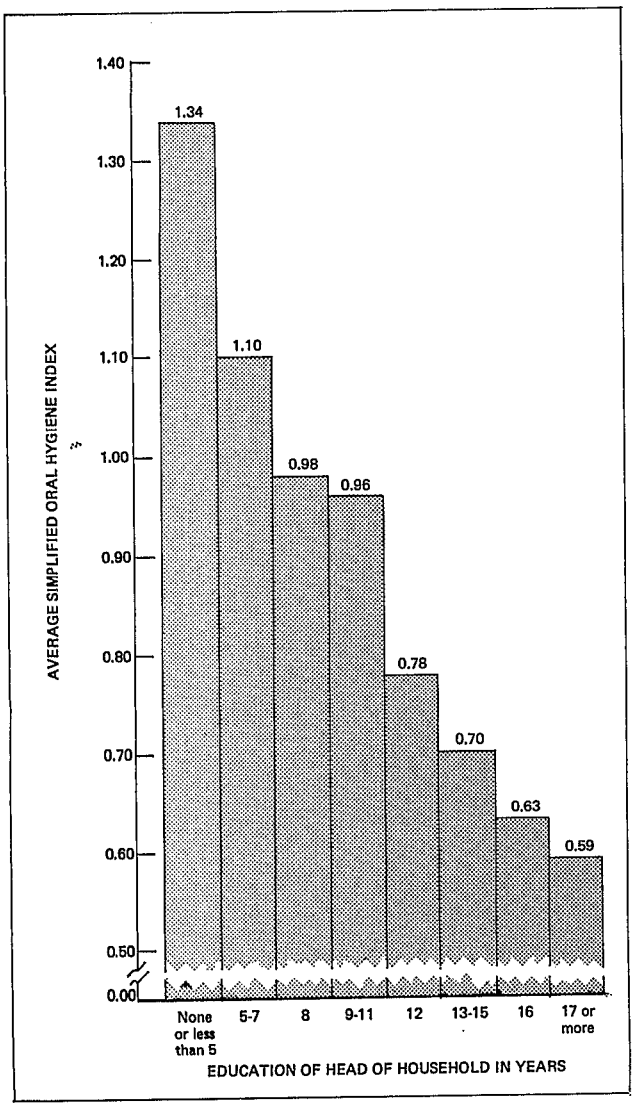

Figure 10. Average Simplified Oral Hygiene Index for youths aged 12-17 years by education of head of household: United States, 1966-70.

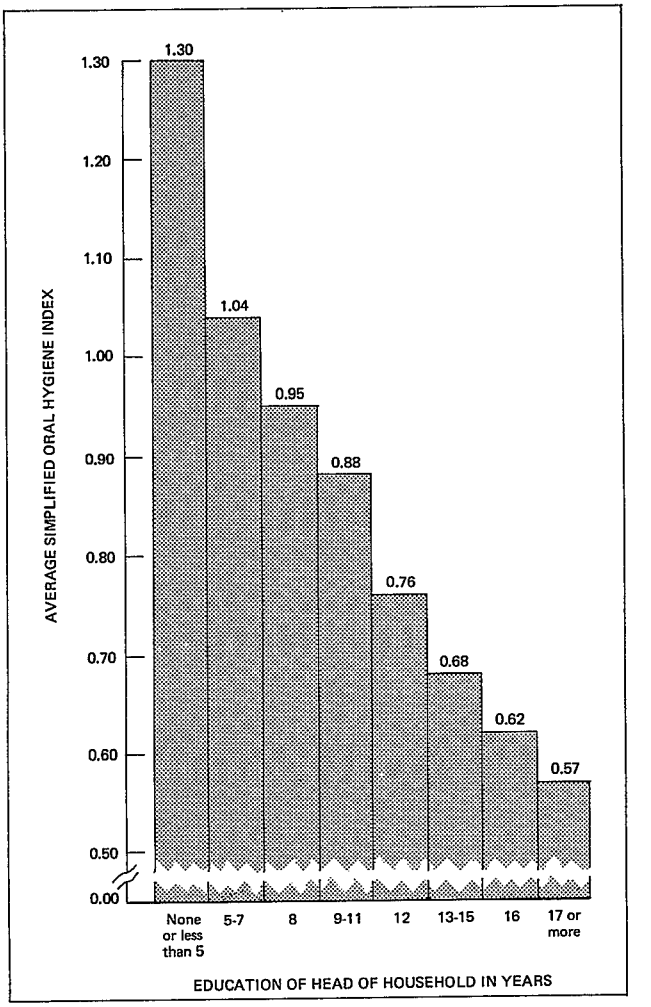

Figure 11. Average Simplified Oral Hygiene Index for white youths aged 12-17 years by education of head of household: United States, 1966-70.

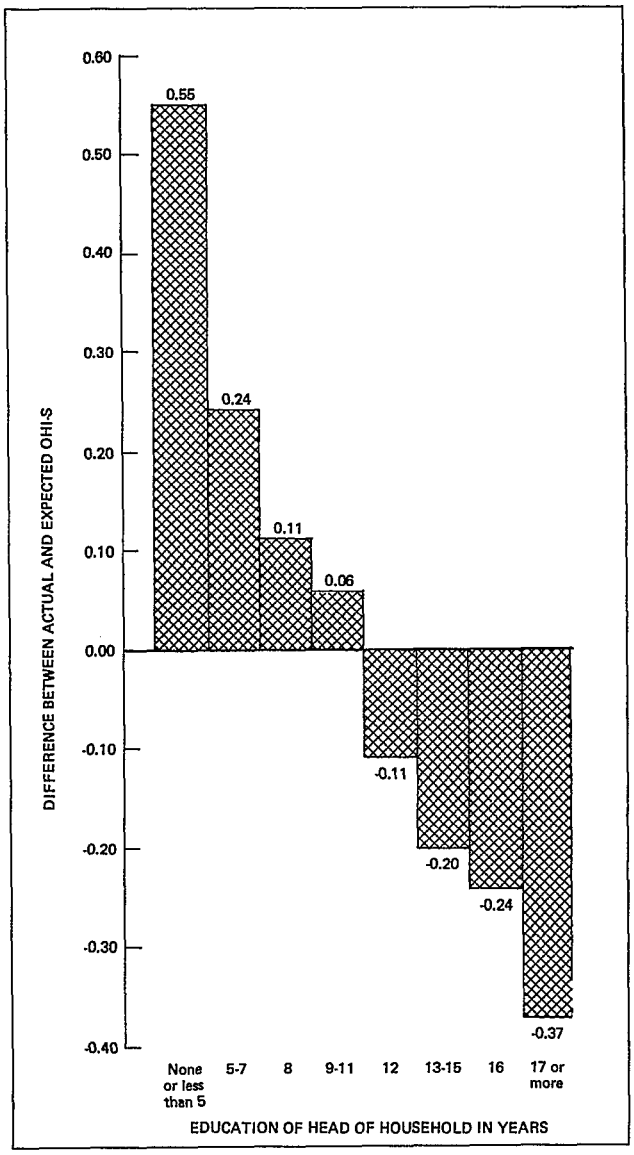

Figure 12. Difference between the actual and expected average Simplified Oral Hygiene Index (OHI-S) for boys aged 12-17 years by education of head of household: United States, 1966-70.

