Data from the
NATIONAL HEALTH SURVEY

Series 11
Number 141

Periodontal Disease

Among Youths 12-17 Years

United States

Estimates of the Periodontal Index (PI) 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 the PI and selected demographic characteristics.

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PERIODONTAL DISEASE

AMONG YOUTHS 12-17 YEARS

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

INTRODUCTION

Contents

This report presents national estimates of the prevalence and severity of periodontal disease among youths aged 12-17 years in the United States according to race, sex, age, and other selected demographic characteristics. The severity and prevalence of periodontal disease were measured by the Periodontal Index[1] (PI). A correlation analysis of the interrelation of the PI and selected demographic variables is also included.

Background and Source of Data

During 1966-70 the Division of Health Examination Statistics conducted a survey of the health of the Nation's youth. The target population was the 22.7 million noninstitutionalized U.S. youths aged 12-17 living in the United States (including Alaska and Hawaii) except those residing on lands reserved for American Indians. A probability sample of 7,514 youths was selected to be representative of the population of U.S. youths.[2] The sample design and the procedure by which the sample was selected are described in appendix III.

The 1966-70 survey was the third in the series of sample surveys conducted by the Division of Health Examination Statistics on specified segments of the U.S. population in which health status was determined by direct examination. The first survey collected information about the health of the Nation's adults[3] aged 18-79 years and focused primarily on determining the prevalence of selected chronic health conditions. The second survey was designed to assess health factors related to the growth and development of the Nation's children aged 6-12 years.[4] The survey of youths was conducted in essentially the same way as that of children. Examinations were conducted in mobile centers that visited 40 randomly selected locations in 25 States.

Examination

A standardized examination as administered to each consenting sample youth whose parents or guardians also consented to his or her participation in the survey. Physicians, psychologists, nurses, technicians, and dentists 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 neuromuscular joint system 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 were height, weight, and other body measurements.

The dental examination was conducted by seven 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, in effect, 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 forbidden to dry or isolate teeth or to remove oral debris and calculus. X-rays 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 that usually lasted about 10 minutes.

Definitions of dental conditions and procedures for conducting the examinations were largely the same as those used during the Health Examination Surveys of adults during 1960-62[5] and of children during 1963-65.[6] The same two dentists who trained new examiners during both previous surveys also trained those for the survey of youths and periodically reviewed their findings. Hence, there is reason to believe that the findings collected on both adults and children are comparable with those obtained on youths. In addition, a comparison of the findings from replicate dental examinations (appendix I) suggests that interexaminer variability was reasonably well controlled and did not seriously bias the PI findings. Appendix I contains a description of the training and calibration 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. The national sample and the examined group are closely representative of the 22.7 million noninstitutionalized youths 12-17 years of age in the United States with respect to age, sex, race, region, population size of place of residence, and rate of population change in size of place of residence from 1950 to 1960. (See appendix II for definitions of demographic and socioeconomic terms.)

Limitations of Data

Several limiting factors need to be considered when using the data contained in this report. The target population did not include institutionalized persons nor did it include persons residing on lands reserved for American Indians. Hence, a portion of the U.S. population that 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, the 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 statistical tests of significance, as specified in appendix III.

PERIODONTAL INDEX (PI)

The prevalence and severity of periodontal disease among U.S. youths were measured by the Periodontal Index[1] (PI). The PI scores each tooth in the mouth, provided it is not a root, according to the presence and severity of periodontal disease. A score of 0 is assigned when no indication of disease is found. If 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).

PERIODONTAL INDEX FINDINGS

Table A shows the estimated number and percent distribution of U.S. youths aged 12-17 years, by status of periodontal disease. As classified by the Periodontal Index (PI), an estimated 15.4 million youths, or about 68 percent, showed a positive indication of periodontal disease. Of those with disease, 14.1 million had gingivitis (inflammation of the gums), and 1.3 million had destructive disease with obvious pocket formation. The remaining 7.3 million youths had no manifest sign of periodontal disease.

Table A. Estimated number and percent distribution of youths aged 12-17 years, by periodontal status: United States, 1966-70

Status of periodontal disease	Number of youths in thousands	Percent distribution
Total	22,679	100.0
Without periodontal disease	7,274	32.1
With periodontal disease	15,405	67.9
Without pockets	14,077	62.1
With pockets	1,328	5.8

Although about 7 out of every 10 youths were classified as having periodontal disease, relatively few had the severe form of the disease (table 1). Nearly half the youths (47.7 percent) had PI scores of 0.1 or less, 69.7 percent had scores of less than 0.4, and 82.4 percent had scores less than 0.6. The concentration of low PI scores and, as noted previously, the small percent (5.8) of youths with destructive disease evident suggest that periodontal disease is not an imminent threat to the oral health of most youths.

The PI was designed for epidemiologic use, and it is both rapid and simple to apply. It is also a relatively objective method of classification that makes it especially suitable for epidemiologic surveys. But even though the PI does not classify periodontal disease by clinical criteria, specified ranges of the index among adults have been found to correspond generally with various clinical stages of gingivitis and chronic destructive disease. The relationship is described by Russell as follows:

> Most persons considered to be normal, clinically, score from zero to 0.1 or 0.2; those with a clinical diagnosis of gingivitis, from 0.1 to 1.0; those with severe gingivitis to incipient destructive disease, from 0.5 to 1.9; those with frankly established destructive disease, from 1.5 to 5.0; and those with disease in terminal stages from about 4.0 to 8.0, the maximum score.[7]

Ranges of the PI and their corresponding clinical stages have not been established for youths. Nevertheless, periodontal disease in U.S. youths may be described as generally ranging from mild to severe gingivitis, with little indication of destructive disease.

Although relatively small differences in the PI are not usually significant clinically, they may nevertheless indicate variations in the prevalence and distribution of periodontal disease 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.

Age

The mean PI for all youths aged 12-17 years was 0.31 (table 2). Although the increases in mean PI between successive years of age are not statistically significant, the mean PI nevertheless appears to increase slightly with advancing age and is significantly greater among older than among younger youths. The mean PI for 12-year-old youths (0.27) was substantially less than that for 17-year-olds (0.36). Also, the mean PI for 12-year-olds was significantly less than that for both 15- and 16-year-old youths. The relationship between age and mean PI is graphically illustrated in figure 1.

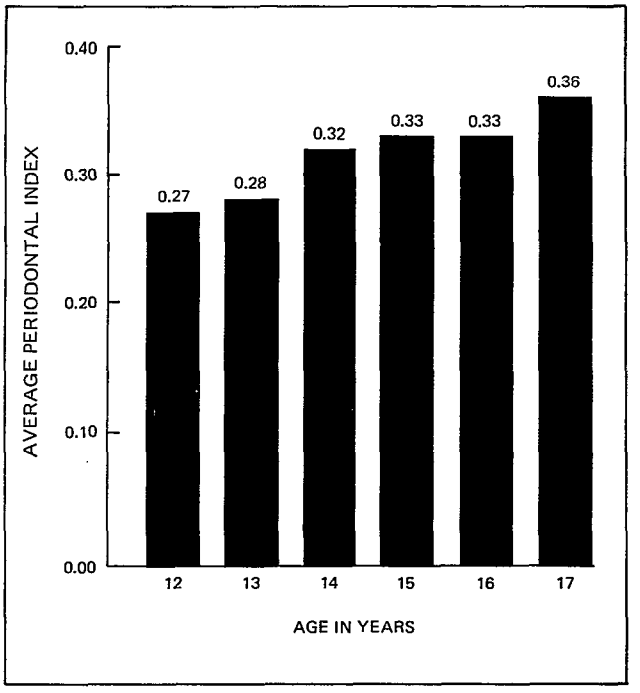

Figure 1. Average Periodontal Index for youths by age: United States, 1966-70.

The national estimates in table 2 also show that there is a direct relationship between periodontal disease and age among Negro youths. The mean PI for 12-year-old Negro youths was significantly lower than that for Negro youths of every other age except for those 13 years old. Among white youths, on the other hand, the mean PI did not increase significantly with advancing age (figure 2). Thus the weak association of PI with age found among youths of all races appears to be primarily a reflection of that same association among Negro youths.

Sex

The mean PI for girls (0.30) of all races was not materially different from that for boys (0.33). In addition, the mean indexes for boys and girls within any of the age groups did not differ significantly. Similarly, the mean PI for white girls was not different from that for white boys nor was that for Negro girls different from that for Negro boys. Regardless of age or race, there was no essential difference between the mean PI of male and female youths.