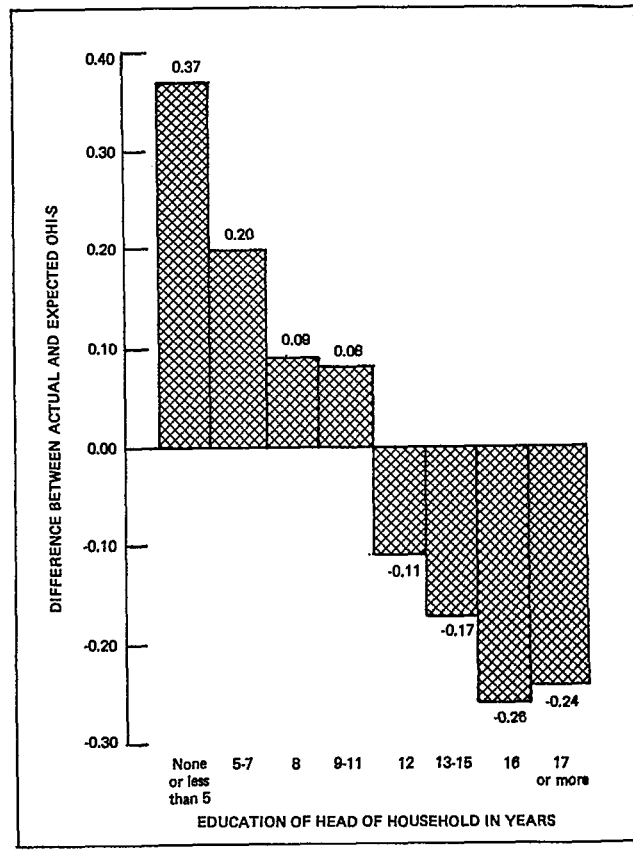

Figure 13. Difference between the actual and expected average Simplified Oral Hygiene Index (OHI-S) for girls aged 12-17 years by education of head of household: United States, 1966-70.

The relationship between the mean OHI-S for Negro youths and the education of the parent is not clear. The mean OHI-S for Negro youths whose parents had less than 5 years of education was not significantly different from those for the two highest educational groups (16 years and 17 years or more). On the other hand the mean OHI-S for Negro adolescents whose parents had 13-15 years of education was substantially less than that for Negro youths whose parents had less than 5 years of education (table 4).

Since there are appreciably more white than Negro youths in the United States, findings for all races reflect to a great extent the findings for white youths. Thus, as noted for youths of all races, the mean OHI-S for white youths was inversely associated with both family income and with the education of parents. However, the relationship between the mean OHI-S for Negro youths and either family income or parent's education was not clear.

Geographic Region

The mean OHI-S for girls of all races was substantially higher in the South—0.93—than in

the West—0.69 (table 5). After age was accounted for, the mean OHI-S for girls remained higher for those in the South than for those in the West. Table 5 also contains estimates of the average OHI-S by race. The mean oral hygiene estimates for white adolescents, regardless of their sex or age, did not differ significantly among the regions. Similarly, the estimates for Negro youths did not vary by region.

DISCUSSION

Interrelation of OHI-S and Selected Demographic Variables

The interrelation of OHI-S and selected demographic characteristics may be further assessed by the statistical method of correlation analysis. By this method, the relative strength of the association of selected variables (age, sex, race, family income, and education of parent) with OHI-S is quantified separately by calculating simple correlation coefficients. The simple correlation coefficients shown in table B indicate that age, sex, race, family income, and parent's education are related in varying degrees to oral hygiene. These correlations would be expected since the mean OHI-S was previously shown to be related to age, sex, race, income, and education. Further insight into the relationship of the variables with oral hygiene may be obtained from the partial correlation coefficients in table B which quantify the correlation between each variable and oral hygiene when the associations between the other variables and OHI-S are held constant.

Family income and parent's education have been shown to be associated with oral hygiene. However, family income is also highly correlated with education in the United States ($r = 0.56$). Two questions now arise: First, is education independently associated with oral hygiene, or is the association due to the correlation between income and education? Second, is family income independently associated with oral hygiene, or is the association a reflection of the correlation between education and income?

With income, age, sex, and race held constant, the partial correlation between education and the oral hygiene index is substantially differ-

Table B. Correlation coefficients between the Simplified Oral Hygiene Index and selected variables with standard errors: United States, 1966-70

Variable	Simple correlation coefficient	Standard error	Partial correlation coefficient for 6-variable equation	Standard error
Age	-.06	.015	-.07	.017
Sex	-.13	.017	-.14	.017
Race	.22	.057	.12	.050
Family income	-.30	.027	-.13	.019
Education of parent	-.29	.025	-.16	.017

Table C. Correlation coefficients between the Periodontal Index (PI) and selected variables with standard errors: United States, 1966-70

Variable	Simple correlation coefficient	Standard error	Partial correlation coefficient for 7-variable equation	Standard error
OHI-S	.62	.019	.59	.017
Age	.06	.014	.12	.013
Race	.12	.041	-.04	.048
Family income	-.21	.019	-.02	.021
Education of parent	-.22	.024	-.04	.027

ent from zero. The partial correlation between income and the oral hygiene index is also significantly different from zero when the effects of education, age, sex, and race are held constant (table B). Thus it would appear that both education and income are independently associated with oral hygiene.

Interrelation of PI, OHI-S, and Selected Demographic Variables

Previous U. S. surveys conducted by the Division of Health Examination Statistics on adults 18-79 years and on children 6-11 years have presented data concerning the relationship between oral hygiene and periodontal disease (an inflammatory disease of the supporting structures of teeth). In order to make a similar analysis of the association of periodontal disease with oral hygiene among adolescents, Russell's Periodontal Index is now presented. Periodontal disease is of special interest to dental epidemiologists and others since it is a leading cause of tooth loss.

Periodontal Index (PI)

The prevalence and severity of periodontal disease among U.S. youths were assessed by the Periodontal Index (PI).[9] The PI is a score for each tooth in the mouth, provided it is not a root, according to the presence and severity of periodontal disease. A score of zero is assigned when no indication of disease is found. When a portion of the free gingiva is inflamed, a score of 1 is assigned. If completely circumscribed by inflammation, the tooth is scored 2. Teeth with overt periodontal pockets are scored 6 if their masticatory function is unimpaired and 8 if it is impaired. An individual's PI is the arithmetic average of all scores. The PI ranges from 0.0 (no inflammation or pockets) to 8.0 (all teeth with pockets and impaired function).

Table C presents the simple and partial correlation coefficients relating the Periodontal Index (PI) with the Simplified Oral Hygiene Index (OHI-S) and selected demographic variables. By comparing the partial coefficients with the corresponding simple correlation coefficients, one may determine the degree of independent correlation each variable has with the PI. As indicated by simple correlation coefficients in table C, periodontal disease is significantly related in varying degrees to age, race, family income, education of parent, and OHI-S.

After calculating the partial correlation coefficients only two variables appear to be independently associated with periodontal disease. With

age, race, family income, and education held constant, the partial correlation between the OHI-S and the PI is substantially greater than zero. Similarly, the partial correlation between age and the PI is significantly greater than zero when the effects of race, family income, education, and OHI-S are held constant. Thus oral hygiene and, to a lesser degree, age emerge as the factors significantly associated with the prevalence and severity of periodontal disease.

As noted before, the association of periodontal disease with oral hygiene among U.S. adults aged 18-79 and U.S. children 6-11 years has been investigated previously. Periodontal disease among adults was found to be related to oral hygiene and to various demographic variables (age, sex, race, income, education). Analysis showed that differences in the occurrence of periodontal disease associated with all the given demographic variables except age, were largely accounted for by significant variations in oral hygiene status. Thus age and oral hygiene were significant variables associated with periodontal disease among adults.

Among children, a correlation analysis was also used to determine the interrelation of periodontal disease, oral hygiene, and selected demographic variables. The analysis also showed that age and oral hygiene were prominent factors associated with the occurrence of periodontal disease.

In summary, oral hygiene and age consistently emerged as statistically significant factors associated with the prevalence and severity of periodontal disease among the U.S. population aged 6-79 years.

Table D. Mean Simplified Oral Hygiene Index (OHI-S) for children, 1963-65, youths, 1966-70, and adults, 1960-63, by age: United States

Age	Mean OHI-S
Children 6-11 years	1.44
Youths 12-17 years	0.89
Adults:	
18-24 years	1.35
25-34 years	1.41
35-44 years	1.49
45-54 years	1.74
55-64 years	1.78
65-74 years	2.06
75-79 years	2.11

OHI-S FINDINGS FROM PREVIOUS HES REPORTS

The estimates presented in this report are part of an epidemiologic study of the dental health of the civilian, noninstitutionalized population aged 6-79 years in the United States. The first report in the dental series contained national estimates of the oral hygiene status of adults aged 18-79 years (1960-62). The second of these reports presented estimates for children 6-11 years (1963-65). The mean OHI-S scores for successive age groups in all three surveys are shown in table D.

The average OHI-S for children, youths, and young adults is shown in table E. The estimates for youths are obviously lower than it would appear they should be. The estimate for 12-year-olds interrupts a gradually declining trend with age by dropping sharply below the estimate for 11-year-olds. Furthermore, the estimate for 17-year-olds is well below that for 18-year-olds.

It is possible that the oral hygiene status of the population improved measurably during the 10-year period over which the successive surveys were conducted. It is also possible that the low

Table E. Mean Simplified Oral Hygiene Index (OHI-S) for children, 1963-65, youths, 1966-70, and young adults, 1960-63, by single year of age: United States

Age	Mean OHI-S
Children 6-11 years:	
6 years	1.38
7 years	1.50
8 years	1.49
9 years	1.47
10 years	1.41
11 years	1.40
Youths 12-17 years:	
12 years	.94
13 years	.92
14 years	.90
15 years	.87
16 years	.86
17 years	.82
Young adults 18-24 years:	
18 years	1.18
19 years	1.33
20 years	1.52
21 years	1.31
22 years	1.31
23 years	1.41
24 years	1.33

estimates for youths reflect, at least in part, intersurvey differences in applying the Simplified Oral Hygiene Index. There is no entirely convincing evidence that will support the occurrence of either possibility. However, the cumulative percent distribution of OHI-S scores collected during the three surveys by individual examiners suggests that an improvement in oral hygiene status did occur (appendix I, table II). For example, 1 percent of all OHI-S scores for children were 0.0, and less than 23 percent were under 0.9. For youths, on the other hand, more than 6 percent of all scores were 0.0 and more than 57 percent were under 0.9. In addition, a much higher proportion of low scores were given among youths than among children by both examiners 1 and 2—the senior dentists who trained all other dentists during the surveys. Thus the oral hygiene findings of the individual examiners show that most of them found relatively more youths than children with low OHI-S scores. The correspondence during the surveys of the findings of the senior dentists with those of the other dentists suggests that intersurvey differences in oral hygiene estimates are not due to a difference in the application of the OHI-S.

It should be pointed out here that there is evidence of a significant improvement in the dental health of the U.S. population during recent years. From 1959 to 1969, the percent of patients receiving preventive treatment—prophylaxis, radiographic examination, and orthodontic and root canal treatments—increased, and the percent receiving reparative treatment—fillings, extractions, and dentures—decreased.[10] In addition, national estimates from the Health Interview survey, another program of the National Center for Health Statistics, show that the percent of adults 45 years or over who have lost all of their natural teeth declined during the 13-year period that ended in 1971.[11]

In some instances but not in others, the association of OHI-S with selected demographic variables prevailed during childhood, adolescence, and adulthood. For example, mean oral hygiene indexes decreased slightly with advancing age during childhood and adolescence. In contrast, mean OHI-S scores among adults increased sharply with advancing age. Analysis of the scores by sex and race shows that the association of OHI-S differed among adults, youths, and children. Mean oral hygiene did not vary by sex for children, but mean scores among male adolescents and adults were higher than those for females of the same ages. Mean scores were also not associated with race during childhood, whereas, mean scores for Negro adolescents and adults were higher than those for white persons of comparable age and sex.

The association of OHI-S with both family income and education prevailed among children, youths, and adults. In contrast, mean oral hygiene indexes did not vary consistently by region among the three age groups.

SUMMARY

The national estimates in this report of the oral hygiene status of youths are based on data collected by the Division of Health Examination Statistics during 1966-70. A probability sample of 7,514 youths in the civilian, noninstitutionalized population was scientifically selected to

represent the Nation's youths 12-17 years of age. Of these, the 6,768 examined youths, 90 percent of the sample, were closely representative of the Nation's adolescent population with respect to age, race, region of residence, family income, and education of parent.

The dental examinations were given by dentists trained to obtain their findings on a uniform basis. Oral hygiene was assessed by the Simplified Oral Hygiene Index (OHI-S), which reflects the presence or absence of oral debris (soft foreign material attached to the tooth) and/or calculus (hardened foreign material firmly attached to the tooth).

The abundance of low OHI-S scores indicates a favorable level of oral hygiene among adolescents. Of the estimated 22.7 million U. S. youths, approximately two-thirds had little or no calculus and debris (OHI-S of 1.0 or less), and less than 1 percent had faulty oral hygiene (OHI-S score in excess of 3.0).

The average OHI-S for approximately 22.7 million adolescents was 0.89. The component indexes of OHI-S that measure oral debris (DI-S) and oral calculus (CI-S) were 0.77 and 0.11, respectively. The component indexes show that poor oral hygiene among youths is mainly due to the presence of oral debris.

As measured by OHI-S, oral hygiene among all youths tends to improve slightly with advancing age. The mean OHI-S was significantly higher among younger youths than among older ones. The mean OHI-S decreased from a high of 0.94 for 12-year-old youths to a low of 0.82 for 17-year-old youths.

The improvement in oral hygiene with advancing age parallels the association between oral debris and age. Among youths of all races, the mean debris indexes decreased with advancing age. Calculus, on the other hand, tends to accumulate slowly with advancing age. Thus the improvement in overall oral hygiene with advancing age is due to the lower level of oral debris among older adolescents.

Oral hygiene among both male and female white youths improved with advancing age as it did for youths of all races. Among Negro youths, however, oral hygiene did not appear to be related to age.

The oral hygiene of youths of all races varied by sex—girls had cleaner teeth than boys. The mean OHI-S for girls of all races (0.80) was significantly less than that for boys (0.97). Within five of the six age groups, the mean OHI-S of girls was appreciably less than that of boys.

White boys had a substantially higher mean OHI-S than white girls. But among Negro youths, the average OHI-S was essentially independent of sex regardless of age.

Significant differences in oral hygiene were associated with race. The mean OHI-S for all Negro youths (1.26) was significantly greater than that for all white youths (0.83). Both Negro boys and girls had materially higher mean indexes than white youths of the same sex. Within the same age groups, Negro adolescents also had appreciably higher mean scores than white adolescents.

The degree of oral cleanliness of youths varied according to family income; the average OHI-S tended to decrease as family income increased. Among youths of all races, for example, the mean OHI-S for those with a family income of less than $3,000 per year was 1.20, but it was only 0.64 for those whose families earned $15,000 per year or more.

As with family income, education of the parent was inversely related to the mean OHI-S for adolescents. This was not unexpected since income and education are highly correlated in the United States. However, it was also found that income and education were independently associated with oral hygiene.

The mean OHI-S for girls of all races, regardless of age, was substantially higher in the South than in the West. The mean oral hygiene estimates of white and Negro adolescents did not differ significantly by region, regardless of sex or age.

The interrelation of oral hygiene, periodontal disease, and selected demographic variables was also analyzed. A correlation analysis showed that age and oral hygiene were the most significant variables associated with the prevalence and severity of periodontal disease among youths.

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Table 1. Number and percent of youths aged 12-17 years, by Simplified Oral Hygiene Index (OHI-S) and sex: United States, 1966-70

OHI-S	Both sexes	Boys	Girls	Both sexes	Boys	Girls
	Number in thousands[1]			Percent		
Total	22,679	11,476	11,203	100.0	100.0	100.0
0.0	1,531	622	909	6.75	5.42	8.12
0.1	-	-	-	-	-	-
0.2	1,428	647	781	6.30	5.64	6.97
0.3	2,842	1,094	1,748	12.53	9.53	15.60
0.4	60	23	37	.27	.20	.33
0.5	2,308	1,079	1,230	10.18	9.40	11.00
0.6	46	25	21	.20	.22	.19
0.7	2,681	1,226	1,455	11.82	10.69	13.00
0.8	2,288	1,209	1,079	10.09	10.54	9.63
0.9	-	-	-	-	-	-
1.0	2,306	1,295	1,011	10.17	11.28	9.02
1.1	-	-	-	-	-	-
1.2	1,622	940	681	7.15	8.20	6.08
1.3	1,481	900	582	6.53	7.84	5.19
1.4	31	13	18	.14	.11	.16
1.5	1,052	604	448	4.64	5.26	4.00
1.6	51	36	15	.22	.32	.13
1.7	786	469	317	3.46	4.08	2.83
1.8	611	348	263	2.69	3.03	2.35
1.9	-	-	-	-	-	-
2.0	491	289	202	2.16	2.52	1.80
2.1	-	-	-	-	-	-
2.2	277	186	91	1.22	1.62	.81
2.3	189	118	71	.83	1.02	.64
2.4	11	8	3	.05	.07	.02
2.5	156	95	61	.69	.83	.54
2.6	7	-	7	.03	-	.06
2.7	123	77	46	.54	.67	.41
2.8	86	59	27	.38	.51	.24
2.9	-	-	-	-	-	-
3.0	72	38	34	.32	.33	.30
3.1	-	-	-	-	-	-
3.2 or more	142	76	65	.62	.67	.58

[1] Includes all racial groups.