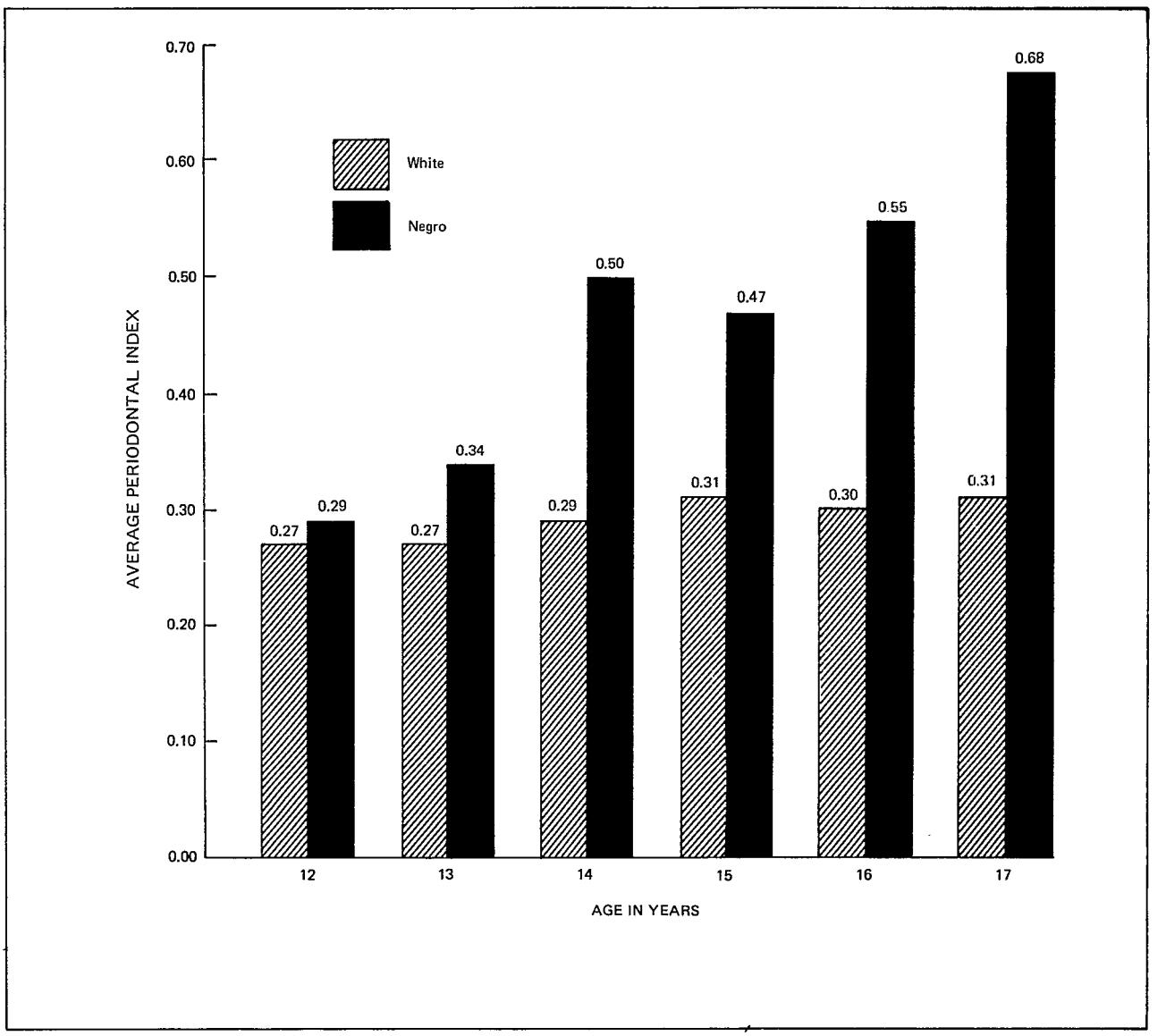

Figure 2. Average Periodontal Index for youths by race and age: United States, 1966-70.

Race

Negro youths had substantially more periodontal disease than white youths. The mean PI for all Negro youths (0.46) was significantly greater than that for all white youths (0.29). In addition, both Negro boys and girls had significantly higher mean PI than white youths of the same sex: the index for Negro boys was 0.45 as compared with 0.31 for white boys, and that for Negro girls was 0.48 as compared with 0.28 for white girls (table 2). Differences in the periodontal status of white and Negro youths were also found among youths of the same age. Within four of the six age groups, Negro youths had significantly higher mean indexes than did white youths (figure 2). Thus the mean PI of Negro youths was materially higher than that of white youths regardless of their age or sex.

Expected (Age-Control) Value

In order to control for age, we introduce the expected value. Since the foregoing estimates indicate that age is related to mean PI, an adjustment was made for differences in the age distribution of the youths 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 mean expected values for the age range 12-17 years was used instead of a comparison of mean age-specific values. Sampling variability for specific age groups was usually larger than for the total age span owing to the smaller number of sample youths at each age. It is because the larger sampling variability for age-specific groups frequently masks the relationship which exists with respect to socioeconomic variables that the summary comparison (actual-expected) was used here instead of mean age-specific comparisons.

Expected values were calculated by weighting age-specific mean PI for the total U.S. population of youths by the number of youths in each 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 PI of a given demographic group is excessively larger or smaller than the mean of that group for the United States and that the excess is not attributed to age.

Income

The amount of yearly income earned by a family was inversely associated with the occurrence of periodontal disease among youths. As illustrated in figure 3, the mean PI for youths in the lowest income group (less than $3,000) was appreciably greater than that for youths in the higher income groups. For example, youths whose families earned less than $3,000 per year had a mean PI of 0.49, but youths whose families earned $15,000 or more per year had a mean PI of only 0.21 (figure 3, table 3).

When age was taken into consideration by comparing mean actual with mean expected values, the inverse relation between mean PI and family income continued to be evident. For in-

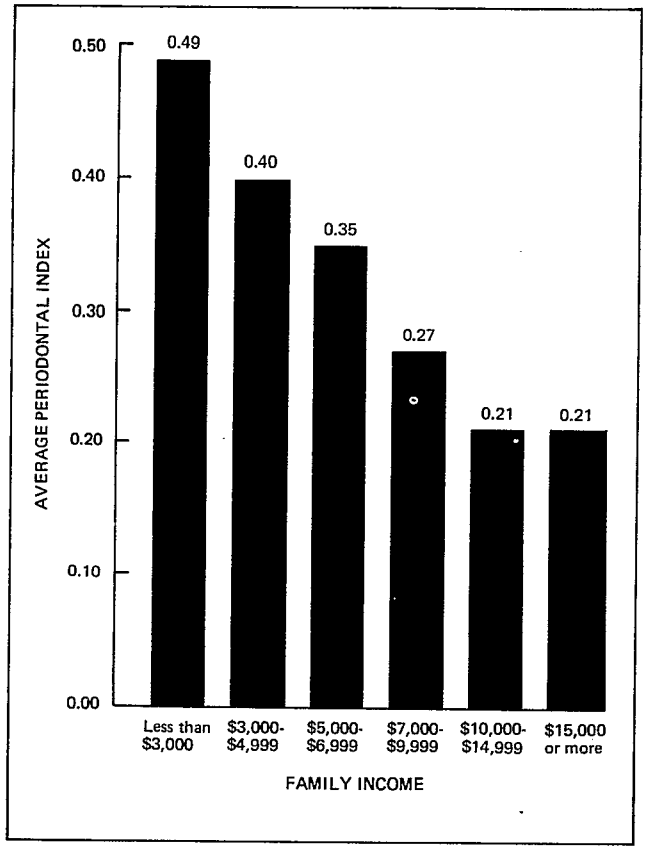

Figure 3. Average Periodontal Index for youths aged 12-17 years by family income: United States, 1966-70.

stance, youths whose families earned less than $3,000 per year had a substantially higher mean PI than expected, whereas youths whose families earned $15,000 or more had a mean PI substantially lower than expected (figure 4).