Table 2. Average Simplified Oral Hygiene Index (OHI-S), Debris Index (DI-S), and Calculus Index (CI-S) for youths, by race, sex, and age: United States, 1966-70

Sex and age	OHI-S			DI-S			CI-S		
	Total[1]	White	Negro	Total[1]	White	Negro	Total[1]	White	Negro
Both sexes 12-17 years	.89	.83	1.26	.77	.74	.96	.11	.08	.29
12 years	.94	.91	1.19	.88	.86	1.04	.06	.05	.14
13 years	.92	.87	1.18	.83	.80	.99	.08	.07	.19
14 years	.90	.83	1.32	.79	.76	.99	.11	.07	.32
15 years	.87	.81	1.25	.74	.71	.93	.12	.09	.31
16 years	.86	.78	1.33	.70	.68	.90	.15	.11	.42
17 years	.82	.75	1.29	.67	.64	.89	.14	.11	.40
Boys 12-17 years	.97	.92	1.30	.85	.83	1.01	.11	.09	.29
12 years	1.04	1.00	1.29	.96	.94	1.13	.07	.05	.16
13 years	.99	.95	1.21	.90	.88	1.02	.08	.06	.18
14 years	.98	.93	1.31	.86	.84	1.02	.11	.08	.29
15 years	.96	.92	1.22	.82	.80	.96	.13	.11	.25
16 years	.91	.84	1.40	.76	.74	.94	.14	.10	.46
17 years	.93	.86	1.40	.77	.74	.98	.15	.12	.41
Girls 12-17 years	.80	.74	1.22	.69	.66	.91	.11	.08	.30
12 years	.85	.82	1.08	.80	.77	.95	.05	.04	.12
13 years	.84	.79	1.16	.75	.71	.97	.09	.07	.19
14 years	.82	.74	1.33	.72	.68	.97	.10	.06	.35
15 years	.78	.70	1.29	.66	.62	.91	.12	.08	.38
16 years	.80	.73	1.26	.64	.61	.87	.16	.12	.38
17 years	.72	.64	1.19	.58	.54	.80	.14	.10	.39

[1]Includes all racial groups.

Table 3. Actual and expected average Simplified Oral Hygiene Index (OHI-S) for youths aged 12-17 years, by sex, race, and family income: United States, 1966-70

Race and family income	Both sexes			Boys			Girls		
	Actual	Expected	Difference	Actual	Expected	Difference	Actual	Expected	Difference
	OHI-S								
Total[1]									
Less than $3,000	1.20	.89	.31	1.34	.96	.38	1.08	.81	.27
$3,000-$4,999	1.10	.89	.21	1.21	.97	.24	.99	.81	.18
$5,000-$6,999	.95	.89	.06	1.02	.97	.05	.88	.80	.08
$7,000-$9,999	.82	.89	-.07	.89	.97	-.08	.74	.81	-.07
$10,000-$14,999	.69	.89	-.20	.77	.97	-.20	.61	.80	-.19
$15,000 or more	.64	.88	-.24	.71	.97	-.26	.57	.80	-.23
Unknown	.94	.88	.06	1.03	.96	.07	.83	.80	.03
White									
Less than $3,000	1.14	.83	.31	1.32	.91	.41	.99	.74	.25
$3,000-$4,999	1.03	.83	.20	1.14	.92	.22	.92	.74	.18
$5,000-$6,999	.90	.83	.07	.98	.92	.06	.82	.74	.08
$7,000-$9,999	.80	.83	-.03	.87	.92	-.05	.72	.74	-.02
$10,000-$14,999	.68	.83	-.15	.76	.92	-.16	.60	.74	-.14
$15,000 or more	.64	.82	-.18	.70	.92	-.22	.56	.73	-.17
Unknown	.86	.82	.04	.99	.91	.08	.71	.73	.02
Negro									
Less than $3,000	1.30	1.26	.04	1.36	1.30	.06	1.25	1.22	.03
$3,000-$4,999	1.30	1.25	.05	1.41	1.30	.11	1.19	1.22	-.03
$5,000-$6,999	1.24	1.26	-.02	1.26	1.30	-.04	1.22	1.21	.01
$7,000-$9,999	1.10	1.26	-.16	1.07	1.31	-.24	1.13	1.21	-.08
$10,000-$14,999	1.02	1.27	-.25	1.03	1.30	-.27	1.02	1.22	-.20
$15,000 or more	1.05	1.26	-.21	1.14	1.34	-.20	.96	1.21	-.25
Unknown	1.42	1.27	.15	1.37	1.32	.05	1.47	1.22	.25

[1]Includes all racial groups.

Table 4. Actual and expected average Simplified Oral Hygiene Index (OHI-S) for youths aged 12-17 years, by sex, race, and education of head of household: United States, 1966-70

Race and education of head of household	Both sexes			Boys			Girls		
	Actual	Expected	Difference	Actual	Expected	Difference	Actual	Expected	Difference
	OHI-S								
Total[1]									
None or less than 5 years	1.34	.89	.45	1.52	.97	.55	1.18	.81	.37
5-7 years	1.10	.89	.21	1.20	.96	.24	1.00	.80	.20
8 years	.98	.88	.10	1.08	.97	.11	.89	.80	.09
9-11 years	.96	.89	.07	1.03	.97	.06	.88	.80	.08
12 years	.78	.89	-.11	.86	.97	-.11	.70	.81	-.11
13-15 years	.70	.89	-.19	.77	.97	-.20	.63	.80	-.17
16 years	.63	.89	-.26	.74	.98	-.24	.54	.80	-.26
17 years or more	.59	.89	-.30	.60	.97	-.37	.56	.80	-.24
Unknown	1.08	.88	.20	1.16	.96	.20	1.01	.80	.21
White									
None or less than 5 years	1.30	.83	.47	1.53	.91	.62	1.08	.75	.33
5-7 years	1.04	.83	.21	1.14	.91	.23	.95	.74	.21
8 years	.95	.83	.12	1.06	.92	.14	.84	.73	.11
9-11 years	.88	.83	.05	.95	.92	.03	.81	.74	.07
12 years	.76	.83	-.07	.85	.92	-.07	.67	.74	-.07
13-15 years	.68	.83	-.15	.75	.92	-.17	.61	.73	-.12
16 years	.62	.83	-.21	.73	.93	-.20	.52	.73	-.21
17 years or more	.57	.83	-.26	.60	.92	-.32	.54	.74	-.20
Unknown	.90	.82	.08	1.07	.90	.17	.72	.73	-.01
Negro									
None or less than 5 years	1.43	1.26	.17	1.49	1.30	.19	1.38	1.23	.15
5-7 years	1.26	1.25	.01	1.35	1.29	.06	1.15	1.21	-.06
8 years	1.30	1.26	.04	1.29	1.31	-.02	1.31	1.23	.08
9-11 years	1.27	1.26	.01	1.37	1.31	.06	1.18	1.21	-.03
12 years	1.05	1.26	-.21	1.03	1.29	-.26	1.06	1.22	-.16
13-15 years	1.04	1.26	-.22	1.19	1.32	-.13	.92	1.20	-.28
16 years	1.03	1.23	-.20	.84	1.31	-.47	1.39	1.15	.24
17 years or more	.92	1.26	-.34	.83	1.32	-.49	1.16	1.15	.01
Unknown	1.52	1.28	.23	1.48	1.33	.15	1.54	1.23	.31

[1]Includes all racial groups.

Table 5. Average Simplified Oral Hygiene Index (OHI-S) for youths aged 12-17 years, by sex, race, and geographic region: United States, 1966-70

Race and geographic region	Both sexes	Boys	Girls
Total[1]	OHI-S		
Northeast	.90	.95	.85
Midwest	.85	.94	.77
South	1.01	1.09	.93
West	.80	.90	.69
White			
Northeast	.86	.92	.80
Midwest	.83	.92	.74
South	.86	.96	.76
West	.78	.89	.68
Negro			
Northeast	1.18	1.22	1.15
Midwest	1.14	1.15	1.12
South	1.41	1.45	1.36
West	1.01	1.10	.91

[1] Includes all racial groups.

Table 6. Standard errors of the number and percent of youths aged 12-17 years, by Simplified Oral Hygiene Index (OHI-S) and sex: United States, 1966-70

OHI-S	Both sexes	Boys	Girls	Both sexes	Boys	Girls
	Standard error of number in thousands			Standard error of percent		
Total	10	10	1	-	-	-
0.0	160	84	92	.70	.73	.82
0.1	-	-	-	-	-	-
0.2	140	85	73	.62	.74	.65
0.3	146	66	104	.64	.58	.93
0.4	17	7	15	.08	.06	.13
0.5	145	92	78	.64	.80	.70
0.6	11	12	7	.05	.10	.06
0.7	105	76	82	.46	.66	.73
0.8	101	68	66	.44	.59	.59
0.9	-	-	-	-	-	-
1.0	82	48	63	.36	.42	.56
1.1	-	-	-	-	-	-
1.2	113	68	73	.50	.59	.65
1.3	110	65	58	.48	.57	.52
1.4	8	5	7	.04	.04	.06
1.5	90	57	58	.40	.49	.52
1.6	13	10	7	.06	.09	.06
1.7	70	38	45	.31	.33	.41
1.8	60	25	46	.26	.22	.41
1.9	-	-	-	-	-	-
2.0	66	45	34	.29	.39	.30
2.1	-	-	-	-	-	-
2.2	25	24	16	.11	.21	.15
2.3	34	28	16	.15	.25	.14
2.4	6	5	3	.02	.04	.02
2.5	31	25	14	.13	.22	.12
2.6	5	-	5	.02	-	.04
2.7	24	22	15	.10	.19	.13
2.8	14	11	8	.06	.10	.07
2.9	-	-	-	-	-	-
3.0	18	12	11	.08	.11	.09
3.1	-	-	-	-	-	-
3.2 or more	24	14	17	.11	.12	.15

[1]Includes all racial groups.

Table 7. Standard errors of the average Simplified Oral Hygiene Index (OHI-S), Debris Index (DI-S), and Calculus Index (CI-S) for youths, by race, sex, and age: United States, 1966-70

Sex and age	OHI-S			DI-S			CI-S		
	Total[1]	White	Negro	Total[1]	White	Negro	Total[1]	White	Negro
	Standard error								
Both sexes 12-17 years	.03	.03	.10	.03	.03	.09	.01	.01	.03
12 years	.03	.03	.10	.03	.03	.08	.01	.01	.02
13 years	.03	.03	.09	.04	.03	.10	.01	.01	.03
14 years	.04	.04	.13	.04	.04	.14	.01	.01	.04
15 years	.03	.04	.11	.03	.03	.08	.01	.01	.06
16 years	.04	.04	.11	.04	.04	.08	.02	.01	.06
17 years	.04	.04	.14	.03	.03	.11	.02	.01	.06
Boys 12-17 years	.03	.03	.11	.03	.03	.10	.01	.01	.03
12 years	.03	.03	.12	.03	.03	.08	.01	.01	.04
13 years	.04	.03	.11	.04	.03	.13	.01	.01	.04
14 years	.05	.04	.17	.04	.04	.16	.01	.01	.03
15 years	.03	.04	.12	.03	.04	.10	.01	.01	.07
16 years	.04	.05	.11	.04	.04	.09	.01	.01	.06
17 years	.05	.05	.17	.04	.04	.14	.02	.02	.06
Girls 12-17 years	.03	.03	.10	.03	.03	.08	.01	.01	.04
12 years	.04	.04	.09	.04	.04	.09	.01	.01	.02
13 years	.04	.04	.09	.04	.04	.09	.01	.01	.03
14 years	.04	.04	.10	.04	.04	.12	.01	.01	.06
15 years	.04	.04	.12	.04	.04	.07	.01	.01	.06
16 years	.04	.04	.14	.04	.04	.10	.02	.02	.07
17 years	.05	.04	.16	.03	.03	.10	.02	.02	.09

[1]Includes all racial groups.

Table 8. Standard errors of the average Simplified Oral Hygiene Index for youths aged 12-17 years by sex, race, and family income: United States, 1966-70

Race and family income	Both sexes	Boys	Girls
	Standard error		
Total[1]	.03	.03	.03
Less than $3,000	.05	.06	.06
$3,000-$4,999	.05	.05	.06
$5,000-$6,999	.04	.05	.04
$7,000-$9,999	.03	.03	.04
$10,000-$14,999	.03	.03	.03
$15,000 or more	.04	.04	.04
Unknown	.06	.06	.07
White	.03	.03	.03
Less than $3,000	.03	.05	.04
$3,000-$4,999	.03	.03	.05
$5,000-$6,999	.04	.05	.04
$7,000-$9,999	.03	.03	.04
$10,000-$14,999	.03	.03	.04
$15,000 or more	.04	.04	.04
Unknown	.05	.06	.05
Negro	.10	.11	.10
Less than $3,000	.11	.12	.10
$3,000-$4,999	.14	.14	.14
$5,000-$6,999	.12	.17	.14
$7,000-$9,999	.09	.12	.12
$10,000-$14,999	.09	.07	.17
$15,000 or more	.39	.37	.56
Unknown	.15	.20	.18

[1] Includes all racial groups.

Table 9. Standard errors of the average Oral Hygiene Index for youths aged 12-17 years by sex, race, and education of head of household: United States, 1966-70

Race and education of head of household	Both sexes	Boys	Girls
	Standard error		
Total[1]			
None or less than 5 years	.07	.06	.10
5-7 years	.06	.09	.06
8 years	.05	.05	.06
9-11 years	.04	.05	.05
12 years	.03	.03	.04
13-15 years	.03	.04	.04
16 years	.05	.05	.06
17 years or more	.05	.06	.05
Unknown	.08	.08	.14
White			
None or less than 5 years	.09	.09	.13
5-7 years	.04	.06	.05
8 years	.05	.05	.06
9-11 years	.04	.04	.05
12 years	.03	.03	.04
13-15 years	.04	.05	.05
16 years	.05	.05	.06
17 years or more	.05	.06	.05
Unknown	.05	.07	.09
Negro			
None or less than 5 years	.10	.09	.12
5-7 years	.15	.18	.13
8 years	.18	.18	.22
9-11 years	.11	.14	.12
12 years	.10	.09	.12
13-15 years	.12	.19	.15
16 years	.32	.53	.33
17 years or more	.30	.23	.70
Unknown	.20	.41	.18

[1]Includes all racial groups.

Table 10. Standard errors of the average Oral Hygiene Index for youths aged 12-17 years by race and geographic region: United States, 1966-70

Race and geographic region	Both sexes	Boys	Girls
	Standard error		
Total[1]			
Northeast	.08	.07	.08
Midwest	.06	.05	.06
South	.10	.10	.09
West	.03	.04	.03
White			
Northeast	.08	.08	.09
Midwest	.06	.06	.07
South	.07	.07	.06
West	.04	.05	.03
Negro			
Northeast	.07	.07	.08
Midwest	.02	.05	.08
South	.19	.20	.17
West	.08	.13	.12

[1]Includes all racial groups.

APPENDIX I

STATISTICAL NOTES

The Survey Design

The sample design for the first three programs (Cycles I-III) of the Health Examination Survey has been essentially similar in that each has been a multi-stage, stratified probability sample of clusters of households in land-based segments. The successive elements for this sample design are primary sampling unit, census enumeration district, segment (a cluster of households), eligible persons, and finally the sample person.