The association of mean PI and family income for white youths was similar to that for youths of all races. As among all races, the mean PI for white youths varied inversely with family income (figure 5). The mean PI of white youths whose families earned $15,000 or more was substantially less than that for white youths whose families earned less than $3,000 (table 3, figure

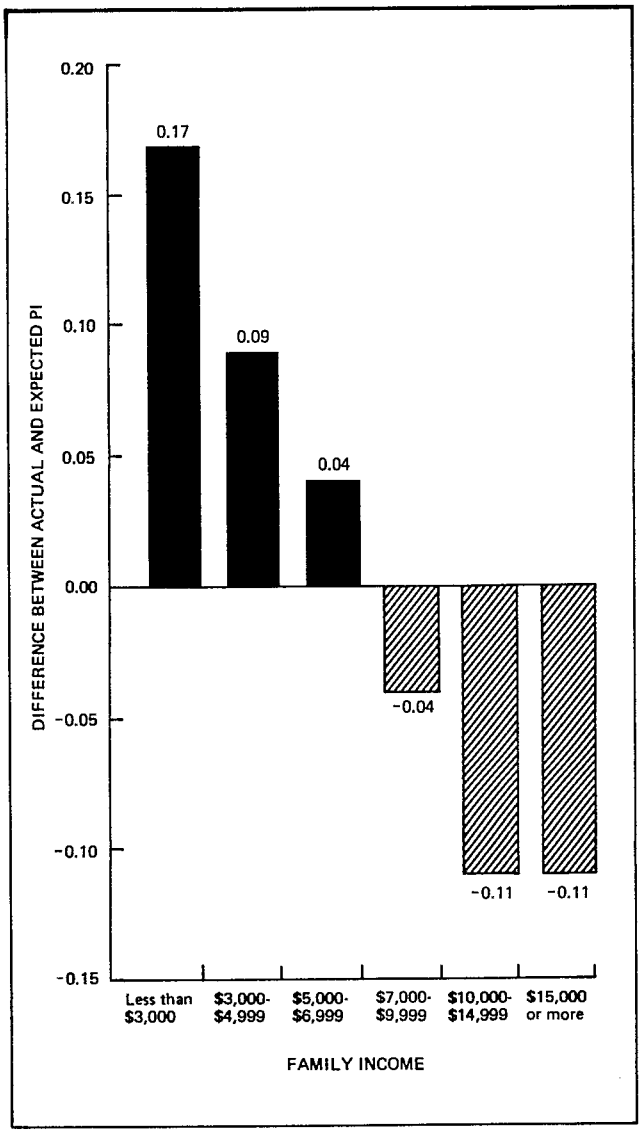

Figure 4. Difference between actual and expected average Periodontal Index (PI) for youths aged 12-17 years by family income: United States, 1966-70.

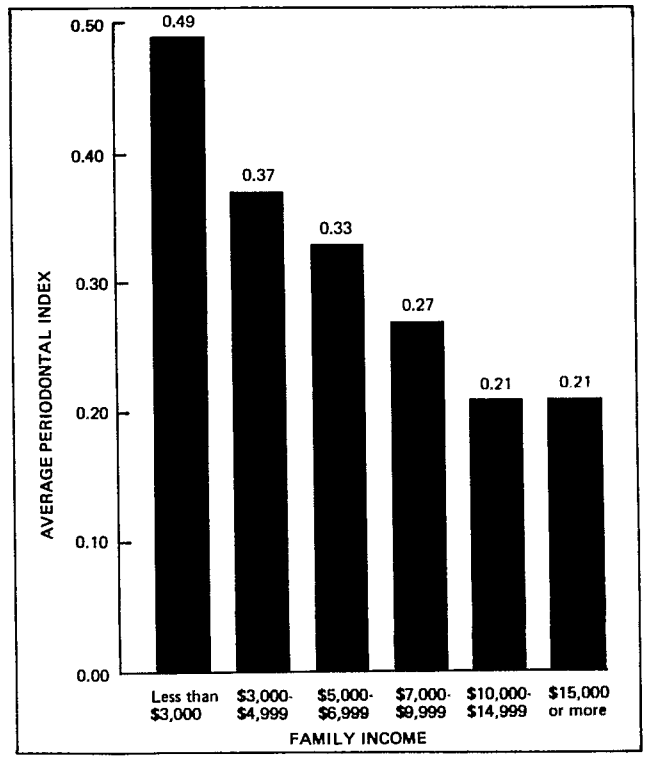

Figure 5. Average Periodontal Index for white youths aged 12-17 years by family income: United States, 1966-70.

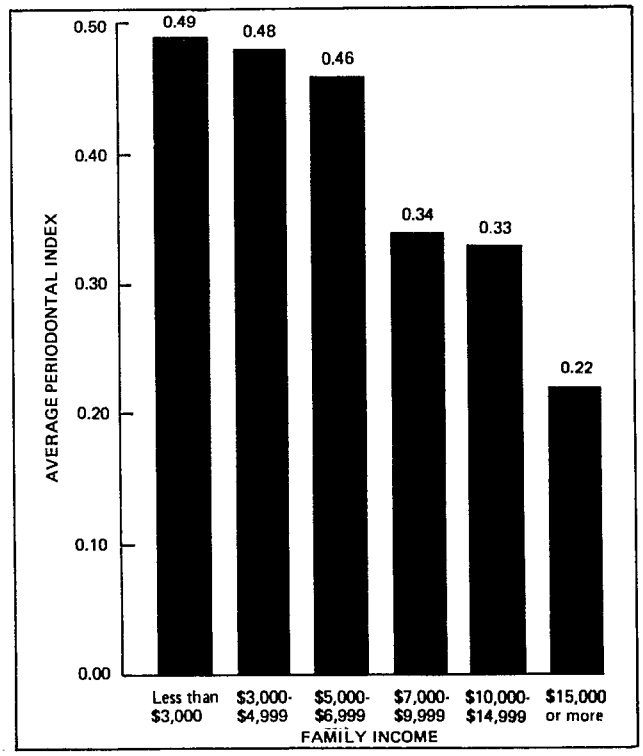

Figure 6. Average Periodontal Index for Negro youths aged 12-17 years by family income: United States, 1966-70.

5). An age control was not applied to white youths in this and the following sections, since it was previously determined that mean PI of white youths was essentially independent of age. Similarly, sex specifics are not discussed in this report, because no relationship between mean PI and sex was noted.

The mean PI of Negro youths also varied inversely with family income. Negro youths in families with an annual income of less than $3,000 had a higher mean PI than those in each of the higher income groups (figure 6). After controlling for age, the weak association between periodontal disease and family income continued to be evident to the extent that Negro youths in the two highest income groups had appreciably less periodontal disease than expected (table 3).

Education

The estimated actual and expected mean PI of youths according to sex, race, and educational attainment of head of household are shown in table 4. The education of parents was inversely associated with periodontal disease of adolescents. PI decreased from a high of 0.61 for youths whose parents had less than 5 years of education to a low of 0.16 for those whose parents had 17 years or more of education (figure 7). After allowances were made for differences in age, the inverse relation continued to be evi-

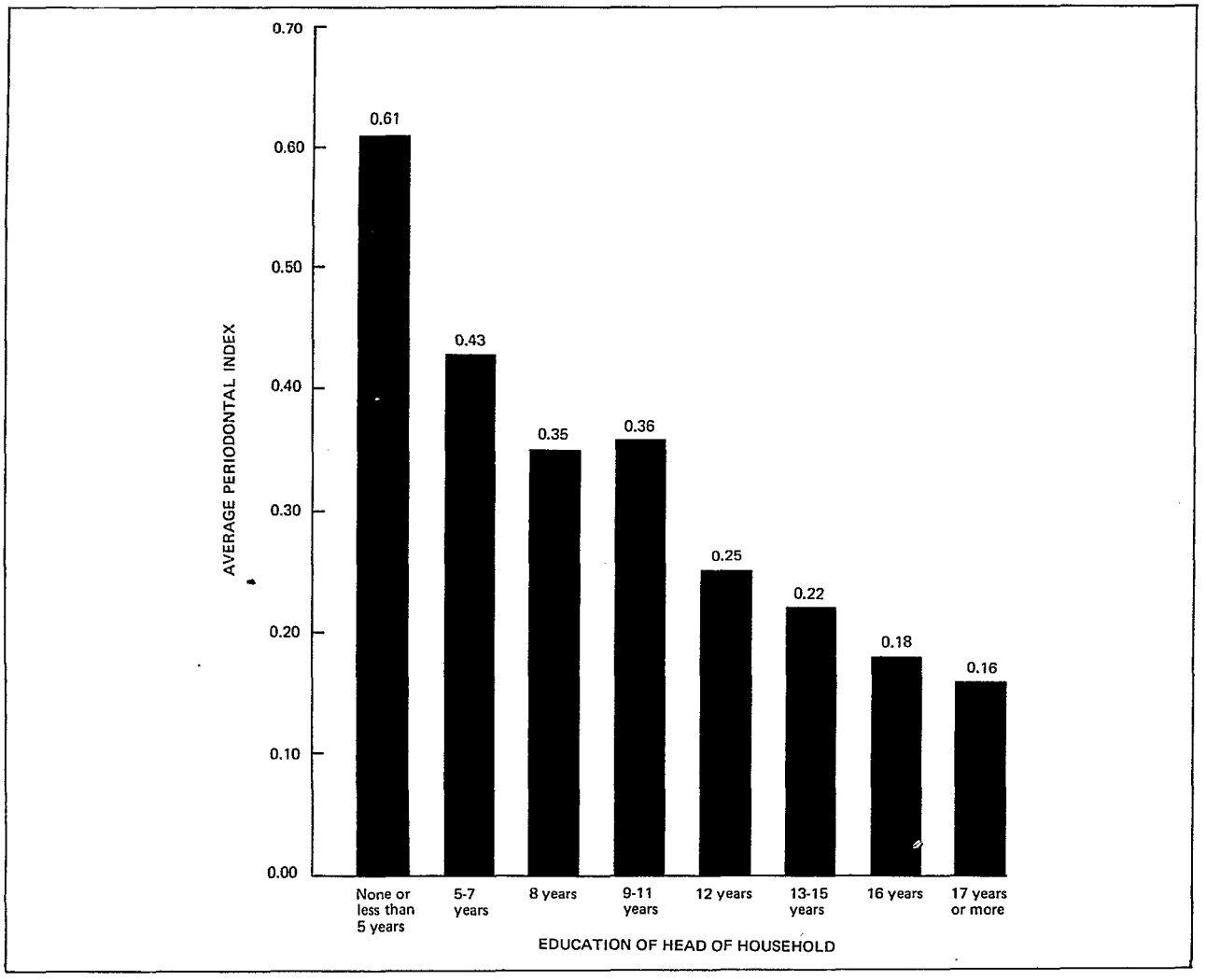

Figure 7. Average Periodontal Index for youths of all races aged 12-17 years by education of head of household: United States, 1966-70.

dent. For example, the mean PI of youths whose parent or guardian had less than 5 years of education was greater than expected, while that for those whose parents had 17 years or more of education was appreciably less than expected (figure 8).

Since there are appreciably more white than Negro youths in the United States, findings for all races reflect, to a great extent, the findings of white youths. Thus, as noted for all youths, the mean PI for white adolescents was inversely associated with the educational achievement of their parents (figure 9). Mean PI decreased from a high of 0.61 for white adolescents whose parents had less than 5 years of education to a low of 0.16 for those whose parents had 17 years or more of education.

For Negro youths, the mean PI did not appear to be related to their parents' educational status. For instance, the mean PI for Negro adolescents whose parents had less than 5 years of education was not appreciably different from that of other Negro youths whose parents had more formal education. After controlling for age, no relation between PI and education of head of household appeared among Negro adolescents.

Region

The mean PI for youths of all races (table 5) was substantially higher in the South (0.39) than in the West (0.29) and Midwest (0.26). After accounting for age, the mean PI of youths in the South remained higher than that of youths in the West and Midwest.

As for youths of all races, Negro adolescents residing in the South had an appreciably greater mean PI (0.56) than did those in both the West (0.28) and Midwest (0.35). After age differences were considered, the mean PI of Negro youths in the South continued to be higher than that of Negro youths in the West and Midwest. The estimates for white youths did not differ significantly for any region.

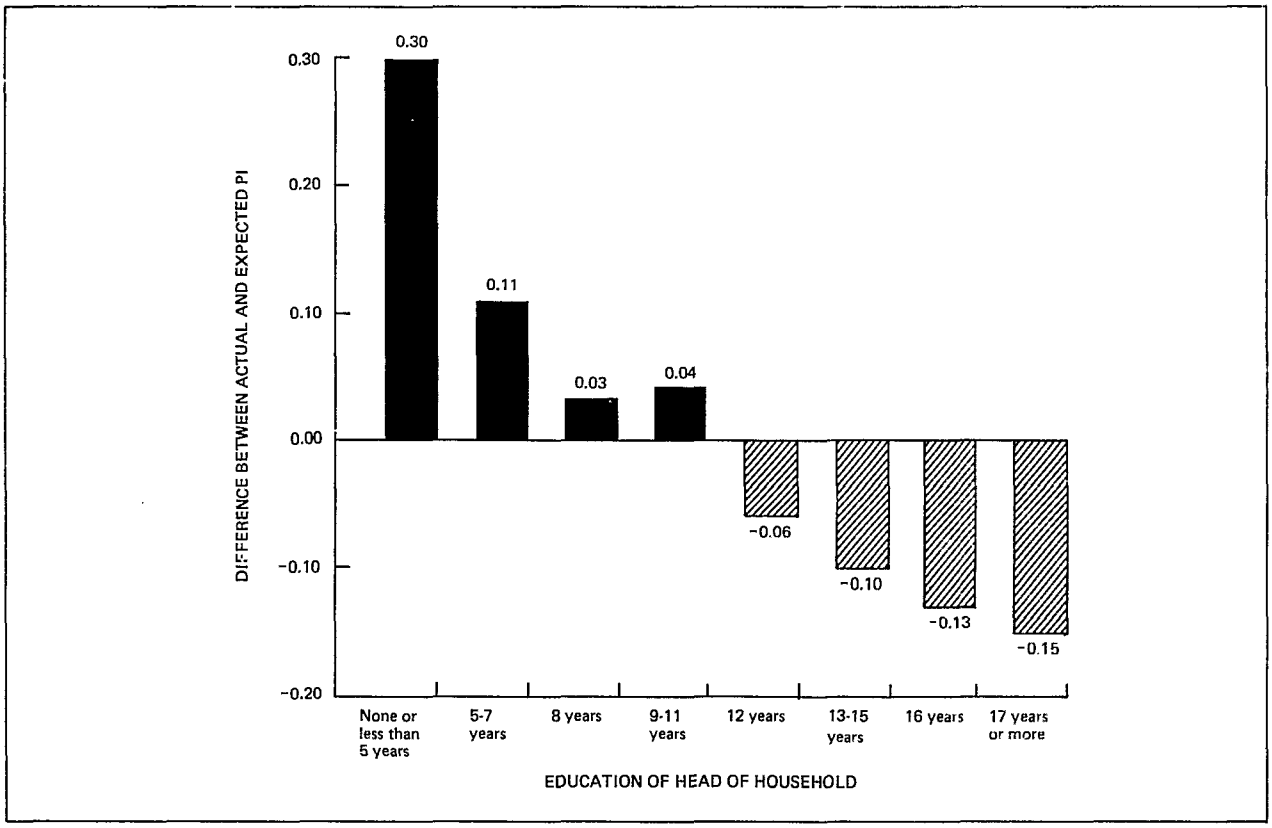

Figure 8. Differences between actual and expected average Periodontal Index (PI) for youths aged 12-17 years by education of head of household: United States 1966-70.