The 40 sample areas and the segments utilized in the design of Cycle III were the same as those in Cycle II. Previous reports describe in detail the sample design used for Cycle II and in addition discuss the problems and considerations given to other types of sampling frames, cluster versus random sampling, and whether or not to control the selection of siblings.[5]

Requirements and limitations placed on the design for youths in Cycle III,[3] similar to those for children in Cycle II, were that:

- The target population be defined as the civilian, noninstitutionalized population of the United States, including Alaska and Hawaii, of ages 12-17 years, with the special exclusion of youths residing on reservation lands of the American Indians. The latter exclusion was due to operational problems encountered on these lands in Cycle I.
- The time period of data collection be limited to about 3 years for each cycle and the length of the individual examination within the specially constructed mobile examination center be between 2 and 3 hours.
- Ancillary data be collected on specially designed household, medical history, and school questionnaires and from birth certificate copies.
- Examination objectives be primarily related to factors of physical and intellectual growth and development.
- The sample be sufficiently large to yield reliable findings within broad geographic regions and population density groups as well as age, sex, and limited socioeconomic groups for the total sample.

The sample was drawn jointly with the U.S. Bureau of Census, starting with the 1960 decennial census list of addresses and the nearly 1,900 primary sampling units (PSU's) into which the entire United States was divided. Each PSU is either 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, each stratum having an average size of about 4.5 million persons, to maximize the degree of homogeneity within strata with regard to the population size of the PSU's, degree of urbanization, geographic proximity, and degree of industrialization. The 40 strata were then classified into four broad geographic regions of 10 strata each and then within each region, cross-classified by four population density classes and classes of rate 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.

Further stages of sampling within PSU's required first the selection of census enumeration districts (ED's). The ED's are small well-defined areas of about 250 housing units into which the entire Nation was divided for the 1960 population census. 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 were selected by systematic sampling with each ED having a probability of selection proportional to the population of children 5-9 years at the time of the 1960 census date. A further random selection by size of segments (smaller clusters of housing units) within each ED was then made.

Because of the 3-year time interval between Cycle II and Cycle III, the Cycle III frame had to be supplemented for new construction and to compensate for segments where housing was partially or totally demolished to make room for highway construction or urban redevelopment.

Advanced planning for the examinations at the various locations or stands provided for about 17

days of examinations, which limited the number of examinees per location to approximately 200. When the number of eligible youths drawn in the sample for a particular location exceeded this number, subsampling was done by deleting from the master list of eligible youths (ordered by segment, household order within segment, and age within household) every nth name on the list starting with the yth name, y being a number between 1 and n selected randomly and n being the extent of oversampling in the original draw.

In Cycle III, as in Cycle II, twins who were deleted in the sample selection were also scheduled for examination when time permitted, as were those youths who had been examined in Cycle II.

The sample was selected in Cycle III, as in Cycle II, to contain the correct proportion of youths from families having only one eligible youth, two eligible youths, and so on to be representative of the total target population. However, since households were one of the elements in the sample frame, the number of related youths in the resultant sample is greater than would come from a design which sampled youths 12-17 years without regard to household. The resulting estimated mean measurements or rates should be unbiased, but their sampling variability will be somewhat greater than those from a more costly, time-consuming systematic sample design in which every kth youth would be selected.

The total probability sample for Cycle III included 7,514 youths representative of the approximately 22.7 million noninstitutionalized United States youths 12-17 years of age. The sample contained youths from 25 different States and approximately 1,000 youths in each single year of age.

The response rate in Cycle III was 90 percent, with 6,768 youths examined out of the total sample. These examinees were closely representative of the total sample as well as the population from which the sample was drawn with respect to age, sex, race, region, population density, and population growth in area of residence. Hence it appears unlikely that nonresponse could bias the findings appreciably.

Reliability

While measurement processes in the surveys were carefully standardized and closely controlled; the correspondence between the real world and survey results cannot be expected to be exact. Survey data are imperfect for three major reasons: (1) results are subject to sampling error, (2) the actual conduct of a survey never agrees perfectly with the design, and (3) the measurement processes themselves are inexact even though standardized and controlled.

The report which describes the plan and operation of Cycle III[3] gives in detail the faithfulness with which the sampling design was carried out.

Data recorded for each sample child and youth are inflated in the estimation process to characterize the larger universe of which the sample youth is representative. The weights used in this inflation process are a product of the reciprocal of the probability of selecting the youth, an adjustment for nonresponse cases, and a poststratified ratio adjustment which increases precision by bringing survey results into closer alignment with known U.S. population figures by color and sex within single years of age 12-17 for the survey of youths.

In the third cycle of the Health Examination Survey (as for the children in Cycle II), the samples were the result of three principal stages of selection—the single PSU from each stratum, the 20 segments from each sample PSU, and the sample youth from the eligible persons. The probability of selecting an individual youth is the product of the probability of selection at each stage.

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 12-17 years had about the same probability of being drawn into the respective samples.

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 youths not examined in that sample PSU.

The poststratified ratio adjustment used in the third cycle achieves most of the gains in precision which would have been attained if the sample had been drawn from a population stratified by age, color, and sex. It also makes the final sample estimates of population agree exactly with independent controls prepared by the Bureau of the Census for the U.S. noninstitutionalized population as of March 9, 1968, (approximate mid-survey point for Cycle III) by color and sex for each single year of age 12-17. The weight of every responding sample youth in each of the 24 age, color, and sex classes is adjusted upward or downward so that the weighted total within the class equals the independent population control for each survey.

Sampling and Measurement Error

In this report several references have been made to efforts to evaluate both bias and variability of the measurement techniques. The probability design of the survey makes possible the calculation of sampling errors. The sampling error is used here to determine how imprecise the survey test results may be because

Table I. Number of examined sample youths by receipt of dental examination, sex, and age: Health Examination Survey, 1966-70

Age	Total	Received dental examination		Did not receive dental examination	
		Boys	Girls	Boys	Girls
	Number				
12-17 years	6,768	3,545	3,223	7	4
12 years	1,190	643	547	1	2
13 years	1,208	626	582	1	-
14 years	1,204	618	586	-	-
15 years	1,116	613	503	1	-
16 years	1,092	556	536	2	1
17 years	958	489	469	2	1

they come from a sample rather than from the measurements of all elements in the universe.

The estimation of sampling errors for a study of the type of the Health Examination Survey is difficult for at least three reasons: (1) measurement error and "pure" sampling error are confounded in the data—it is not easy to find a procedure which will either completely include both or treat one or the other separately, (2) the survey design and estimation procedure are complex and accordingly require computationally involved techniques for the calculation of variances, and (3) from the survey are coming thousands of statistics, many for subclasses of the population for which there are a small number of cases. Estimates of sampling error are obtained from the sample data and are themselves subject to sampling error which may be large when the number of cases in a cell is small or even occasionally when the number of cases is substantial.

Estimates of approximate sampling variability for selected statistics used in this report are included in tables 6-10. These estimates have been prepared by a replication technique which yields overall variability through observation of variability among random subsamples of the total sample. The method reflects both "pure" sampling variance and a part of the measurement variance. A similar pseudoreplication technique[8] was used to estimate the standard errors of the correlation coefficients shown in the Discussion section.

By the end of the survey of youths only 11 examined youths had not received a dental examination. These 11 examined youths received imputed dental findings. The imputed values were randomly selected from a pool of adolescents' dental records with the same or similar demographic characteristics. The age-sex distribution for the 6,757 youths given the dental examination and the 11 sample youths for whom findings were imputed are shown in table I. The estimated U.S. population aged 12-17 years by race, sex, and age is shown in table II.