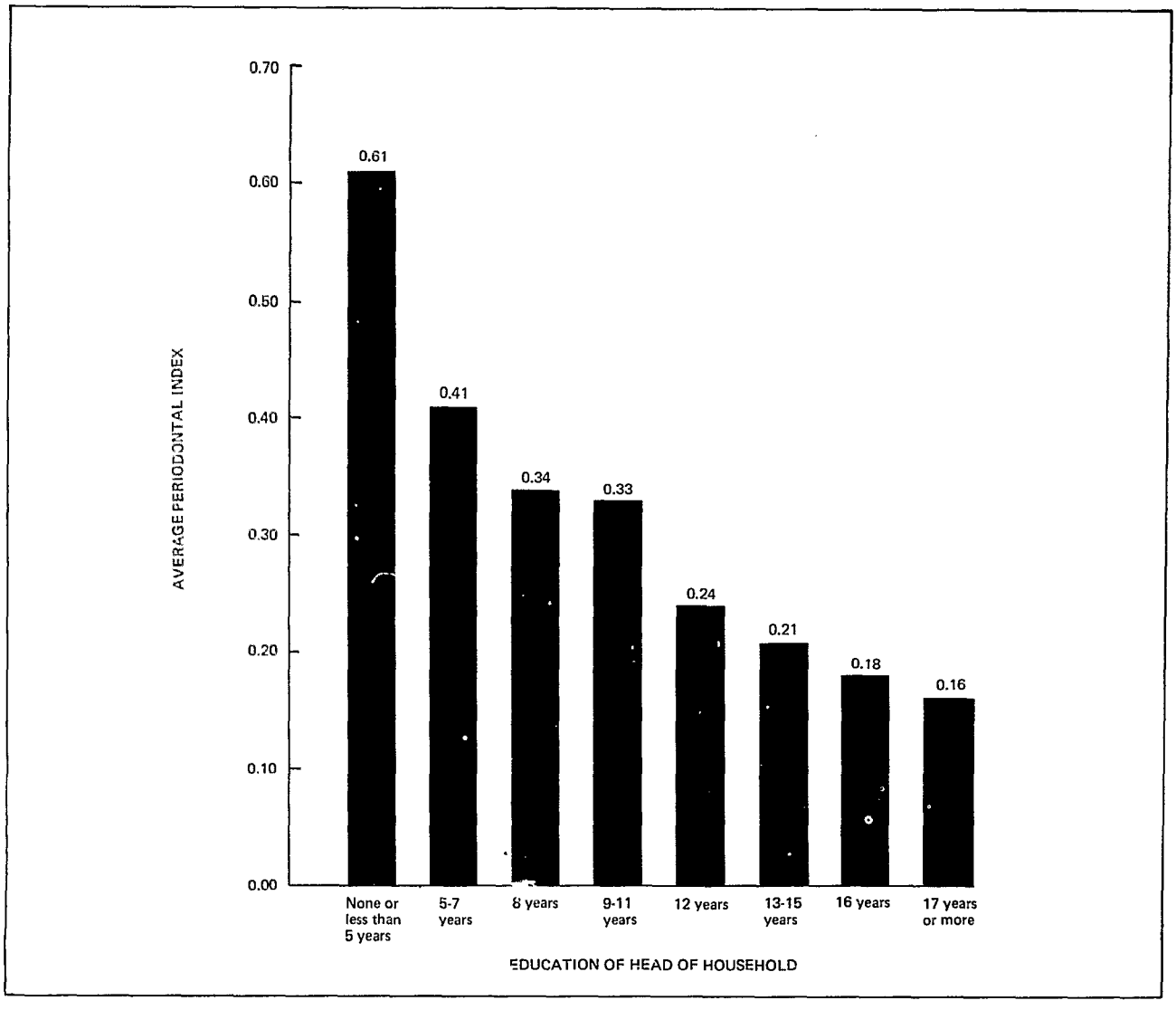

Figure 9. Average Periodontal Index for white youths aged 12-17 years by education of head of household: United States, 1966-70.

DISCUSSION

Interrelation of PI and Selected Demographic Variables

The interrelation of PI 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, race, income, and education) with PI are quantified separately by calculating simple correlation coefficients. The simple correlation coefficients shown in table B indicate that age, race, family income, and education of head of household are related, in varying degrees, to periodontal disease. These correlations would be expected since the mean PI was previously shown to be related to age, race, income, and education. Further insight into the relationship of the variables with periodontal disease may be obtained from the partial correlation coefficients in table B which quantify the correlation between each variable and periodontal disease when the associations between the other variables and PI are held constant.

Thus, when the association among periodontal disease and age, income, and education are

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

Selected variables	Correlation coefficients and standard errors			
	Simple	Standard error	Partial for 5-variable equation	Standard error
Age	.06	.014	.06	.015
Race	.12	.041	.05	.045
Family income	-.21	.019	-.09	.022
Education of head of household	-.22	.024	-.12	.023

held constant, the correlation between periodontal disease and race becomes insignificant. Hence, the association between race and periodontal disease is largely accounted for by differences in income and education.

Income and education have been shown to be associated with periodontal disease. However, family income is also highly correlated with education ($r = 0.56$). Two questions now arise: First, is education independently associated with the Periodontal Index, or is the association due to the correlation between income and education? Second, is income independently associated with the Periodontal Index, or is the association a reflection of the correlation between education and income?

With income, race, and age held constant, the partial correlation between education and the Periodontal Index is substantially different from zero. The partial correlation between income and the Periodontal Index is also significantly different from zero when the effects of education, race, and age are held constant. It would appear that both education and income are independently associated with periodontal disease.

PI Findings From Previous HES Reports

The national estimates in this report bring to completion an epidemiologic description of the occurrence of periodontal disease in the noninstitutionalized, civilian U.S. population aged 6-79 years. The first report that contained national estimates for a major segment of the Nation's population described the occurrence of periodontal disease among adults aged 18-79 years (1960-62).[8] The second one contained estimates for children aged 6-11 years (1963-65).[6] The mean PI scores for the successive age groups in all three surveys are shown in table C.

The periodontal findings for children, youths, and adults are believed to be comparable, largely because the training and supervision of the examining dentists were essentially the same throughout the three surveys. It should be pointed out, however, that the data on which the estimates are based were collected during different years, and it is not known whether the periodontal status of the population changed appreciably during the period that began in 1960 at the start of the adults' examinations and ended in 1970 at the close of the youths' exami-

Table C. Average Periodontal Index (PI) for children, 1963-65; youths, 1966-70; and adults, 1960-63, by age: United States

Age	Mean PI
Children, 6-11 years	0.13
Youths, 12-17 years	0.31
Adults, 18-79 years	1.13
18-24 years	0.54
25-34 years	0.75
35-44 years	1.04
45-54 years	1.42
55-64 years	1.84
65-74 years	2.05
75-79 years	2.92

nations. Nonetheless, it seems reasonable to assume that any change in periodontal status that might have occurred, especially among children and youths, was minimal.

The average score per person for children, youths, and adults is shown according to single year of age in table D. The upward trend with increasing age suggests that the relationship of PI with age approximates a linear one. In addition, the uptrend is fairly smooth, suggesting that the estimates for the three population segments are comparable for all practical purposes.

The qualitative changes that occur in periodontal disease with advancing age are indicated in table E. The percent free of overt signs of gingival and periodontal disease decreased from 61.3 for children to 32.1 for youths and to 26.1 for adults. The percent with inflamed gums but without periodontal pockets increased from 37.9 for children to 62.1 for youths and then decreased to 48.5 for adults. The smaller percent of adults than of youths with gingivitis resulted from the rapid increase in the prevalence of destructive periodontal disease among older adults. For instance, the percent with periodontal pockets increased from 0.8 for children to 5.8 for youths and finally to 25.4 for adults. Furthermore, the percent of adults with pocket formation rose steadily from a low of about 10 for those aged 18-24 years to a high of about 55 for those aged 75-79 years. Clinically, the picture is one in which, on the one hand, the prevalence and severity of gingivitis rise rapidly during adolescence and, on the other hand, the prevalence and severity of chronic destructive disease rise rapidly during adulthood.

The association of PI with selected demographic characteristics prevailed consistently during childhood, adolescence, and adulthood in some instances but not in others. For example, scores rose with age more consistently among white than among Negro children; whereas during adolescence only the scores of Negro youths showed upward trends with age. By contrast, the PI of both white and Negro adults increased sharply with advancing age.

Table D. Average Periodontal Index (PI) for children, 1963-65; youths, 1966-70; and adults, 1960-63, by single year of age: United States

Age	Mean PI
Children, 6-11 years	0.13
6 years	0.07
7 years	0.11
8 years	0.13
9 years	0.15
10 years	0.14
11 years	0.16
Youths, 12-17 years	0.31
12 years	0.27
13 years	0.28
14 years	0.32
15 years	0.33
16 years	0.33
17 years	0.36
Adults, 18-24 years	0.54
18 years	0.36
19 years	0.51
20 years	0.62
21 years	0.44
22 years	0.61
23 years	0.66
24 years	0.57

Table E. Percent distribution of children, 1963-65; youths, 1966-70; and adults, 1960-63; by status of periodontal disease and age: United States

Status of periodontal disease and age	Percent distribution
U.S. children, 6-11 years	100.0
Without periodontal disease	61.3
With periodontal disease	38.7
Without pockets	37.9
With pockets	0.8
U.S. youths, 12-17 years	100.0
Without periodontal disease	32.1
With periodontal disease	67.9
Without pockets	62.1
With pockets	5.8
U.S. adults, 18-79 years	100.0
Without periodontal diseases	26.1
With periodontal diseases	73.9
Without pockets	48.5
With pockets	25.4

The association of PI with sex and race also differed during the three stages of growth and development. Mean scores for children and youths did not differ by sex, but mean scores for men were consistently higher than those for women of comparable age. Further, scores were not associated with race among children, but scores for Negro youths and adults were consistently higher than those for white youths and adults of comparable age and sex.