Table II. Estimated number of noninstitutionalized youths, by race, sex, and age: United States, 1966-70

Age	Total	White		Other races	
		Boys	Girls	Boys	Girls
	Number in thousands				
12-17 years	22,692	9,930	9,622	1,560	1,580
12 years	4,003	1,747	1,685	285	286
13 years	3,952	1,729	1,667	277	279
14 years	3,851	1,686	1,632	265	268
15 years	3,750	1,646	1,594	254	256
16 years	3,625	1,594	1,542	242	247
17 years	3,511	1,528	1,502	237	244

Table III. Number of sample youths who received an imputed OHI-S score by sex and age: Health Examination Survey, 1966-70

Age	Total	Boys	Girls
	Number		
12-17 years	85	44	41
12 years	15	4	11
13 years	28	19	9
14 years	21	12	9
15 years	9	4	5
16 years	4	1	3
17 years	8	4	4

Of the 6,757 youths who received dental examinations, 85 youths did not have an OHI-S score. These 85 received an imputed score. The imputed score was randomly selected from a pool of adolescents' dental records with the same or similar periodontal index, age, race, and family income. The 85 sample youths for whom an OHI-S was imputed are shown in table III by age and sex.

Tests of Significance

Tests of significance for oral hygiene and periodontal indexes were performed in one of two ways. The first determined if the difference between two estimated means is equal to or greater than two times the standard error of the difference. The test assumes, in accordance with usual practice, that a 68-percent confidence interval ranges within one standard error of the tabulated statistics and that a 95-percent confidence interval ranges within two standard errors. An approximation of the standard error of the difference $d = x - y$ of two statistics x and y is given by the formula $S_d = (S_x^2 + S_y^2)^{1/2}$ where S_x and S_y are standard errors, respectively, of x and y, as shown in tables 6-10. For example, table 2 shows that the mean OHI-S for 12-year-old youths of all races is 0.94 and 0.82 for 17-year-old youths of all races, while table 7 indicates that the standard error for 12-year-old youths is 0.03 and that for 17-year-olds is 0.04. The formula yields an estimated standard error of the difference ($d = 0.13$) of $S_d = 0.05$. Hence, as the observed difference is more than twice its standard error, it can be concluded that the mean OHI-S of adolescents aged 12 is significantly higher than that of adolescents aged 17.

The second test is to determine if the difference between the estimated actual and expected values is at least two times the standard error of the actual value. For example, for white youths from families with less than $3,000 yearly income, the difference between the actual and expected mean periodontal scores is 0.31 (table 3) and the standard error is 0.03 (table 8). Since the difference is at least twice the standard error, it is deemed statistically significant.

The criterion for significance among geographic regions was more stringent than that for other demographic characteristics. To determine whether the difference between estimated means for youths in any two of the four geographic regions was significant, the difference was required to be at least 2.5 times the standard error.

Small Numbers

In some tables magnitudes are shown for cells for which the sample size is so small that the sampling error may be several times as great as the statistic itself. Obviously in such instances the statistic has no meaning in itself except to indicate that the true quantity is small. Such numbers, if shown, have been included in the belief that they may help to convey an impression of the overall story of the table.

Expected Value

In tables 3-4 the actual mean PI per person is compared with expected estimates. The computation of the expected rates was done as follows:

Suppose it is estimated that in a subgroup there are N_i persons in the ith age group ($i = 1, 2, \ldots 6$; sum of $N_i = N$). Suppose it is estimated that the mean PI per person for the United States in the ith age-sex group is X_i. Then the expected mean PI for the subgroup is

$$\frac{1}{N} \sum_i N_i \, \overline{X}_i$$

Comparison of any actual value for, say, an income group with the expected value for that region is undertaken on the assumption that a meaningful statement can be made which holds, in some average way, for all youths who are in the family income group. This may or may not be true. The specified income group may have higher values for younger youths and lower values for older youths than those found in other income groups. In that case an average comparison would obliterate one or both of these differentials.

In arriving at the general conclusions expressed in the text, an effort was made to consider all the specific data, including data not presented in this report, but it must be recognized that balancing such evidence is a qualitative exercise rather than a quantitative one. The standard error of the difference between an actual and expected value may be approximated by the standard error of the actual value (tables 8-9).

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APPENDIX II

DEMOGRAPHIC AND SOCIOECONOMIC TERMS

Age.—The age recorded for each youth was the age at last birthday before the date of examination. The age criterion for inclusion in the sample used in this survey was defined in terms of age at time of interview. Since the examination usually took place 2-4 weeks after the interview some of those who were 17 years old at the time of interview became 18 years old by the time of examination. There were 23 such cases. In the adjustment and weighting procedures used to produce national estimates these 23 were included in the 17-year group.

Race.—Race was recorded as "white," "Negro," or "other." "Other" included American Indians, Chinese, Japanese, and all races other than white or Negro. Mexican persons were included with "white" unless definitely known to be American Indian or of a race other than white. Negroes and persons of mixed Negro and other parentage were recorded as "Negro."

Geographic region.—For purposes of stratification the United States was divided into four geographic regions of approximately equal population. These regions, which correspond closely to those used by the Bureau of the Census, were as follows:

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

Family income.—The income recorded was the total income of the past 12 months received 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 their own farm or business, in which case net income was recorded.

Parent.—A parent was the natural parent or, in the case of adoption, the legal parent of the child.

Guardian.—A guardian was responsible for the care and supervision of the youth. He (or she) did not have to be the legal guardian to be considered the guardian for this survey. A guardianship could only exist when the parent(s) of the youth did not reside within the sample household.

Head of household.—Only one person in each household was designated as the "head." He (or she) was the person who was regarded as the "head" by the members of the household. In most cases the head was the chief breadwinner of the family although this was not always true. In some cases the head was the parent of the chief earner or the only adult member of the household.

Education of head of household.—The highest grade completed in school was recorded. The only grades counted were those completed in a regular public or private school in which persons received formal education, either during the day or night, with either full-time or part-time attendance. A regular school is one which advances a person toward an elementary or high school diploma or toward a college, university, or professional school degree. Education in vocational, trade, or business schools outside a regular school system was not counted in determining the highest grade of school completed.

APPENDIX III

THE DENTAL EXAMINATION

The periodontal disease status and oral hygiene status of the sample youths who participated in the health examinations conducted during 1966-70 were assessed by the Periodontal Index[2] and the Simplified Oral Hygiene Index.[1] The procedures for scoring and calculating the two indexes follow.

The Periodontal Index (PI)

Scores are assigned according to these criteria:

0 Negative. There is neither overt inflammation in the investing tissues nor loss of function due to destruction of supporting tissues.

1 Mild gingivitis. There is an overt area of inflammation in the free gingivae, but the area does not circumscribe the tooth.

2 Gingivitis. Inflammation completely circumscribes the tooth, but there is no apparent break in the epithelial attachment.

6 Gingivitis with pocket formation. The epithelial attachment has been broken and there is a pocket (not merely a deepened gingival crevice due to swelling in the free gingivae). There is no interference with normal masticatory function; the tooth is firm in its socket and has not drifted.

8 Advanced destruction with loss of masticatory function. The tooth may be loose; may have drifted; may sound dull on percussion with a metallic instrument.

RULE: When in doubt, assign the lesser score.

Each tooth present in the mouth, unless it is a root, is scored, and the arithmetic average of all scores is the individual's PI.

The Simplified Oral Hygiene Index (OHI-S)

Selected surfaces of six teeth are used in making this estimation of oral hygiene status. For the purposes of this examination each surface that is used, buccal or lingual, is considered to encompass half of the circumference of the tooth. The buccal surface of a molar, for example, is considered to include half of the mesial surface and half of the distal.

On both sides of the arch the posterior tooth assessed is the most anterior fully erupted permanent molar or, in its absence, the most distal fully erupted primary molar. In most cases this will be a first permanent molar, but in others it may be a first or second primary molar or a second permanent molar. The buccal surfaces of upper molars and the lingual of lowers are examined. In the anterior portion of the mouth, the labial surfaces of the upper right central incisor and the lower left central incisor are examined. When these teeth are missing, only the adjacent central incisor is examined.

Examining for oral debris.—The surface area covered by debris is estimated by running a number five explorer along the surface being examined and noting the occlusal or incisal extent of the debris as it is removed from the tooth surface and adheres to the explorer.

Scores are assigned according to the following criteria:

0 No debris or stain present.

1 (a) Soft debris covering not more than the gingival third of the tooth surface, or (b) the presence of extrinsic stains without debris regardless of surface area covered.