By contrast, the inverse association of PI with family income and education (both the adults' own and that of the children's and youths' parents) prevailed among all three age ranges of the population. In addition, mean periodontal scores per person were significantly higher for those children and youths of all races living in the South than for those living in the Midwest and West.

As indicated in table E, significant qualitative changes occurred in periodontal disease with advancing age. The PI measures only quantitative changes, which for youths aged 12-17 years and also for children 6-11 years of age were usually so slight that they gave no clinical significance. Thus the association of PI with a demographic characteristic must be a relatively strong one to persist during childhood, adolescence, and adulthood.

The Oral Hygiene Index and its relation to PI and various demographic characteristics are not included in this report.

SUMMARY

The data presented in this report are national estimates from the Division of Health Examination Statistics survey of youths in 1966-70. A probability sample of 7,514 adolescents 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 (or 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 parent education. The prevalence and severity of periodontal disease were measured by Russell's Periodontal Index.

Periodontal disease, although quite prevalent among the adolescents of the United States, is not usually severe in this group. Approximately 68 percent of the Nation's youths had some visible sign of periodontal disease, but the abundant number of youths with low PI scores and the relatively small proportion of youths with destructive disease indicate that periodontal disease, when present, was usually mild.

The average PI for all youths aged 12-17 years was 0.31. Periodontal disease increases slightly with advancing age, rising from 0.27 for 12-year-olds to 0.36 for 17-year-olds. Similarly the mean PI for Negro adolescents was directly associated with age; but among white adolescents, periodontal disease does not increase significantly with advancing age.

The prevalence of periodontal disease is similar among boys and girls, regardless of age or race. The mean PI for girls (0.30) of all races was not materially different from that of boys (0.33). In addition, within any of the age groups the mean PI for boys did not differ significantly from that of girls. The mean PI for white boys was not different from that of white girls nor was that for Negro boys different from that of Negro girls.

Significant differences in periodontal disease were found by race. The mean PI for all Negro youths (0.46) was significantly greater than that for all white youths (0.29). Both Negro boys and girls had materially higher mean indexes than white adolescents of the same sex. Within the same age group, Negro adolescents usually had appreciably higher mean scores than did white youths.

The difference observed in periodontal disease by race was attributed primarily to differences in family income and education. With both income and education held constant, the partial correlation between race and the Periodontal Index was not materially different from 0. Hence, the association between race and periodontal disease is largely accounted for by differences in income and education.

Periodontal disease, as measured by the Periodontal Index, is inversely related to income. Among the adolescents of all races, for example, the mean PI of youths in families with an income of less than $3,000 per year was 0.49, but those in families with an income of $15,000 per year or more had a mean PI of 0.21.

As with family income, education of parents was inversely associated with mean PI of adolescents. This was not unexpected since income

and education are highly correlated. However, it was also found that income and education were independently associated with periodontal disease.

Regardless of age, the mean PI for youths was higher in the South than in the West and Midwest. Similarly, Negro youths in the South had a higher mean PI than Negro youths in the West and Midwest. The estimates of PI scores for white youths did not differ materially among the regions.

A comparison of this report's findings with the findings of Health Examination Surveys of children in 1963-65 and of adults in 1960-62 is included in this report. The comparison shows a similar association of PI with demographic characteristics, particularly family income and education, during childhood, adolescence, and adulthood.

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Table 1. Number and percent distribution of youths aged 12-17 years, by Periodontal Index and sex: United States, 1966-70

Periodontal Index	Both sexes	Boys	Girls	Both sexes	Boys	Girls
	Number in thousands[1]			Percent distribution		
Total	22,679	11,476	11,203	100.0	100.0	100.0
0.0	7,274	3,507	3,767	32.1	30.6	33.6
0.1	3,536	1,609	1,927	15.6	14.0	17.2
0.2	2,643	1,340	1,304	11.7	11.7	11.6
0.3	2,340	1,149	1,191	10.3	10.0	10.6
0.4	1,706	986	719	7.5	8.6	6.4
0.5	1,180	684	495	5.2	6.0	4.4
0.6	780	464	316	3.4	4.0	2.8
0.7	585	336	250	2.6	2.9	2.2
0.8	581	313	268	2.6	2.7	2.4
0.9	382	226	156	1.7	2.0	1.4
1.0	272	188	83	1.2	1.6	0.7
1.1	258	126	132	1.1	1.1	1.2
1.2	152	72	81	0.7	0.6	0.7
1.3	139	77	62	0.6	0.7	0.6
1.4	136	77	59	0.6	0.7	0.5
1.5	140	61	78	0.6	0.5	0.7
1.6	90	45	45	0.4	0.4	0.4
1.7	70	35	36	0.3	0.3	0.3
1.8	68	43	25	0.3	0.4	0.2
1.9	53	24	28	0.2	0.2	0.3
2.0	61	30	31	0.3	0.3	0.3
2.1	34	11	23	0.2	0.1	0.2
2.2	19	13	6	0.1	0.1	0.1
2.3	31	13	18	0.1	0.1	0.2
2.4	20	3	18	0.1	0.0	0.2
2.5	21	3	18	0.1	0.0	0.2
2.6	3	-	3	0.0	-	0.0
2.7	14	7	7	0.1	0.1	0.1
2.8	-	-	-	-	-	-
2.9	8	5	3	0.0	0.1	0.0
3.0	6	-	6	0.0	-	0.1
3.1	7	4	3	0.0	0.0	0.0
3.2 or more	71	25	46	0.3	0.2	0.4

[1] Rounded to nearest thousand.

Table 2. Average Periodontal Index for youths, by race, sex, and age: United States, 1966-70

Sex and age	All races[1]	White	Negro
Both sexes			
Total, 12-17 years	0.31	0.29	0.46
12 years	0.27	0.27	0.29
13 years	0.28	0.27	0.34
14 years	0.32	0.29	0.50
15 years	0.33	0.31	0.47
16 years	0.33	0.30	0.55
17 years	0.36	0.31	0.68
Boys			
Total, 12-17 years	0.33	0.31	0.45
12 years	0.28	0.27	0.35
13 years	0.29	0.28	0.31
14 years	0.34	0.32	0.46
15 years	0.35	0.33	0.43
16 years	0.33	0.30	0.54
17 years	0.37	0.33	0.66
Girls			
Total, 12-17 years	0.30	0.28	0.48
12 years	0.25	0.26	0.23
13 years	0.28	0.26	0.38
14 years	0.30	0.26	0.55
15 years	0.32	0.29	0.51
16 years	0.34	0.30	0.56
17 years	0.34	0.29	0.70

[1] Includes data for "other races," which are not shown separately.

Table 3. Actual and expected average Periodontal 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		
	Actual	Expected	Difference	Actual	Expected	Difference	Actual	Expected	Difference
All races[1]									
Less than $3,000	0.49	0.32	0.17	0.55	0.33	0.22	0.45	0.30	0.15
$3,000-$4,999	0.40	0.31	0.09	0.36	0.33	0.03	0.39	0.30	0.09
$5,000-$6,999	0.35	0.31	0.04	0.35	0.33	0.02	0.34	0.30	0.04
$7,000-$9,999	0.27	0.31	-0.04	0.28	0.33	-0.05	0.26	0.30	-0.04
$10,000-$14,999	0.21	0.32	-0.11	0.23	0.33	-0.10	0.19	0.30	-0.11
$15,000 or more	0.21	0.32	-0.11	0.21	0.33	-0.12	0.20	0.31	-0.11
Unknown	0.37	0.32	0.05	0.35	0.33	0.02	0.38	0.31	0.07
White									
Less than $3,000	0.49	0.29	0.20	0.55	0.31	0.24	0.43	0.28	0.15
$3,000-$4,999	0.37	0.29	0.08	0.36	0.31	0.05	0.38	0.27	0.11
$5,000-$6,999	0.33	0.29	0.04	0.35	0.31	0.04	0.32	0.27	0.05
$7,000-$9,999	0.27	0.29	-0.02	0.28	0.31	-0.03	0.25	0.28	-0.03
$10,000-$14,999	0.21	0.29	-0.08	0.23	0.31	-0.08	0.18	0.28	-0.10
$15,000 or more	0.21	0.29	-0.08	0.21	0.31	-0.10	0.20	0.28	-0.08
Unknown	0.33	0.29	0.04	0.35	0.31	0.04	0.29	0.28	0.01
Negro									
Less than $3,000	0.49	0.47	0.02	0.47	0.46	0.01	0.50	0.48	0.02
$3,000-$4,999	0.48	0.46	0.02	0.51	0.44	0.07	0.45	0.48	-0.03
$5,000-$6,999	0.46	0.46	0.00	0.46	0.44	0.02	0.46	0.47	-0.01
$7,000-$9,999	0.34	0.46	-0.12	0.31	0.45	-0.14	0.40	0.46	-0.06
$10,000-$14,999	0.33	0.49	-0.16	0.33	0.45	-0.12	0.33	0.52	-0.19
$15,000 or more	0.22	0.49	-0.27	0.31	0.50	-0.19	0.14	0.49	-0.35
Unknown	0.68	0.48	0.20	0.45	0.47	0.02	0.88	0.49	0.39

[1] Includes data for "other races," which are not shown separately.

Table 4. Actual and expected average Periodontal 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		
	Actual	Expected	Difference	Actual	Expected	Difference	Actual	Expected	Difference
All races[1]									
Less than 5 years	0.61	0.31	0.30	0.69	0.33	0.36	0.54	0.30	0.24
5-7 years	0.43	0.32	0.11	0.47	0.33	0.14	0.39	0.30	0.09
8 years	0.35	0.32	0.03	0.35	0.33	0.02	0.34	0.30	0.04
9-11 years	0.36	0.32	0.09	0.35	0.33	0.02	0.36	0.30	0.06
12 years	0.25	0.31	−0.06	0.26	0.33	−0.07	0.24	0.30	−0.06
13-15 years	0.22	0.32	−0.10	0.24	0.32	−0.08	0.20	0.31	−0.11
16 years	0.18	0.31	−0.13	0.21	0.32	−0.11	0.15	0.30	−0.15
17 years or more	0.16	0.31	−0.15	0.15	0.33	−0.18	0.18	0.30	−0.12
Unknown	0.47	0.32	0.15	0.46	0.33	0.13	0.47	0.31	0.16
White									
Less than 5 years	0.61	0.29	0.32	0.70	0.31	0.39	0.52	0.27	0.25
5-7 years	0.41	0.29	0.12	0.46	0.31	0.15	0.37	0.27	0.10
8 years	0.34	0.29	0.05	0.33	0.31	0.02	0.34	0.28	0.06
9-11 years	0.33	0.29	0.01	0.33	0.31	0.02	0.33	0.27	0.06
12 years	0.24	0.29	−0.05	0.25	0.31	−0.06	0.22	0.27	−0.05
13-15 years	0.21	0.29	−0.08	0.23	0.31	−0.08	0.19	0.28	−0.09
16 years	0.18	0.29	−0.11	0.22	0.30	−0.08	0.14	0.28	−0.14
17 years or more	0.16	0.29	−0.13	0.15	0.31	−0.16	0.18	0.27	−0.09
Unknown	0.43	0.29	0.14	0.46	0.31	0.15	0.41	0.28	0.13
Negro									
Less than 5 years	0.62	0.46	0.16	0.66	0.44	0.22	0.59	0.49	0.10
5-7 years	0.47	0.46	0.01	0.49	0.44	0.05	0.44	0.48	0.04
8 years	0.43	0.47	−0.04	0.47	0.45	0.02	0.39	0.50	−0.11
9-11 years	0.46	0.47	−0.01	0.44	0.46	−0.02	0.49	0.47	0.02
12 years	0.35	0.45	−0.10	0.28	0.43	−0.15	0.42	0.47	−0.05
13-15 years	0.55	0.47	−0.12	0.39	0.45	−0.06	0.32	0.48	−0.16
16 years	0.34	0.38	−0.04	0.20	0.40	−0.20	0.60	0.33	0.27
17 years or more	0.34	0.47	−0.13	0.30	0.50	−0.20	0.46	0.32	0.14
Unknown	0.55	0.49	0.06	0.45	0.48	0.03	0.59	0.51	0.08

[1] Includes data for "other races," which are not shown separately.

Table 5. Average Periodontal Index for youths aged 12-17 years, by sex, race, and geographic region: United States, 1966-70

Race and geographic region	Both sexes	Boys	Girls
All races[1]			
Northeast	0.33	0.31	0.34
Midwest	0.26	0.28	0.24
South	0.39	0.39	0.39
West	0.29	0.33	0.26
White			
Northeast	0.31	0.30	0.31
Midwest	0.25	0.27	0.23
South	0.33	0.34	0.32
West	0.29	0.33	0.26
Negro			
Northeast	0.47	0.40	0.52
Midwest	0.35	0.38	0.32
South	0.56	0.55	0.56
West	0.28	0.28	0.29

[1] Includes data for "other races," which are not shown separately.

Table 6. Standard errors of estimates of the number and percent of youths aged 12-17 years, by Periodontal Index and sex: United States, 1966-70

Periodontal Index	Both sexes	Boys	Girls	Both sexes	Boys	Girls
	Number			Percent		
0.0	480	232	258	2.1	2.0	2.3
0.1	179	84	116	0.8	0.7	1.0
0.2	150	81	91	0.7	0.7	0.8
0.3	119	55	88	0.5	0.5	0.8
0.4	109	71	53	0.5	0.6	0.5
0.5	74	56	42	0.3	0.5	0.4
0.6	52	42	28	0.2	0.4	0.3
0.7	34	29	27	0.2	0.3	0.2
0.8	62	31	46	0.3	0.3	0.4
0.9	42	31	35	0.2	0.3	0.3
1.0	25	20	15	0.1	0.2	0.1
1.1	39	20	25	0.2	0.2	0.2
1.2	32	22	22	0.1	0.2	0.2
1.3	22	15	15	0.1	0.1	0.1
1.4	22	16	16	0.1	0.1	0.1
1.5	23	14	16	0.1	0.1	0.1
1.6	21	8	15	0.1	0.1	0.1
1.7	15	12	12	0.1	0.1	0.1
1.8	18	13	12	0.1	0.1	0.1
1.9	13	6	11	0.1	0.1	0.1
2.0	18	14	8	0.1	0.1	0.1
2.1	15	6	10	0.1	0.1	0.1
2.2	10	7	4	0.0	0.1	0.0
2.3	11	6	8	0.1	0.1	0.1
2.4	8	3	7	0.0	0.0	0.1
2.5	10	3	9	0.0	0.0	0.1
2.6	3	-	3	0.0	-	0.0
2.7	8	6	5	0.0	0.1	0.1
2.8	-	-	-	-	-	-
2.9	5	4	3	0.0	0.0	0.0
3.0	4	-	4	0.0	-	0.0
3.1	5	4	3	0.0	0.0	0.0
3.2	20	10	15	0.1	0.1	0.1

[1] Includes data for "other races," which are not shown separately.

Table 7. Standard errors of estimates of the average Periodontal Index for youths, by race, sex, and age: United States, 1966-70

Sex and age	All races[1]	White	Negro
Both sexes			
Total, 12-17 years	0.01	0.01	0.05
12 years	0.02	0.02	0.03
13 years	0.02	0.02	0.03
14 years	0.02	0.02	0.07
15 years	0.02	0.02	0.07
16 years	0.02	0.02	0.05
17 years	0.02	0.02	0.10
Boys			
Total, 12-17 years	0.01	0.02	0.04
12 years	0.02	0.02	0.03
13 years	0.02	0.02	0.03
14 years	0.02	0.02	0.06
15 years	0.02	0.02	0.07
16 years	0.03	0.02	0.08
17 years	0.03	0.03	0.13
Girls			
Total, 12-17 years	0.02	0.02	0.05
12 years	0.02	0.02	0.04
13 years	0.03	0.03	0.05
14 years	0.02	0.01	0.10
15 years	0.03	0.03	0.10
16 years	0.03	0.03	0.08
17 years	0.03	0.03	0.12

[1] Includes data for "other races," which are not shown separately.