2 Soft debris covering more than one-third but not more than two-thirds of the exposed tooth surface.

3 Soft debris covering more than two-thirds of the exposed tooth surface.

Examining for oral calculus.—A number five explorer is also used to estimate surface area covered by supragingival calculus and to probe for subgingival calculus.

Scores are assigned according to the following criteria:

0 No calculus present.

1 Supragingival calculus covering not more than one-third of the exposed tooth surface.

2 Supragingival calculus covering more than one-third but not more than two-thirds of the exposed tooth surface, and/or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth.

3 Supragingival calculus covering more than two-thirds of the exposed tooth surface and/or a continuous heavy band of subgingival calculus around the cervical portion of the tooth.

Calculating the index.—The debris scores are totaled and divided by the number of surfaces scored to obtain the Simplified Debris Index. The Simplified Calculus Index is determined similarly. The debris and calculus scores are then added to give the Simplified Oral Hygiene Index.

Training of Examiners

Each of the 6,757 sample youths who received dental examinations during 1966-70 was examined by one of seven dentists. The dentists included two senior examiners, A and B, who trained and supervised the other examiners—C, D,E, F, and G.

Sample youths were not assigned randomly or equally among the various examiners. At most survey locations youths were examined by only one dentist—C, D, E, F, or G. At 14 of 40 locations, however, a small group was examined only by either A or B. Thus, the senior dentists examined few sample youths. The number and percent of youths examined by each dentist were as follows:

	Number	Percent
All examiners	6,757	100.0
A	236	3.5
B	302	4.5
C	1,055	15.6
D	448	6.6
E	1,689	25.0
F	1,472	21.8
G	1,555	23.0

Table IV. Percent distribution of differences in the Periodontal Index (PI) between senior dentists and other dentists on replicate dental examinations: Health Examination Statistics, 1966-70

Difference in Periodontal Index	Examiner					
	C, D, E, F, G	C	D	E	F	G
Median difference	0.0	0.0	0.1	0.0	0.0	0.0
Mean difference	-0.01	-0.01	0.10	-0.03	-0.01	-0.01
Standard deviation of the difference	0.31	0.33	0.17	0.34	0.32	0.19
Number of replicate examinations	407	47	25	162	126	47
	Percent distribution					
All replicate examinations	100.0	100.0	100.0	100.0	100.0	100.0
-1.0 or less	2.2	4.3	-	2.5	2.4	-
-0.9	0.3	-	-	0.6	-	-
-0.8	0.3	-	-	0.6	-	-
-0.7	0.3	-	-	0.6	0.8	-
-0.6	0.7	2.1	-	-	-	-
-0.5	1.0	-	-	0.6	1.6	2.1
-0.4	2.7	-	-	2.5	4.7	2.1
-0.3	3.4	4.3	-	3.7	2.4	6.4
-0.2	8.6	8.5	-	7.4	10.3	12.8
-0.1	13.0	14.9	24.0	13.6	11.1	8.5
0.0	30.4	27.6	24.0	33.4	23.0	42.6
+0.1	18.4	21.2	20.0	14.8	24.6	10.6
+0.2	7.6	4.3	8.0	10.5	6.4	4.3
+0.3	5.2	4.3	16.0	03.1	6.4	4.3
+0.4	2.5	-	4.0	2.5	0.4	6.4
+0.5	1.1	4.3	4.0	0.6	2.4	-
+0.6	0.5	2.1	-	-	0.8	-
+0.7	0.5	2.1	-	0.6	-	-
+0.8	0.5	-	-	0.6	0.8	-
+0.9	0.5	-	-	0.6	0.8	-
+1.0 or more	0.3	-	-	0.6	-	-

Most examinations completed by the senior dentists resulted from a planned series of replicate examinations. As a rule, the findings of the senior dentists were included in the sample youth's examination record, and the findings of the dentist with whom he was paired were kept separate. The primary aim of the replicate examinations was to correct any examiner divergence from the accepted examination procedures.

Throughout the replicate examinations, the senior dentist completed his examination first, without the other dentist present, and dictated his findings to a trained recorder. Then the other dentist completed his examination and the senior dentist recorded the findings. Appreciable interexaminer differences as well as any procedure that diverged from the accepted one were discussed and, if indicated, either resolved or corrected while the sample child was still present. However, the findings originally recorded by the examiner were not altered.

To indicate the level of agreement on the PI, the results of the replicate examinations are shown in table IV. The direction of the disagreements that occurred is shown by positive or negative numbers. A positive number indicates that a finding of the senior dentist was lower than that of the other dentist, while a negative number indicates the opposite.

The data in table IV suggest that the level of examiner agreement between the senior dentists and other dentists was relatively high. Perfect agreement resulted in 30.4 percent of the examinations and about 62 percent of the periodontal scores differed by no more than 0.1. Differences greater than 0.3 occurred in only about 13 percent of the examinations.

Table IV also gives the percent distribution of difference between the PI's assigned by examiners C, D, E, F, and G individually and those assigned by the senior examiners. Examiners D and F achieved perfect agreement less often than did examiners C, E, and G; but no examiner had an absolute mean or median difference in excess of 0.1.

OHI-S Scores by Examiner

The distribution of the OHI-S scores obtained by individual dentists in the Health Examination Surveys of adults in 1960-62, children in 1963-65, and youths in 1966-70 (table V), gives a basis for roughly assessing the comparability of OHI-S scoring over the 10-year period. Only the senior dentists, Examiners 1 and 2, were the same during this entire period. Only one of the other survey dentists conducted examinations

Table V. Cumulative percent distribution of OHI-S scores for children 6-11 years, youths 12-17 years, and adults 18-79 years, by specified score and examiner and number of examinees by survey and examiner: Health Examination Surveys, 1963-65, 1966-70, and 1960-62

Survey and OHI-S score	All examiners	Examiner 1	2	3	4	5	6	7
Children 6-11 years (1963-65)	Percent of examinees							
0	1.0	2.3	0.3	0.3	2.1	-	-	-
0.8 or less	22.5	29.2	23.7	22.6	24.5	12.9	-	-
1.8 or less	78.6	82.3	79.1	80.1	72.6	86.0	-	-
2.8 or less	98.2	99.1	98.7	99.2	95.6	99.9	-	-
Youths 12-17 years (1966-70)								
0	6.7	3.4	4.6	12.8	-	6.7	4.8	7.2
0.8 or less	57.8	54.0	49.8	70.1	14.7	62.4	54.9	61.9
1.8 or less	92.9	90.3	89.8	95.8	83.3	95.3	90.9	94.0
2.8 or less	99.0	98.3	98.3	99.5	97.1	99.4	98.4	99.5
Adults 18-79 years (1960-62)								
0	6.0	2.9	6.6	7.4	5.1	6.7	-	-
0.8 or less	37.5	39.6	34.7	37.7	36.7	38.8	-	-
1.8 or less	66.0	68.2	66.2	64.7	64.5	68.8	-	-
2.8 or less	82.1	85.2	84.8	81.4	79.1	85.3	-	-
3.8 or less	92.9	93.2	94.0	91.8	90.1	97.7	-	-
4.8 or less	98.3	98.8	98.1	98.1	97.2	99.9	-	-
	Number of examinees							
Children 6-11 years	7,096	469	397	3,193	2,185	852	-	-
Youths 12-17 years	6,765	237	303	1,057	450	1,691	1,472	1,555
Adults 18-79 years	5,382	487	467	1,460	1,781	1,187	-	-

in more than one survey. The two senior dentists examined only a limited number of persons in most survey locations while the other dentists gave most of the examinations at all but a few locations. No adjustment has been made in this table for the differences in the age, sex, area, or socioeconomic background of the examinees which might have contributed to the variation in scoring patterns among the regular examining dentists.

In the survey of children only 1 percent of all OHI-S scores were under 0.0 and 22.5 percent were under 0.9 in contrast with the findings for youths in which more than 6 percent of the scores were 0.0 and 57.8 percent were under 0.9. Among adults 6 percent of the scores were 0.0, but only 37.5 percent were under 0.9. In addition it is evident that a much higher proportion of low scores (less than 0.9) were given among youths than among either children or adults by both senior Examiners 1 and 2, the dentists who trained all other dentists during the three surveys.

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