Table 8. Standard errors of estimates of the average Periodontal 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
All races[1]			
Less than $3,000	0.03	0.04	0.04
$3,000-$4,999	0.02	0.02	0.03
$5,000-$6,999	0.03	0.03	0.03
$7,000-$9,999	0.02	0.01	0.03
$10,000-$14,999	0.01	0.02	0.02
$15,000 or more	0.02	0.02	0.02
Unknown	0.03	0.03	0.06
White			
Less than $3,000	0.04	0.05	0.04
$3,000-$4,999	0.02	0.02	0.04
$5,000-$6,999	0.03	0.03	0.03
$7,000-$9,999	0.02	0.01	0.03
$10,000-$14,999	0.01	0.02	0.02
$15,000 or more	0.02	0.02	0.02
Unknown	0.03	0.03	0.04
Negro			
Less than $3,000	0.06	0.05	0.08
$3,000-$4,999	0.04	0.06	0.03
$5,000-$6,999	0.15	0.18	0.13
$7,000-$9,999	0.08	0.10	0.09
$10,000-$14,999	0.05	0.05	0.08
$15,000 or more	0.03	0.11	0.10
Unknown	0.13	0.08	0.30

[1] Includes data for "other races," which are not shown separately.

Table 9. Standard errors of estimates of the average Periodontal 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
All races[1]			
None or less than 5 years	0.08	0.08	0.11
5-7 years	0.03	0.04	0.03
8 years	0.03	0.02	0.04
9-11 years	0.02	0.02	0.04
12 years	0.02	0.01	0.02
13-15 years	0.02	0.03	0.02
16 years	0.02	0.03	0.02
17 years or more	0.02	0.01	0.03
Unknown	0.05	0.07	0.06
White			
None or less than 5 years	0.10	0.06	0.15
5-7 years	0.02	0.04	0.03
8 years	0.03	0.03	0.04
9-11 years	0.02	0.02	0.04
12 years	0.02	0.01	0.02
13-15 years	0.01	0.02	0.02
16 years	0.02	0.03	0.02
17 years or more	0.02	0.01	0.03
Unknown	0.05	0.08	0.07
Negro			
None or less than 5 years	0.13	0.18	0.11
5-7 years	0.06	0.07	0.08
8 years	0.06	0.09	0.06
9-11 years	0.05	0.04	0.08
12 years	0.07	0.06	0.09
13-15 years	0.11	0.17	0.13
16 years	0.36	0.23	0.77
17 years or more	0.18	0.16	0.36
Unknown	0.12	0.20	0.11

[1] Includes data for "other races," which are not shown separately.

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

Race and geographic region	Both sexes	Boys	Girls
All races[1]			
Northeast	0.03	0.02	0.04
Midwest	0.03	0.03	0.04
South	0.03	0.03	0.03
West	0.02	0.02	0.02
White			
Northeast	0.02	0.01	0.03
Midwest	0.04	0.03	0.04
South	0.04	0.04	0.04
West	0.02	0.03	0.02
Negro			
Northeast	0.08	0.06	0.10
Midwest	0.03	0.05	0.08
South	0.06	0.06	0.07
West	0.08	0.08	0.10

[1] Includes data for "other races," which are not shown separately.

APPENDIX I

THE DENTAL EXAMINATION

The periodontal disease status of sample youths who participated in the health examinations conducted during 1966-70 was assessed by the Periodontal Index. The procedures for scoring and calculating the index 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 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.

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 made the examination for few sample youths. The number and percent distribution of youths examined by each dentist were as follows:

Examiner	Number of sample youths examined	Percent distribution of sample youths examined
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

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, while the other dentist was absent, the senior dentist completed his examination first, dictating his findings to a trained recorder. Then the other dentist completed his examination, and the senior dentist recorded these findings. Appreciable interexaminer differences as well as ny procedure that diverged from the accepted one were discussed and, if indicated, either resolved or corrected while the sample youth 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 I. 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 I 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 I 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.

Table I. Differences in the Periodontal Index between senior dentists and other dentists on replicate dental examinations and percent distribution of the differences: Health Examination Survey, 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	-	-	-	0.8	-
-0.6	0.7	2.1	-	1.2	-	-
-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	27.7	24.0	33.3	23.0	42.6
0.1	18.4	21.3	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	-	-

APPENDIX II

DEMOGRAPHIC AND SOCIOECONOMIC TERMS

Age.—The age recorded for each youth was the age at last birthday on 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-old group.

Race.—Race was recorded as "white," "Negro," or "other races." "Other races" included American Indian, 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 another race. 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 U.S. 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 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 when a family had its 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 the person 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 neither parent resided 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 where persons receive 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

STATISTICAL NOTES

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 multistage, stratified probability sample of clusters of households in land-based segments. The successive elements of the design are primary sampling unit (PSU), census enumeration district (ED), segment (a cluster of households), household, eligible youths, and, finally, the sample youth.

The 40 sample areas and the segments utilized in the design of Cycle III were the same as those in Cycle II. A previous report describes in detail the sample design used for Cycle II and also discusses 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.[4]

Requirements and limitations placed on the design for Cycle III, similar to those for Cycle II, were that:

1. The target population be defined as the civilian, noninstitutional population of the United States, including Alaska and Hawaii, aged 12 through 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.

2. 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.

3. Ancillary data be collected on specially designed household, medical history, and school questionnaires and from copies of birth certificates.

4. Examination objectives be primarily related to factors of physical and intellectual growth and development.

5. The sample be sufficiently large to yield reliable findings within broad geographic regions and population density groups as well as within age, sex, and limited socioeconomic groups for the total sample.

The sample was drawn jointly with the U.S. Bureau of the Census, starting with the 1960 Decennial Census list of addresses and the nearly 1,900 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, in such a manner as 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 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 9" 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 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 in the sample drawn for a particular location exceeded this figure, 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, time permitting, as were youths deleted from the Cycle III sample who had been examined in Cycle II.

The sample was selected in Cycle III, as it had been in Cycle II, so as to contain the correct proportion of youth 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 that sampled youths 12-17 years without regard to household. The resultant estimated mean measurements or rates should be unbiased, but their sampling variability will be somewhat greater than those from 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 U.S. youths aged 12-17 years. The sample contained youths from 25 different States and approximately 1,000 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 those in the samples as well as the population from which the samples were 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 that describes the plan and operation of Cycle III[2] gives in detail the faithfulness with which the sampling design was carried out.

Data recorded for each sample 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 that increased precision by bringing survey results into closer alignment with known U.S. population figures by race and sex within single years of age from 12 through 17.

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 youths. The probability of selecting an individual youth is the product of the probability of selection at each stage.

Since the strata were 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 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 Cycle III achieved 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. The adjustment 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 for Cycle III), by color and sex for each single year of age 12-17 years. 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 and its appendixes 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 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 that 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 that 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 was used to estimate the standard errors of the correlation coefficients shown in the "Discussion" section.[9]

By the end of the survey of youths, only 11 youths examined 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 that had 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 II. The estimated U.S. population aged 12-17 years by race, sex, and age is shown in table III.

Tests of Significance

Tests of significance for Periodontal Index scores by selected demographic characteristics were performed in one of two ways. The first is to determine 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 1 standard error of the tabulated statistics and that a 95-percent confidence interval

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

Age	All youths	Dental examination given		No dental examination given	
		Boys	Girls	Boys	Girls
Total, 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

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

Age	All races	White		All other	
		Boys	Girls	Boys	Girls
	Number in thousands				
Total, 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

ranges within 2 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, shown in tables 6-10. For example, table 2 shows that the mean PI is 0.46 for Negroes aged 12 years and 0.68 for Negroes aged 17 years, while table 7 indicates that the standard error of Negroes aged 12 is .03 and that of Negroes aged 17 is .10. The formula yields an estimated standard error of the difference ($d = -.22$) of $S_d = .1044$. Thus, as the observed difference is more than twice its standard error, it can be concluded that the mean PI of Negroes aged 12 is significantly lower than that of Negroes aged 17 years.

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 in families with a yearly income of less than $3,000, the difference between the actual and expected mean periodontal scores is 0.20 (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 geographical 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 Values

In tables 3 and 4 the actual mean PI per person is compared with expected estimates. The computation of the expected rates were 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 $\overline{X}_i$. 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 and 9).

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